POLY-CHAR 2023

Conference Handbook

Sunday 22 January – Thursday 26 January
Sir Owen G Glenn Building, The University of Auckland

Contents

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Hosted by: University of Auckland Waipapa Taumata Rau New Zealand

Welcome

It is our great pleasure to welcome you to the 2023 Annual World Forum on Advanced Materials (POLY-CHAR). The conference will run from the 22nd to the 26th of January at the University of Auckland in New Zealand.

POLY-CHAR is a nonprofit, non-governmental organisation devoted to creating a friendly environment for sharing information, establishing student exchange and strengthening international cooperation. We provide an inclusive platform for scientists from all over the world working in the fields of Materials Science; in particular, Polymer Characterization and Polymer Materials Science and Technology. POLY-CHAR is driven by groundbreaking polymer research from synthesis all the way to applications.

An important goal of POLY-CHAR is offering a forum for PhD students and young researchers to create their own scientific networks and experience a vested scientific community. POLY-CHAR will always be committed to improving our world through education and distribution of knowledge.

The activities and structure of POLY-CHAR are determined by the Scientific Committee (SciCom). SciCom is composed of eminent scientists from around the world who are dedicated to the success of POLY-CHAR by making it enjoyable and valuable for everyone. The members of SciCom take an active part in the activities of the organisation and contribute to the expansion and functioning of the organisation and its meetings.

Jean-Marc Saiter
POLY-CHAR President

Holger Schönherr
Deputy President

Michael Hess
Vice President

Sven Henning
Vice President

POLY-CHAR [Auckland] 2023

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Masaru Matsuo – Japan

Alejandro J Müller – Spain & Venezuela

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Chuanliang Feng – China

Archana Bhaw-Luximon – Mauritius

Visit Vao-soongnern – Thailand

Kristina Gusakova – Ukraine

Welcome to the POLY-CHAR [2023] Auckland

Tēnā koutou POLY-CHAR family!

It is my great privilege to be the conference organiser for POLY-CHAR 2023, which will be held right here in Auckland! After lengthy postponement from January 2021, New Zealand is finally ready to welcome you to our shores in January 2023. We have had several fantastic POLY-CHAR conferences over the years: Malaysia, Nepal, Italy and Germany. Now, for the first time, POLY-CHAR is coming to Middle Earth! This event is especially important as we look beyond the horizon towards post-COVID-19 pandemic recovery. As an important aspect of POLY-CHAR tradition, we continue to focus on developing and enhancing valuable friendship and collaborations between students, researchers and polymer industries.

The conference venue will be University of Auckland Business School in the Sir Owen G. Glenn building and will run for a total of five days from Sunday 22nd January to Thursday 26th January. The format will be one full day of workshops, plus four days of technical presentations, with plenty of time to explore the beautiful city of Auckland and enjoy summertime Down Under!

On behalf of the POLY-CHAR [Auckland] 2023 Conference Organising Committee, I wish to thank our generous conference sponsors and supporters. Most importantly, I thank each and every one of our amazing participants for joining us. I greatly look forward to seeing you all here soon.

Nau mai, haere mai!

Professor Jianyong Jin
POLY-CHAR [Auckland] 2023 Chair

POLY-CHAR [AUCKLAND] 2023

Workshops - Sunday 22 January	
0830	**Registration** OGGB Level 0 Foyer
0900	**Opening Remarks** 260-073 / OGGB 4 Lecture Theatre
0915 - 1015	**Workshop 1 Dr Natalie Rudolph (Virtual) - Sponsored by NETZSCH Analyzing & Testing** Thermal Analysis and Rheology in Polymer Additive Manufacturing 260-073 / OGGB 4 Lecture Theatre
1015 - 1030	**Morning Tea Break** OGGB Level 0 Foyer
1030 - 1130	**Workshop 2 Prof Jean-Marc Saiter** What is Science? 260-073 / OGGB 4 Lecture Theatre
1130 - 1230	**Workshop 3 Prof Alejandro J Müller** Polymer Crystallization and its kinetics 260-073 / OGGB 4 Lecture Theatre
1230 - 1300	**Lunch Break** OGGB Level 0 Foyer
1300 - 1400	**Workshop 4 Prof Michael Hess** Rheology and thermal characterization of polymer systems 260-073 / OGGB 4 Lecture Theatre
1400 - 1500	**Workshop 5 Dr Sergej Filippov** Dynamic Light Scattering: basics, rules, and application to polymer science 260-073 / OGGB 4 Lecture Theatre
1500 - 1515	**Afternoon Tea Break** OGGB Level 0 Foyer

1515 - 1615	**Workshop 6 Prof Volker Abetz** Thermodynamics of polymer solutions and blends 260-073 / OGGB 4 Lecture Theatre
1615 - 1715	**Workshop 7 Prof Domagoj Vrsaljko** 3D printing with polymers 260-073 / OGGB 4 Lecture Theatre
	Day 0 Concludes

Day 1 – Monday 23 January	
0730 - 0830	**Registration** OGGB Level 0 Foyer
0830 - 0900	**Powhiri** 260-115 / OGGB Lvl 1 Fisher & Paykel Appliances Auditorium
0900 - 0930	**Welcome Remarks** 260-115 / OGGB Lvl 1 Fisher & Paykel Appliances Auditorium
0930 - 1020	**Plenary Speaker PL01 - Professor Volker Abetz** Paper 58: Self-assembling Block Copolymers as Base Materials for Vitrimers and Membranes: Preparation, Modification and Performance Session Chair - Prof Huanting Wang | OGGB 260-115 / Lvl 1 Fisher & Paykel Appliances Auditorium
1020 -1050	**POLY-CHAR 2023 Group Photograph & Morning Tea Break** OGGB Level 0 Foyer
	POLY-CHAR Showcase 1 Session Chair: Prof Alejandro J. Muller | OGGB 260-115 / Lvl 1 Fisher & Paykel Appliances Auditorium
1050 - 1120	**Showcase Speaker: Cyrille Boyer** Paper 129: Using Living/Controlled Radical Polymerization in 3D printing
1120 - 1150	**Showcase Speaker: Gao Liu** Paper 77: The Application of Conductive Polymers in Lithium Rechargeable Batteries
1150 - 1220	**Showcase Speaker: Moon Jeong Park** Paper 134: Superionic polymer electrolytes with tailored intermolecular interactions
1220 - 1250	**Showcase Speaker: Jiantao (Jason) Xu** Paper 88: Porous Polymer Films Grown from Hydrogel Surfaces: towards Structural and Function Precision of Human Skin
1250 - 1320	**Showcase Speaker: Jadranka Travas-Sejdic** Paper 55: Conducting polymer biointerfaces and applications
1320 - 1400	**Lunch Break** OGGB Level 0 Foyer
1400 - 1450	**Plenary Speaker PL02 - Professor Ben Zhong Tang (Virtual)** Paper 131: Advanced Polymeric Materials Based on AIEgens Session Chair Prof Dennis Smith | 260-073 / OGGB 4 Lecture Theatre

1450 - 1520	**Afternoon Tea Break** OGGB Level 0 Foyer		
Concurrent Session 1: **Advanced synthetic polymer chemistry and polymeric materials** Session Chair: Dr. Yinyin Bao | 260-073 / OGGB 4 Lecture Theatre		**Concurrent Session 2:** **Biological functional polymers and Advanced biomaterials for healthcare and medical use** Session Chair: Prof. Holger Schonherr | 260-092 / OGGB 3 Lecture Theatre	
1520 - 1545	**Keynote Speaker: Yinyin Bao** Paper 22: Charge Transfer Polymers with Color-Tunable Solid-State Emission	1520 - 1545	**Keynote Speaker: Holger Schonherr** Paper 49: Unveiling and Exploiting Thermally-Triggered Changes in Hydration State in LCST Polymer Brushes for Biomedical Applications
1545 - 1600	**Oral Speaker**: Prof Sergey Filippov Paper 95: Beyond classical hydrophilic-hydrophobic amphiphiles: triblock poly(2-oxazoline)s with a fluorinated block as a new platform for self-assembly	1545 - 1600	**Oral Speaker: Dr Filippo Pierini** Paper 23: Light-activated polymeric nanomaterials: from nature-inspired biomaterials to smart multifunctional face masks
1600 - 1615	**Oral Speaker:** Dr Ricardo Manríquez-González Paper 24: Chemical functionalization of cellulose and silica materials with ionic moieties: synthesis, characterization and applications	1600 - 1615	**Oral Speaker: Beata Kaczmarek-Szczepańska** Paper 60: The physicochemical and antibacterial properties of chitosan-based materials modified with phenolic acids irradiated by UVC light
1615 - 1640	**Keynote Speaker: Feng Wang (Virtual)** Paper 71: Cooperative Supramolecular Polymerization of π-Conjugated Systems	1615 - 1630	**Oral Speaker: Kawaljit Kaur** Paper 87: Towards spatially Targeted Eradication of Antimicrobial-resistant Bacteria: Novel Polymer-based Antimicrobial Photodynamic Therapy
1640 - 1705	**Keynote Speaker: A/Prof Anchao Feng (Virtual)** Paper 84: Preparation of PVC block copolymers via RAFT polymerization and their applications as PVC based additives	1630 - 1655	**Keynote Speaker: Guangfeng Li (Virtual)** Paper 103: Construction and Mechanical Properties of Woven Polymer Networks
1700 - 1900	**Welcome Reception** OGGB Level 1 Atrium		
	Day One Concludes		

Day 2 – Tuesday 24 January	
0730 - 0900	**Registration** OGGB Level 0 Foyer
0730 - 0900	**Breakfast Poster Session** OGGB Level 0 Foyer

Suman Kumar Ghosh
Paper 6: Carbonaceous Nanofillers Based Thermoplastic Elastomeric Blend Composites to Mitigate Radiation Pollution in X-band
Krishnendu Nath
Paper 13: Facile preparation of light-weight biodegradable and electrically conductive polymer-based nanocomposites for superior electromagnetic interference shielding effectiveness
Sebastian Balser
Paper 21: Preparation and Characterization of Highly Conductive and Biorepulsive Polypyrrole/Polyglycerol Surface Films
Mathias Rößling
Paper 27: Investigation of the efficiency of polyethyleneimines modified with coordinating groups for the removal of corrosions products from aluminium surfaces
Hyuong Joon Jin
Paper 33: Decomposition behavior of aliphatic polyesters under accelerated conditions for waste plastic treatment
Maicon Bertin
Paper 43: Imaging the Molecular Orientation at the Disperse-Continuous Interface of a PP-PA6 blend by the Four-Polarization FTIR Method
Patrick Imrie
Paper 44: Direct-ink-write 3D printing of "living" polymer hydrogels via type I photoinitiated RAFT polymerization
Chris Bainbridge
Paper 46: Novel Transformations in RAFT-based Living Polymer Networks
Haiyi Xie
Paper 59: Proton and Redox Couple Synergized Aqueous Electrolytes for Low Voltage-Driven Amorphous WO3 Electrochromic Devices

Devon Bryant
Paper 81: Novel conducting polymer sensor for the detection and analysis of biothiols
Lukasz Jakubski and Justyna Lipus
Paper 83: Synergistic effect of the combination of magnetite and molecular magnet for ethanol dehydration via pervaporation
Sven Henning
Paper 86: Comparative study of bulk and thin film morphology of multigraft (PS-g-PI) copolymer blends by Atomic Force Microscopy
Laksmi Mukundan
Paper 93: Polycaprolactone encrusted bioactive glass antibiotic nanohybrid through drug mediated surface initiated polymerization: an overcoat approach for modulated burst release
Mahdieh Ghofran
Paper 99: Towards the methylation analysis of heparan sulfates
Vanessa Picoli
Paper 105: Palygorskite/polymer nanocomposites as drilling fluids additives
Olga Grygoryeva
Paper 109: Polycyclotrimerization of cyanate ester resin. Effect of boron nitride filler
Pawel Grzybek
Paper 119: Alginate composite membrane filled with silver and nickel nanowires – characteristic and application in pervaporation dehydration of ethanol
Liam Van Mechelen
Paper 135: Harakeke Reinforced Furan Bio-Composites
Danny McDougall
Paper 145: What makes mussels stick?

0900 - 0950	**Plenary Speaker PL03 - Professor Vincent Craig** Paper 113: Re-entrant swelling and redissolution of polyelectrolytes at high salt concentrations: The role of underscreening Session Chair: Prof Julian Zhu | 260-073 / OGGB 4 Lecture Theatre

	POLY-CHAR Showcase 2 Session Chair: Dr Jianyong Jin | 260-073 / OGGB 4 Lecture Theatre		
0950 - 1020	**Showcase Speaker: Suwabun Chirachanchai** Paper 130:Tailoring Chitosan Bio/smart Materials via Water-based System		
1020 - 1050	**Showcase Speaker: Dennis Smith** Paper 63: Synthesis and Multi-Mechanistic Characterization of Fluoropolymers and High Yield Carbon Precursor Networks.		
1050 - 1120	**Morning Tea Break** OGGB Level 0 Foyer		
Concurrent Session 3: **Advanced synthetic polymer chemistry and polymeric materials** Session Chair: Dr Gao Liu | 260-073 / OGGB 4 Lecture Theatre		**Concurrent Session 4:** **Biological functional polymers and Advanced biomaterials for healthcare and medical use** Session Chair: Dr Changkui Fu | 260-092 / OGGB 3 Lecture Theatre	
1120 - 1145	**Keynote Speaker: Chunye Xu** Paper 75: Investigation on Electrochromism of Transparent to Black Transition via Different Path	1120 - 1145	**Keynote Speaker: Mario Gauthier** Paper 10: Arborescent polypeptides based on poly(γ-benzyl L-glutamate) for drug delivery applications
1145 - 1210	**Keynote Speaker: Cheng Zhang** Paper 80: A Versatile and Scalable Strategy to Functional Polymers with Controlled Structures	1145 - 1200	**Oral Speaker: Mr Xumin Huang** Paper 89: Polymer-assisted Transformable Magnetic Nanohybrids for T1/T2 Switchable MR Imaging
1210 - 1225	**Oral Speaker:** Mr Chris Bainbridge Paper 47: Living Polymer Networks	1200 - 1215	**Oral Speaker: Miss Jaidene Parks** Paper 138: Bismuth (III) complexes of maltol analogues and their application as antimicrobial ring-opening polymerisation catalysts
1225 - 1250	**Keynote Speaker: Vinh Truong (Virtual)** Paper 9: Programming Soft Matter Materials with Light	1215 - 1240	**Keynote Speaker: Marija Gizdavic-Nikolaidis** Paper 16: Fast and facile enhanced eco-friendly microwave synthesis of antibacterial polyaniline/chitosan based composites
1250 - 1700	**Lunch and Excursion to Muriwai** Assembly at OGGB Level 0 Foyer		
1800 - 2300	**POLY-CHAR International Scientific Committee** Old Government House		
	Day Two Concludes		

Day 3 – Wednesday 25 January			
0800 - 0830	**Registration** OGGB Level 0 Foyer		
0830 - 0920	**Plenary Speaker PL04 - Professor Martina Stenzel** Paper 142: Glycopolymers for Drug Delivery: Opportunities and Challenges Session Chair: Prof Jadranka Travas-Sejdic | 260-073 / OGGB 4 Lecture Theatre		
	POLY-CHAR Showcase 3 Session Chair: Prof Cyrille Boyer | 260-073 / OGGB 4 Lecture Theatre		
0920 - 0950	**Showcase Speaker: Changkui Fu** Paper 32: Sulfoxide Polymers: A New Class of Low-Fouling Polymers for Biological Applications		
0950 - 1020	**Showcase Speaker: Zhongfan Jia** Paper 118: Electrochemistry of radical polymer gels and polyelectrolytes		
1020 - 1050	**Showcase Speaker: Dr Ruirui Qiao (Virtual)** Paper 34: Functionalization of Metal-based Inorganic Nanoparticles with RAFT Polymer for Biomedical Applications		
1050 - 1120	**Morning Tea Break** OGGB Level 0 Foyer		
Concurrent Session 5: Polymers for additive manufacturing (3D/4D printing) and other processing technologies Session Chair: Prof Domagoj Vrsaljko | 260-055 / Case Room 3	**Concurrent Session 6: Nanomaterials and Smart Materials** Session Chair: Prof Sven Henning | 260-073 / OGGB 4 Lecture Theatre	**Concurrent Session 7: Polymer physics and characterisation, rheology, modelling and simulation, bulk and surface analysis** Session Chair: Marian Fatou-Gomez | 260-092 / OGGB 3 Lecture Theatre	**Concurrent Session 8: Polymers and environmental sustainability: Polymer recycling, biodegradable polymers, Ocean plastic reduction, Environmental Improvements and Solutions** Session Chair: Prof Paul Kilmartin | 260-057 / Case Room 2

1120 - 1145	**Keynote Speaker: Domagoj Vrsaljko** Paper 40: Effect of 3D printing settings and post-processing conditions on polyacrylate materials used in stereolithography	1120 - 1145	**Keynote Speaker: Sven Henning** Paper 85: Electrospun hybrid nanofibers: Morphology, micromechanics, and properties	1120 - 1145	**Keynote Speaker: Araceli Flores (Virtual)** Paper 61: Understanding indentation creep in polymer materials. The new case of sustainable crosslinked polyurethane adhesives	1120 - 1145	**Keynote Sepaker: Prof Suprakas Sinha Ray** Paper 65: Development of Polylactide-based Sustainable Materials for Durable Applications
1145 - 1200	**Oral Speaker:** Dr Liwen Zhang Paper 54: Gallium Liquid Metal Nanoparticles Mediated 3D and 4D Printing	1145 - 1200	**Oral Speaker:** Prof You-lo Hsieh Paper 64: Functionalized nanocelluloses for advanced materials and applications	1145 - 1210	**Keynote Speaker: Alejandro J. Muller** Paper 127: Recent Applications of the Successive Self-nucleation and Annealing (SSA) Thermal Fractionation Technique	1145 - 1200	**Oral Speaker:** Dr Peter Shuttleworth Paper 122: Natural polymer derived mesoporous structures regulated via temperature control and nanocomposite addition
1200-1215	**Oral Speaker:** Mr Kyle Engel Paper 7: The Additive Manufacturing of Ionically Conductive Polymer Artificial Muscles	1200 - 1225	**Keynote Speaker: Yu Jin Jang (Virtual)** Paper 104: Chiral Inorganic Nanostructures from Achiral Platforms: A Universal Synthesis Route via Supramolecular Self-Assembly	1210 - 1225	**Oral Speaker:** Prof Jean-Marc Saiter Paper 137: Rheological Behavior And Microstructural Study of A Ready-To-Use Therapeutic Food	1200 - 1215	**Oral Speaker:** Prof Paul Kilmartin Paper 8: Gelatin-based active and intelligent packaging incorporating grape skin and seed tannins

Day 3 – Wednesday 25 January (continued)							
1215 - 1230	**Oral Speaker:** Mr Mohammad Sagor Hosen Paper 28: Additive manufacturing of a recycled semi-crystalline polymer: Structure-property-printability correlations for PET	1225 - 1250	**Keynote Speaker: Hailong Che (Virtual)** Paper 91: Formation and characterization of bowl-shaped polymer vesicles and their applications as nanomotor system	1225 - 1250	**Keynote Speaker: Mehrdad Neganban** Paper 67: Multiple-traversing of the glass transition in amorphous polymers: Modeling the story of polycarbonate	1215 - 1240	**Keynote Speaker: Prof Rui Yang (Virtual)** Paper 39: How to quickly determine degradation rates of polymer materials?
1230 - 1245	**Oral Speaker:** Ms Keemi Lim Paper 36: Study the Interactions of POM Based Binder System for Titanium Metal Injection Moulding (Ti-MIM)	1250 - 1315	**Keynote Speaker: Qiang Yan (Virtual)** Paper 79: Shaping Polymer Self-Assemblies by Gas via Frustrated Lewis Polymers	1250 - 1305	**Oral Speaker:** Mr Weihan Wang (Virtual) Paper 25: Application of viscoelastic polymer in wave isolation of stiffened panels	1240 - 1255	**Oral Speaker:** Dr. Juan F. Vega Paper 52: The key role of polymeric interactions in the eco-design of mechanically recyclable multilayers
1300 - 1350	**Lunch Break** OGGB Level 0 Foyer						
1350 - 1440	**Plenary Speaker PL05 - Professor Yongfang Li (Virtual)** Paper 48: Polymerized small molecule acceptors for high performance all-polymer solar cells Session Chair: Prof. Jiun-Tai Chen | 260-073 / OGGB 4 Lecture Theatre						
1440 -1510	**Afternoon Tea Break** OGGB Level 0 Foyer						

Concurrent Session 9: Advanced synthetic polymer chemistry and polymeric materials Session Chair: Dr Changkui Fu | 260-073 / OGGB 4 Lecture Theatre		**Concurrent Session 10: Polymers and Environmental sustainability: Polymer recycling, biodegradable polymers, Ocean plastic** Session Chair: Prof Suwabun Chirachanchai | 260-055 / Case Room 3		**Concurrent Session 11: Porous polymers for separation membrane and gas adsorption** Session Chair: Prof Huanting Wang | 260-057 / Case Room 2		**Concurrent Session 12: Polymer physics and characterisation, rheology, modelling and simulation, bulk and surface analysis** Session Chair: Prof Greg Russell | 260-092 / OGGB 3 Lecture Theatre	
1510 - 1525	**Oral Speaker:** Mr Bo Zhang (Virtual) Paper 133: Synthesis and Semiconducting Properties of π-Conjugated Polymers Containing Resonance Assisted Hydrogen Bonds	1510 - 1525	**Oral Speaker:** Nethmie Jayasooriya Paper 102: Cellulose from Macroalgae Cultivated in Municipal Wastewater	1510 - 1535	**Keynote Speaker: Huanting Wang** Paper 66: Polymer composite membranes for molecular separations	1510 - 1525	**Oral Speaker:** A/Prof Paul Joseph Paper 56: A preliminary investigation of the tacticity of some chain-growth polymers obtained through radial routes using high-field NMR spectroscopy
1525 - 1540	**Oral Speaker:** Eyal Zussman Paper 74: An electric field-driven one-dimensional assembly of polyelectrolyte complexes	1525 - 1540	**Oral Speaker:** Sven Henning Paper 121: Biomass-based and compostable polymer composites: Structure-properties correlations	1535 - 1550	**Oral Speaker:** Mr Sheung Yin Li Paper 96: Permeate flux control of a conductive membrane through redox switching	1525 - 1550	**Keynote Speaker: Xia Dong (Virtual)** Paper 92: Effect of Hydrogen-Bonding Organization on Crystal Form Transition of PA1012 and Its Block Copolymers

Day 3 – Wednesday 25 January (continued)							
1540 - 1605	**Keynote Speaker: Zvonimir Katancic** Paper 20: Development of poly(3,4-ethylenedioxythiophene) based stretchable conductive polymers for flexible electronics	1540 - 1555	**Oral Speaker:** Mr Patakorn Pilasen Paper 144: Thermoplastic Starch Vitrimer through Thermoreversible Diels-Alder	1550 - 1605	**Oral Speaker:** Prof Ildoo Chung Paper 76: Biodegradable porous microspheres by UV irradiation	1550 - 1605	**Oral Speaker:** Prof Greg Russell Paper 73: Refinement of SEC Analysis – The Final Frontier for Determination of Propagation Rate Coefficients in Radical Polymerization?
1605 - 1620	**Oral Speaker:** Alexander Fainleib (Virtual) Paper 17: Extra high temperature resistant polymer nanocomposites from thermoreactive CΞN-containing resins	1555 - 1610	**Oral Speaker:** Miss Supattra Khemlek Paper 140: Thermoresponsive Catalyst Microcapsules for Tailoring PLA Biodegradability	1605 - 1620	**Oral Speaker:** Dr Yen Truong Paper 143: Polyvinyl alcohol-graphene oxide membranes for removing microbial and chemical contaminants from wastewater	1605 - 1620	**Oral Speaker:** Dr Amirah Amalina Ahmad Tarmizi Paper 14: Dielectric Investigation at Different Temperature Values on a Ready to Use Therapeutic Food Material Composed of Lipids
1620 - 1635	**Oral Speaker:** Dr Kristina Gusakova (Virtual) Paper 108: Microporous cyanate ester resins: effect of boron nitride content	1610 - 1625	**Oral Speaker:** Dr Natasa Tomic Paper 26: The enhancement of ionic conductivity of PVA based hydrogels by the addition of natural hydrocolloids as self-healing electrolytes	1620 - 1635	**Oral Speaker:** Mr Steven Wu Paper 97: Effect of processing conditions on suspension polymerization reaction of molecularly imprinted adsorption media	1620 - 1645	**Keynote Speaker: Weichao Shi (Virtual)** Paper 45: Phase transitions at liquid-liquid interfaces

1635 - 1700	**Keynote Speaker: Jie Zhang (Virtual)** Paper 57: Biomimic Self-assembly of Amphiphilic Helical Poly(phenylacetylene)s	1625 - 1650	**Keynote Speaker: Guangjie Song (Virtual)** Paper 70: Structure regulation and properties of cellulose materials under external fields	1635 - 1650	**Oral Speaker:** Alessio Giove Paper 69: Design of an original Ni(II) ion imprinted polymer for highly selective remediation of Ni(II) ions in acidic and neutral solutions	1645 - 1700	**Oral Speaker:** Atsushi Kajwara Paper 101: Direct Observation of Active Species in Radical Polymerizations using Electron Spin Resonance (ESR/ EPR) Spectroscopy in Higher Sensitivity
1800 - 2300	**POLY-CHAR 2023 Conference Dinner** Hilton Auckland | Princes Wharf						
Day Three concludes							

Day 4 – Thursday 26 January			
0830 - 0900	**Registration** OGGB Level 0 Foyer		
Concurrent Session 13: **Advanced polymeric networks** Session Chair: Mr Chris Bainbridge | 260-073 / OGGB 4 Lecture Theatre		**Concurrent Session 14:** **Polymers and Environmental sustainability: Polymer recycling, biodegradable polymers, Ocean plastic reduction, Environmental Improvements and Solutions** Session Chair: Patrick Imrie | 260-092 / OGGB 3 Lecture Theatre	
0900 - 0915	**Oral Speaker:** Andrey Shibaev Paper 110: Synthesis and rheological properties of self-healing magnetic hydrogels with anisotropic nanoparticles	0900 - 0915	**Oral Speaker:** Mr Nattapat Vivattanasan Paper 139: Branching PLA with Aniline Pentamer: An Approach to Develop Antistatic Biodegradable Packaging
0915 - 0930	**Oral Speaker:** Andrey Shibaev Paper 107: Reversible cross-linking of microgels into a macrogel by dynamic bonds	0915 - 0930	**Oral Speaker:** Prof Marian Gomez_Fatou Paper 50: Searching solutions for multilayered packaging recycling: dual modification of the polyurethane adhesive
0930 - 0945	**Oral Speaker:** Mr Chris Bainbridge Paper 38: RAFT-based Networks as a 4D Polymer Platform	0930 - 0945	**Oral Speaker:** Mr Ringo Leung Paper 53: Characterization of PET-co-PCL synthesized using catalytic transesterification
0945 - 1010	**Keynote Speaker: Chuan-Liang Feng 传良 冯 (Virtual)** Paper 128: Bioinspired Supramolecular Chiral hydrogels	0945 - 1000	**Oral Speaker:** Andriy Voronov Paper 125: Sustainable Polymers and Polymeric Materials based on Plant/Vegetable Oils
1010 - 1040	**Morning Tea Break** OGGB Level 0 Foyer		
	POLY-CHAR Showcase 4 Session Chair: Prof Jiantao (Jason) Xu | 260-115 / OGGB Lvl 1 Fisher & Paykel Appliances Auditorium		
1040 - 1110	**Showcase Speaker: Costas Patrickios** Paper 94: Model Amphiphilic Polymer Conetworks with Large Domain Size & Long-range Ordering Based on Inverse Pluronics: Synthesis & Characterization		
1110 - 1140	**Showcase Speaker: Qiang Fu** Paper 37: Nanoengineered membrane materials of energy and environmental applications		

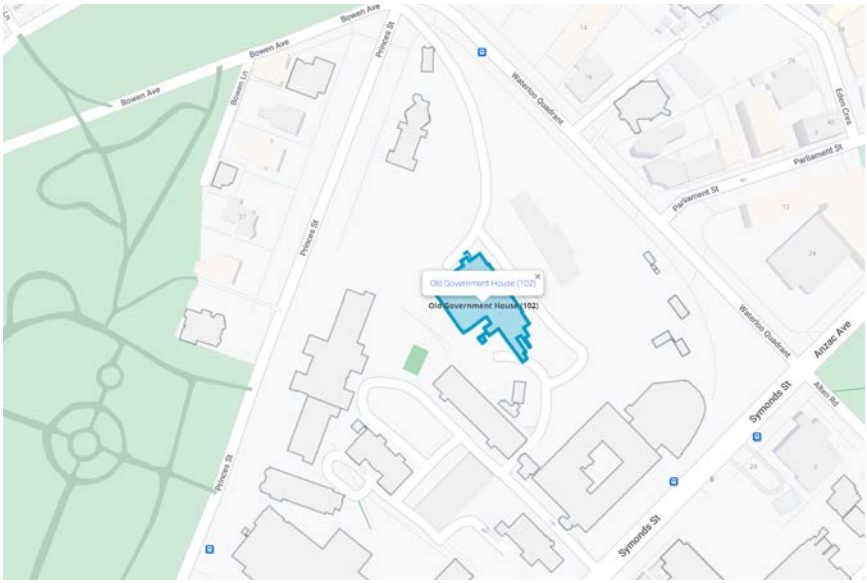
1140 - 1230	**Plenary Speaker PL06 - Dr Jian Ping GONG (Virtual)** Paper 141: Challenges and Opportunities of Hydrogels Session Chair: Dr Qiang Fu | 260-115 / OGGB Lvl 1 Fisher & Paykel Appliances Auditorium
1230 - 1340	**Lunch Break** OGGB Level 0 Foyer
1340 -1430	**Plenary Speaker PL07 - Professor Bin Liu (Virtual)** Paper 136: Organic nanoparticles for sensing, imaging, and therapy Session Chair: Prof Simon Hinkley | 260-115 / OGGB Lvl 1 Fisher & Paykel Appliances Auditorium
1430 - 1500	**Afternoon Tea Break** OGGB Level 0 Foyer
	POLY-CHAR Showcase 5 Session Chair Prof Costas Patrickios | 260-115 / OGGB Lvl 1 Fisher & Paykel Appliances Auditorium
1500 - 1530	**Showcase Speaker: Simon Hinkley** Paper 100: Heparan sulfate, the next polymer paradigm in therapeutics
1530 - 1600	**Showcase Speaker: Julian Zhu** Paper 30: Two-way Reversible Shape-Memory Polymers
1600 - 1630	**Showcase Speaker: Jiun-Tai Chen** Paper 90: Polymer Nanomaterials Using Porous Templates
1630 - 1700	**Conference Awards and Wrap up** 260-115 / OGGB Lvl 1 Fisher & Paykel Appliances Auditorium
	Day Four POLY-CHAR 2023 concludes

Conference Venue

Sir Owen G Glenn Building (OGGB)
University of Auckland
Business School
12 Grafton Road
Auckland CBD

Access the car park via Grafton Road, opposite Stanley Street. The building is mobility and wheelchair accessible.

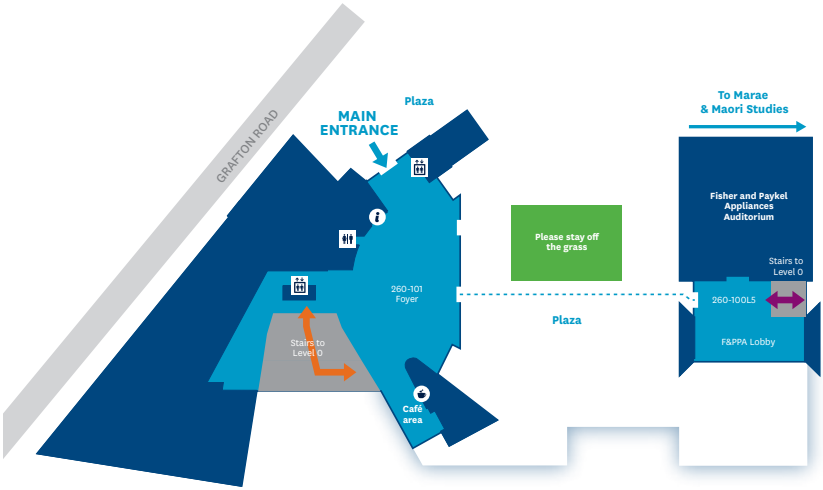
Use the Journey Planner of the Auckland Transport website for nearest bus, train and ferry stations. Check landmarks nearby using maps available online.



International Scientific Committee Meeting:
Old Government House, 24 Princes Street, Auckland CBD
450m from OGGB | 6mins walk

Conference Dinner Venue:
Hilton Auckland, Princes Wharf, 147 Quay Street, Auckland CBD
2.2km from OGGB | 25-35 mins leisure walk

OGGB Floor Map Level 1



OGGB Floor Map Level 0

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SCIENCE SCHOOL OF CHEMICAL SCIENCES

Presenters

Plenary speakers

Prof. Yongfang Li

Professor in Institute of Chemistry, Chinese Academy of Sciences (ICCAS) and in Soochow

Yongfang Li is a professor in Institute of Chemistry, Chinese Academy of Sciences (ICCAS) and in Soochow University. He received his Ph. D. degree in department of Chemistry from Fudan University in 1986, then did his postdoctoral research at ICCAS from 1986 to 1988. He became a staff in 1988 and promoted to professor in 1993 in ICCAS. He did his visiting research in Institute for Molecular Science, Japan from 1988.10. to 1991.

Prof. Ben Zhong Tang

Center for Aggregation-Induced Emission, State Key Laboratory of Luminescent Materials and Devices, South China University of Technology, Guangzhou, China

Hong Kong Branch of Chinese National Engineering Research Center for Tissue Restoration and Reconstruction and Department of Chemistry, The Hong Kong University of Science and Technology, Hong Kong, China.

Ben Zhong Tang is Stephen K. C. Cheong Professor of Science, Chair Professor of Chemistry, and Chair Professor of Chemical and Biological Engineering at The Hong Kong University of Science and Technology (HKUST). Tang received B.S. and Ph.D. degrees from South China University of Technology and Kyoto University, respectively. He conducted postdoctoral research at University of Toronto. He joined HKUST as an assistant professor in 1994 and was promoted to chair professor in 2008. Tang has published >1,400 papers.

Prof. Martina Stenzel

University of New South Wales, Australia

Martina Stenzel studied chemistry at the University of Bayreuth, Germany, before completing her PhD in 1999 at the Institute of Applied Macromolecular Chemistry, University of Stuttgart, Germany. She started as a postdoctoral fellow at UNSW in 1999 and is now a full Professor in the school of chemistry as well as co-director of the Centre for Advanced Macromolecular Design (CAMD).

Her research interest is focused on the synthesis of functional nanoparticles for drug delivery applications. Martina Stenzel published more than 300 peer reviewed papers mainly on polymer and nanoparticle design.

She is scientific editor of Materials Horizons and serves currently on a range of editorial boards. She received a range of awards including the 2011 Le Fèvre Memorial Prize of the Australian Academy of Science. Martina Stenzel is currently chairing the National Chemistry Committee of the Australian Academy of Science and she is also a Fellow of the Academy.

Prof. Jian Ping Gong

Distinguished Professor, Faculty of Advanced Life Science, Laboratory of Soft & Wet Matter at Hokkaido University

Jian Ping Gong obtained her bachelor's degree in electronic physics from Zhejiang University, China, and received her Master's degree in polymer science from Ibaraki University, Japan. She studied high Tc superconductors at the Tokyo Institute of Technology for two years where she earned her Doctor of Engineering. She has been working on polymer science since 1993 at Hokkaido University, and received her Doctorate of Science in polymer sciences. She has received various scientific awards, including the Chemical Society of Japan (CSJ) Award in 2022, the MEXT Commendation for Science and Technology in 2019, the DSM Materials Sciences Award 2014, and The Award of the Society of Polymer Science, Japan in 2006. She also serves on the editorial and advisory boards of the Biointerphases, Asia Materials, Soft Matter, Mechanics of Soft Materials, Advanced Materials, and Materials Horizons. She served as Director of Global Station for Soft Matter, GI-Core from April, 2016 until March, 2019. She has been serving as PI for WPI-ICReDD since October, 2018 and International Advisory Board for DoDyNet since 2019. She focuses on the study of physical and biological properties of soft and wet matters.

Prof. Liu Bin

National University of Singapore

Professor Liu Bin, Provost's Chair, was appointed Vice President (Research and Technology) at the National University of Singapore (NUS) on 1 September 2019. She has been the Head of the Department of Chemical and Biomolecular Engineering since July 2017.

Liu Bin graduated with a bachelor's and master's degree from Nanjing University, and PhD in Chemistry from NUS. She had postdoctoral training at the University of California at Santa Barbara. She joined NUS as an Assistant Professor in 2005, and was promoted to full Professorship in 2016.

Liu Bin is a leader in the field of organic functional materials, who has been well-recognised for her contributions in polymer chemistry and applications of organic nanomaterials for biomedical research, environmental monitoring and energy devices. She is named among the World's Most Influential Minds and the Top 1% Highly Cited Researchers in Materials Science by Thomson Reuters and Clarivate Analytics. She is a prolific researcher with over 350 publications and holds 30 patents with 16 of them licensed to different companies in US, UK and Asia. In 2014, she co-founded Luminicell, an NUS spin-off company that produces organic luminescent nanoparticles for use in medical and biological applications.

Liu Bin has an impressive list of accolades to her name, including the National Science and Technology Young Scientist Award 2008, L'Oréal Women in Science National Fellowship in 2011 and the 2016 President's Technology Award. Most recently, she was awarded the prestigious 2019 American Chemical Society ACS Nano Lectureship Award, which honors three award recipients from around the world who have significantly impacted the fields of nanoscience and nanotechnology.

Liu Bin is a Fellow of the Singapore Academy of Engineering, Asia Pacific Academy of Materials, and Royal Society of Chemistry. She serves on the editorial advisory boards of more than a dozen top peer-reviewed chemistry and materials journals. Since 2019, she serves as the Deputy Editor to launch and develop ACS Materials Letters, a flagship materials journal of the American Chemical Society. She is passionate about nurturing the next generation research leaders and encouraging more women to pursue careers in science and engineering.

Prof. Volker Abetz

Director of the Institute of Membrane Research at Helmholtz-Zentrum Hereon

Prof. Abetz is Director of the Institute of Membrane Research at Helmholtz-Zentrum Hereon and head of a working group in Physical Chemistry at University of Hamburg. He worked on spectroscopic polarimetry of polymer systems and received his degrees Dipl. chem. (1987) and Dr. rer. nat. (1990) under the supervision of Prof. Reimund Stadler. 1988/1989 he was a visiting scholar in the Department of Chemical Engineering at Stanford University in the group of Prof. Gerald G. Fuller. From 1990 to 1993 he stayed at the Max-Planck-Institut für Polymerforschung in Mainz, where he worked on structure and dynamics of polymer blends in the department Physics of Polymers (group of Prof. Erhard W. Fischer). 1993/1994 he worked at the École d'Applications des Hauts Polymères at l'Université Louis Pasteur in Strasbourg on interpenetrating polymer networks in the group of Prof. Guy C. Meyer, 1994-1997 he worked on block copolymers at the Johannes Gutenberg-Universität Mainz (Institute of Organic Chemistry, Prof. Reimund Stadler), 1997-2004 he continued the works on morphological properties of block copolymers at the Universität Bayreuth (Chair of Macromolecular Chemistry II, Prof. Reimund Stadler (until 1998), Prof. Axel. H.E. Müller (1999-2004), habilitation in 2000). In 2004 he became a Professor for Polymer Chemistry at the Universität Potsdam and at the Faculty of Technology at the Christian-Albrechts-Universität zu Kiel.

Prof. Vincent Craig

Department of Applied Mathematics at the Australian National University

Prof. Vincent Craig leads the colloids group in the Department of Applied Mathematics at the Australian National University. He completed both his B.Sc. (Honours in Chemistry in 1992) and Ph.D. degrees (jointly in Applied Maths and Chemistry in 1997) at the ANU before postdoctoral positions at UC Davis, California and the University of Newcastle, NSW.

He was awarded an ARC Postdoctoral fellowship in 1998, an ARC Research Fellowship in 2001 and an ARC Future Fellowship in 2009. His research contributions are in a number of areas including surface force measurement where he has extended the range of materials that can be studied and has made significant contributions to our understanding of the influence of roughness, our understanding of the forces between hydrophobic surfaces and boundary slip. In the field of surfactant adsorption he has revealed that the kinetics of surfactant adsorption can be very slow when aggregates are present on the surface but not in bulk. In his studies on electrolytes he has described and codified the effect of ions on bubble coalescence and demonstrated the existence of the fundamental ion.

Showcase presenters

Prof. Cyrille Boyer received his PhD from the University of Montpellier II in collaboration with Solvay-Solexis for the preparation of new adhesives. After working in collaboration with Dupont Performance Elastomers, he joined the University of New South Wales in the School of Chemical Engineering. In 2009, he was awarded an Australian Research Council Fellowship. In 2012, Cyrille has been awarded an Australian Research Council - Future Fellowship. In January 2017, Cyrille has been promoted as full Professor and co-Director of Australian Centre for Nanomedicine. He also serves as Deputy Head of School. In 2022, he was awarded an ARC - Australian Laureate Fellowship. Cyrille's research interests mainly cover the preparation of functional macromolecules, where he develops new polymerization techniques using photocatalysts. These macromolecules find applications in various areas, including in nanomedicine and in energy storage. The research of his group has been recognized by several research awards, including 2018 IUPAC-Polymer International Young Researcher award, 2016 ACS Biomacromolecules/ Macromolecules Young Researcher Awards, 2016 Journal of Polymer Science Innovation Award, Le Fevre Memorial Prize for Chemistry; and 2015 Malcolm McIntosh Prize for Physical Science (one of the six Prime Minister Prize).

Dr. Gao Liu is a Senior Scientist and Group Leader of the Applied Energy Materials Group at Lawrence Berkeley National Laboratory, a Fellow of the Electrochemical Society and a Fellow of the Royal Society of Chemistry. Dr. Liu has over 20 years of experience in developing materials and system engineering for electrical energy storage. Liu's research combines synthetic chemistry, composite engineering and electrochemistry to solve interdisciplinary problems in energy generation, storage and usage. The Dr. Liu's lab uses advanced diagnostics to understand fundamental and critical issues in energy systems, and synthetic techniques to develop new materials that improve overall system performance. Dr. Liu pioneered the multifunctional conductive polymer adhesive research. Dr. Liu's electrode binder research contributes to the fundamental understanding of behaviors of the polymeric binder in the composite electrode, and leads to rational design of functional electrode binders for new storage chemistries. Dr. Liu's on-going researches in energy storage cover electrode binder, silicon, sulfur and lithium metal materials, electrode engineering, electrolytes and additives, and solid-state conductors. Besides energy storage research, Dr. Liu also performs materials and engineering research in building resiliency, circular economy, and advanced manufacturing. Dr. Liu has over 190 peer-reviewed publications and over 20 granted patents.

Prof. Moon J. Park is a Full Professor of Department of Chemistry at Pohang University of Science and Technology, South Korea. She is also an Adjunct Professor of School of Integrated Technology at Yonsei University, South Korea. She earned her B.S and Ph.D. in Chemical Engineering from Seoul National University. She was a Postdoctoral Fellow at UC Berkeley. Her research focuses on elucidating the interplay of morphology and transport in nanostructured charged polymer materials based on a fundamental understanding of molecular interactions. Her recent interests include the development of new ion-containing polymeric materials that are more efficient, predictable, and sustainable for energy storage and transport. Recent recognitions include the 2022 American Physical Society DPOLY Fellow, 2017 American Physical Society Dillon Medal, and 2016 IUPAC Young Polymer Scientist Award, and 2016 Young Scientist Award of Ministry of Science of Korea. She was also selected as the 15th Female Scientist and Engineer of the Year Award of Korea.

Prof. Julian X.X. Zhu is a professor of chemistry at University of Montreal. He holds the Canada Research Chair in Polymeric Biomaterials. His team works on the research and development of new polymers for biomedical and pharmaceutical applications, including degradable polymers, hydrogels, drug delivery systems and dental composites. His primary interests focus on the use of natural compounds for the preparation of novel polymeric materials with green chemistry approaches. He is a co-author of over 290 scientific publications and several patents. He also received the Macromolecular Science and Engineering Award from the Chemical Institute of Canada.

Showcase presenters

Prof. Jadranka Travas-Sejdic is a Professor at the School of Chemical Sciences, The University of Auckland. She is Director of the Polymer Biointerface Centre at The University of Auckland and a Principal Investigator of the New Zealand Centre of Research Excellence – MacDiarmid Institute for Advanced Materials and Nanotechnology. Her research interests are in the areas of biosensors, nanostructured conjugated polymers and functionalised organic electronic materials for bioelectronics.

Professor Travas-Sejdic has authored over 260 publications, 9 book and 2 encyclopaedia chapters. She is a Fellow of the Royal Society New Zealand (2017), a Fellow of the New Zealand Institute of Chemistry (2009), she received Early Career Research Excellence Award (2005), Easterfield Medal (2006), Maurice Wilkins Centre Prize for Chemical Sciences (2017), Shorland Medal (2018) and Hector Medal (2019, Royal Society Te Apārangi). She has been a Councillor of the Pacific Polymer Federation since 2009.

Prof. Suwabun Chirachanchai obtained his Ph.D. from Graduate School of Engineering, Applied Fine Chemistry, Osaka University in 1995 and joined the Petroleum and Petrochemical College, Chulalongkorn University as a Faculty member since then. He became a full Professor in 2009 with the research area in advanced polymeric materials, especially biopolymers and bioplastics related. He published more than 130 papers in leading Journals, 8 book chapters, including 2 international and 5 local patents. He was awarded Distinguish Researcher in Chemistry and Pharmaceutical from the National Research Council of Thailand (NRCT), Chair Professor from NSTDA and PTT, Senior Scholar from NRCT. As part of the contribution to the Polymer community, he was the President of Polymer Society of Thailand during 2012-2016 and a board member of the Pacific Polymer Federation.

Prof. Dennis Smith is Professor of Chemistry and Department Head at Mississippi State University. He received a B.S. in chemistry and mathematics from Missouri State University (1988), and a Ph.D. in chemistry from the University of Florida (1992). His interests include science & technology leadership, technology transfer, entrepreneurship, and chemistry/materials research. He was a Dow Chemical post-doctoral Fellow in Germany (1993), Dow Project Leader (1993-1998); Chair, Local ACS Section (1996); Professor of Chemistry and Material Science & Engineering (MSE); co-founder and Center Director at Clemson University (1998-2010), Co-Founder of Tetramer Technologies, LLC (2001), Visiting Professor – University of Heidelberg (2001), Robert A. Welch Distinguished Professor of Chemistry & MSE at the University of Texas at Dallas (2010-2014); Director of NSF-I/UCRCs; Chair, ACS Division of Polymer Chemistry (2009), Officer of IUPAC, founder of FLUOROPOLYMER (2000-2018), Editor of Polymer Bulletin, Journal of Nanoscience & Technology, and several other journal Boards. He is Fellow of the American Chemical Society (2010), IUPAC Fellow (2016), Cottrell Scholar of Research Corporation (2001), and ACS Charles Stone Award recipient (2008). Prof. Smith has published 146 refereed journal articles (H=45), 28 US patents issued or pending, 300+ conference papers, 5 book editorships, and 200+ invited lectures.

Prof. Ruirui Qiao is a Group Leader and NHMRC Emerging Leadership Fellow at AIBN, University of Queensland. She received her BSc (2005) and MSc (2007) in Peking University and was a tenured associate professor (2016–2017) and research assistant professor (2007–2015) at the Institute of Chemistry, Chinese Academy of Sciences (CAS), where she received her PhD in 2014. In 2017, she joined ARC Centre of Bio-Nano Science (CBNS), Monash University as a project co-leader. Currently, she leads a nanobiotechnology research group at AIBN, focusing on the development of functional nanohybrids toward biomedical and clinical translations. Prof. Ruirui Qiao's research has attracted over $2 M funding from various funding sources in Australia, Germany and China. She was invited to University of Muenster as a visiting scholar sponsored by DAAD. She's currently serving as the associate editor for Journal of Nanobiotechnology and guest editor for several journals. Her research focuses on the development of polymeric/inorganic nanocomposites and assemblies for disease diagnosis and drug delivery.

Showcase presenters

Prof. Zhongfan Jia is an Associate Professor in the College of Science and Engineering at the Flinders University. He graduated with a PhD in Polymer Chemistry and Physics in 2007 from Fudan University. Followed by postdoctoral research in the Centre for Advanced Macromolecular Design (CAMD) at the University of New South Wales from 2007 to 2009, he worked at the Australian Institute for Bioengineering and Nanotechnology (AIBN), University of Queensland (UQ) until 2020. He was an Australian Research Council Future Fellow (2013-2017), Advanced Queensland Industry Fellow (2018-2020), a Lecturer at the University of New England (2019), and a Senior Lecturer at Flinders University (2020-2022). He has authored more than 100 publications on the synthesis of complex polymer architectures, focusing on their applications in biomedicine, catalysis, and energy storage.

Dr Changkui Fu is currently an NHMRC Emerging Leadership Fellow at the Australian Institute for Bioengineering and Nanotechnology of The University of Queensland, where he leads a team working on functional polymers for biomedical applications. His research interest focuses on 1) building innovative synthetic methodologies for advanced polymer synthesis; 2) developing biocompatible polymers with tailored structure and function for drug delivery and imaging applications; 3) developing advanced protein-polymer therapeutics with improved stability, pharmacokinetics, and pharmacodynamics. He has published 75 papers in a variety of leading journals such as Angew Chem, JACS, ACS Macro Letters and Biomacromolecules, receiving over 3000 citations and an h-index of 32.

Prof. Costas S Patrickios leads the Polymer Science Group in the Department of Chemistry at the University of Cyprus where he has been a faculty member since 1998. His research focuses on the preparation and characterization of well-defined polymer networks with various functionalities, including amphiphilicity, ampholyticity, degradability and, more recently, reversibility via the employment of dynamic covalent crosslinks. Properties of interest of these novel materials include their swelling behavior, self-organization, mechanical strength and self-healing ability. Prof. Patrickios is a graduate of the National Technical University of Athens (NTUA; BSc in 1988) in Greece, and the Massachusetts Institute of Technology (MIT; M.Sc. in 1990 and Ph.D. in 1993; Ph.D. Thesis Advisor Prof. T. A. Hatton) in the USA. After post-doctoral work on polymer synthesis at the University of Sussex (1994 – 1996; groups of Profs. S. P. Armes and N. C. Billingham) in Brighton, UK, he served on the faculty of the Chemical Engineering Department of the University of Manchester Institute of Science and Technology (UMIST; 1996 – 1997) also in the UK.

Prof. Qiang Fu received his B.E. in Chemical Engineering from Shanghai Jiao Tong University (China) in 2004. He completed his Ph.D. in Polymer Chemistry at Fudan University (China) in 2009 before working as a Postdoctoral Fellow at the University of Melbourne. Dr Fu was the recipients of an ARC Super Science Fellowship (2011-2014), an ATSE Emerging Future Leader Fellowship (2012) and an ARC Future Fellowship (2018-2022). He is currently leading a research group in The Centre for Technology in Water and Wastewater (CTWW) at The University of Technology Sydney, focusing on the development of functional polymer materials, 2D materials, MOFs, membranes and nanotechnology for energy and environmental applications.

Showcase presenters

Assoc. Prof. Simon Hinkley completed his PhD studies at the University of Otago with Dr Rex Weavers and Prof. Nigel Perry working on natural product isolation and organic synthesis. Postdoctoral research with Prof Bruce Jarvis at the University of Maryland focused on fungal metabolites and the chemotaxonomy of the infamous Stachybotrys black moulds. Returning to New Zealand to complete high-potency drug manufacture, that contributed to the development of Kadcyla, he then joined the Ferrier Research Institute where he leads the polysaccharide research team. Research completed in the group ranges from developing novel cellulosic biopolymers as commodity chemicals, to complex carbohydrate characterisation, through to the organic synthesis of biopolymer mimetics as human therapeutics.

Prof. Jason Xu is Associate Professor at School of Chemical Engineering, UNSW Sydney. His research group in the Centre for Advanced Macromolecular Design (CAMD) and Australian Centre for NanoMedicine (ACN) has the focus on green and precision polymer synthesis and polymer hydrogels. Dr. Xu received his BS and PhD Degrees in Polymer Science from Fudan University. He was awarded ARC Future Fellowship and took a Lecturer position in 2017. He was promoted to Senior Lecturer in 2019 and Associate Professor in 2023. He has more than 120 peer-reviewed publications in high-impact, attracting >10,000 citations and an H-index of 55 (Dec 2022, Google Scholar). He has successfully secured >2M research funds including ARC Future Fellowship and two ARC DP projects. He has been nominated as Emerging Investigator by Polymer Chemistry (2018) and Chemical Communications (2018), and Pioneering Investigator by Polymer Chemistry (2021). His areas of research interests are green chemistry and sustainable polymer synthesis, precision polymer synthesis mimicking natural perfection, photoredox catalysis for living polymerization, polymer hydrogel materials for nanomedicine and bioengineering applications.

Prof. Jiun-Tai Chen received his B.S. degree in 1999 and M.S. degree in 2001 from the Department of Applied Chemistry at National Yang Ming Chiao Tung University (NYCU). He obtained his Ph.D. in 2008 at the University of Massachusetts, Amherst in Polymer Science and Engineering. He then joined the University of Texas at Austin as a postdoctoral fellow. In the summer of 2010, he joined the Department of Applied Chemistry at NYCU as an assistant professor. He is currently a Distinguished Professor and the Associate Dean of the College of Science at NYCU. He is also the Director of the Degree Program of Science at NYCU. His research interests include the fabrication and characterization of polymer nanomaterials for optoelectronic applications.

Keynote speakers

Dr Yinyin Bao
ETH Zurich

A/Prof Anchao Feng
Beijing University of Chemical Technology

Prof Hailong Che
Shanghai University

Prof. Araceli Flores
ICTP, CSIC

Prof Xia Dong
Institute of Chemistry,
Chinese Academy of Sciences

Prof Mario Gauthier
University of Waterloo

Prof Chuan-Liang Feng
Shanghai Jiao Tong University

Dr Marija Gizdavic-Nikolaidis
Waipapa Taumata Rau
University of Auckland

Prof. Sven Henning
Fraunhofer IMWS

Dr Yu Jin Jang
Sungkyunkwan University

A/Prof Zvonimir Katancic
University of Zagreb
Faculty of Chemical Engineering
and Technology

Prof. Guangfeng Li
Zhejiang University

Prof Alejandro J. Müller
Basque Country University UPV/EHU

Prof Mehrdad Negahban
University of Nebraska-Lincoln

Prof Suprakas Sinha Ray
Council for Scientific and Industrila
Research and University of
Johannesburg

Prof Holger Schönherr
University of Siegen

Keynote speakers

Prof Weichao Shi
Nankai University

Prof Feng Wang
University of Science and Technology of China

Prof Guangjie Song
Institute of Chemistry, Chinese Academy of Sciences

Prof Huanting Wang
Monash University

Dr Vinh Truong
Institute of Materials Research and Engineering, A*STAR

Prof Chunye Xu
University of Science and Technology of China

Prof Domagoj Vrsaljko
University of Zagreb, Faculty of Chemical Engineering and Technology

Prof Qiang Yan
Fudan University

Prof Rui Yang
Tsinghua University

Dr Cheng Zhang
University of Queensland

Prof Jie Zhang
Peking University

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Dr Sven Henning
Fraunhofer IMWS

Dr Amirah Amalina Ahmad Tarmizi
Universiti Teknologi Mara Shah Alam, Malaysia

Mr Chris Bainbridge
University of Auckland

Prof Ildoo Chung
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Mr Kyle Engel
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Prof Jean-Marc Saiter
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Prof Alexander Fainleib
The National Academy of Sciences of Ukraine

Prof Sergey Filippov
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Mr Alessio Giove
Lappeenranta-Lahti University of Technology LUT

Prof Marian Gomez-Fatou
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Dr Kristina Gusakova
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Mr Mohammad Sagor Hosen
University of Canterbury

Prof You-lo Hsieh
University of California, Davis

Mr Xumin Huang
The University of Queensland

Ms Nethmie Jayasooriya
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A/Prof Paul Joseph
Victoria University

Dr Beata Kaczmarek-Szczepańska
Nicolaus Copernicus University in Torun

Prof Atsushi Kajiwara
Nara University of Education

Miss Kawaljit Kaur
University of Siegen

Miss Supattra Khemlek
The Petroleum and Petrochemical College, Chulalongkorn University

Prof Paul Kilmartin
University of Auckland

Mr Ringo Leung
University of Auckland

Mr Sheung Yin Li
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Ms Keemi Lim
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Miss Jaidene Parks
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Lomonosov Moscow State University

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Dr Liwen Zhang
The University of Queensland

Mr Bo Zhang
Shanghai Jiaotong University

Prof Eyal Zussman
Technion - Israel Institute of Technology

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Mr Chris Bainbridge
University of Auckland

Mr Sebastian Balser
Goethe University Frankfurt

Mr Maicon Bertin
The University of Auckland

Mr Devon Bryant
University of Auckland

Mr Suman Kumar Ghosh
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Goethe-University Frankfurt am Main

Mr Liam Van Mechelen
The University of Auckland

Haiyi Xie
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Danny McDougall
University of Auckland

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Carbonaceous Nanofillers Based Thermoplastic Elastomeric Blend Composites to Mitigate Radiation Pollution in X-band

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Abstract

Microwave absorbing materials based on polymer blend composites are now receiving great interest to mitigate radiation pollution at ultra-low filler concentrations. In this work, polystyrene (PS)/ethylene-co-methyl acrylate (EMA) thermoplastic elastomeric blend composites were prepared via wet mixing method utilizing two different dimensional and acid-functionalized carbonaceous nanofillers of multi-walled carbon nanotubes (MWCNTs) and carbon nanofibers (CNFs). The development of a compact spatial conductive network throughout the matrix as a result of selective confinement of these functionalized nanofillers in the EMA phase of the PS/EMA co-continuous mix reduces the electrical percolation threshold significantly. When these nanofillers are oxidized, they become more evenly dispersed in the EMA phase, increasing the composites' thermal conductivity. The higher aspect ratio of FCNFs helps to construct more interconnected conductive pathways in the composite than FCNTs which tend to more increment in electrical, thermal and EMI shielding properties of the composite materials. The electrical and thermal conductivities obtained for PS/EMA/FCNT and PS/EMA/FCNF thermoplastic elastomeric composites with 15wt% of filler concentration are 0.32, 0.7 S/cm and 0.84, 0.86 W/m.K, respectively. The as-prepared blend composites have an absorption-dominant EMI shielding performance of -34.9 and -36.7 dB for 15wt% of FCNT and FCNF loading, respectively in X-band frequency region. With increasing nanofiller content, complex permittivity rises; yet, AC impedance displays frequency-independent behavior. The proposed two types of thermoplastic elastomeric blend composites with improved electrical and thermal conductivity may be successfully applied as efficient EMI shields and for thermal control applications in the future generation of wearable electronics.

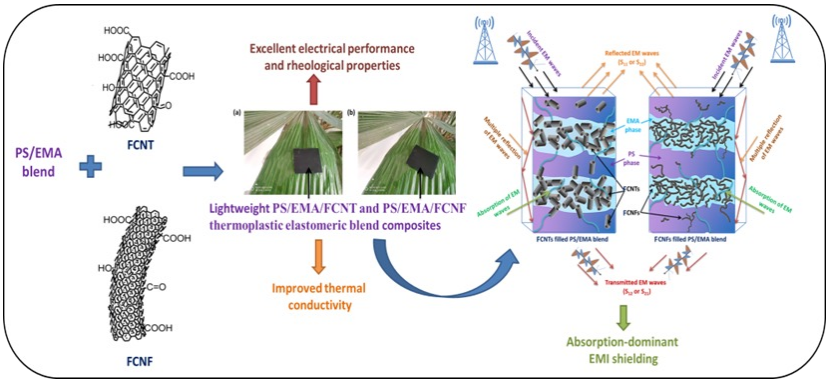

Figure 1. Representation of polymer blend composites showing improved properties

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The Additive Manufacturing of Ionically Conductive Polymer Artificial Muscles

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Abstract

While Electroactive Polymers or EAPs are a rapidly growing field of research interest, there are difficulties in integrating additive manufacturing techniques to produce ionic EAP complex objects. Other research groups, such as Carrico et al. (2015), use extrusion-based additive manufacturing techniques. However, light-based additive manufacturing of ionic EAPs remains a novel and exciting approach. Our research has shown promising results in the vat-based additive manufacturing of these ionic EAP actuators. Our ionomeric polymer network was synthesised from a liquid resin by combining vat-based photo-polymerisation techniques and synthetic polymer chemistry. Under photo-polymerisation, this novel resin forms an ionomeric polymer material that undergoes cation exchange from a cation-chloride salt solution. Coating precious metal electrodes via surficial adsorption of the metal salt and corresponding reduction to nanoparticles can fabricate ionic EAP actuators. These ionomeric polymer networks facilitate cation motion through the polymer network under an electric field. This novel photo-resin has shown printability in a commercially available Digital Light Processing (DLP) 3D printer. These 3D printed Ionic EAP actuators were also controllably actuated via a sinusoidal waveform from a signal generator. 3D printed Ionic EAP actuators displayed a displacement range of up to 3mm using a frequency of 0.01 Hz and an amplitude of 3 V. This research has shown that by merging the fields of polymer chemistry and materials engineering, newfound understanding in the additive manufacturing of ionomeric materials can be attained. Therefore, further advancing the fields of soft robotics, soft sensors and membranology. Recently, our works have also explored the use of intrinsically conducting polymers in photocurable 3D printable inks. These conducting polymers can be used to develop 3D printable actuators and multi-material 3D printing of composite materials.

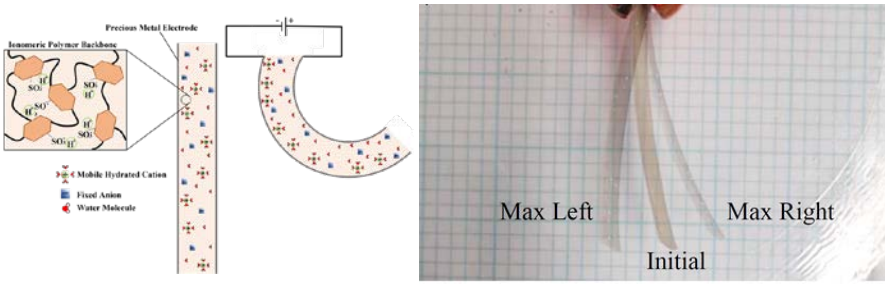

Figure 1: Left: Schematic of the actuation mechanism of the 3D printed IPMC actuator[1]. Right: Reversible actuation of a DLP fabricated cation conductor polymer actuator.

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Gelatin-based active and intelligent packaging incorporating grape skin and seed tannins

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Abstract

Novel applications of waste streams from the wine industry are being developed to improve the sustainability of the industry and to create new high-value products. Tannins extracted from grape seeds (SeedT) and grape skins (SkinT) were added into gelatin to create biopolymer films with active and intelligent properties. Higher phenolic content and antioxidant capacity were determined for the SeedT extract (~440 mg gallic acid (GA)/g extract), with lower values obtained for the SkinT extract (14 mg GA/g extract). At the same time, both extracts displayed differences in colour in solution as the pH was changed. The colouration carried through into the gelatin films, as did the pH indicator ability, an intelligent function, in the case of SkinT-containing films. Otherwise, the films were transparent and were good absorbers of UV radiation (secondary antioxidant function). As a result of the tannin additions, the films exhibited lower wettability (92° water contact angle) related to hydrogen bonding between gelatin and the tannins, seen in a shift and broadening of the amide A band in FTIR. They were also capable of releasing a proportion of the tannins into a 50% ethanolic food simulant at 4°C. The films also exhibited antioxidant activity, given by the DPPH radical scavenging after exposure to the same food simulant, and more so with the SeedT additions and in a concentration-dependent manner (Table 1). The tannin additions have promising applications in food packaging, where a pH-dependent colour change can signal spoilage in seafood and meat products, while antioxidant effects, both at the film surface and through released tannins, can length product shelf-life.

Film	Tannin addition (%)	Release (%)	I (%)
Control		-	-
SeedT1	1	9.5 ± 0.6	6.0 ± 1.1
SeedT2	2	13.9 ± 1.9	13.3 ± 1.6
SkinT11	11	20.4 ± 2.1	3.5 ± 0.5
SkinT16.5	16.5	18.9 ± 0.8	5.4 ± 0.6

Table 1. Tannin release into 50% ethanol at 4 °C as a percentage of the tannin added, and DPPH antioxidant inhibition (I), for gelatin films with added grape seed (SeedT) or grape skin (SkinT) tannin.

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Programming Soft Matter Materials with Light

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Abstract

Photochemistry has become an indispensable tool for numerous spatially addressable applications in materials science and biology.Indeed, photochemistry has seen an immense resurgence and development in the last 20 years. In soft matter materials applications, light-induced bond formation or cleavage provides a high degree of versatility in tuning specific material properties by varying the irradiation wavelengths and intensity. The critical advantage of light responsive materials is the on-demand spatial and temporal control that is valuable for applications in biological environment.

The current lecture will discuss recent progress in visible light-enabled chemical reactions introduced by our team and their applications in soft matter materials. Specifically, we have employed red-shifted photocycloaddition for wavelength-selective crosslinking of polymer networks, subsequently tuning the materials stiffness by using different colours of visible light. We have also incorporated various photocleavable groups within polymer structures, enabling on-demand photodegradation – and softening – of the materials by different wavelengths.We further demonstrated the utility of such materials in cell cultures and investigation of cell-materials interaction.

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Arborescent polypeptides based on poly(γ-benzyl L-glutamate) for drug delivery applications

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Abstract

Polymeric micelles have attracted much attention as promising drug delivery nanocarriers, because their size and structure are similar to natural carriers in biological systems. Herein we report the synthesis of biocompatible arborescent polymeric micelles with poly(γ-benzyl L-glutamate) (PBG) and poly(ethylene oxide) segments. The arborescent poly(γ-benzyl L-glutamate) core was synthesized by ring-opening polymerization of γ-benzyl L-glutamic acid N-carboxyanhydride initiated with *n*-hexylamine, and successive grafting reactions via standard peptide coupling techniques. Amphiphilic unimolecular micelles of poly(benzyl L-glutamate)-*g*-poly(ethylene oxide) copolymers were obtained by grafting the hydrophobic arborescent PBG substrates with hydrophilic side chains of poly(ethylene oxide) by the same peptide coupling techniques. The synthesized polymers were characterized with ^{1}H NMR, gel permeation chromatography, atomic force microscopy, dynamic light scattering and transmission electron microscopy.

The encapsulation and release properties of these nanocarriers were investigated using doxorubicin (DOX) as a model hydrophobic anticancer drug, which was effectively encapsulated via three different methods. Doxorubicin hydrochloride (DOX×HCl) was successfully loaded into the hydrophilic arborescent poly(L-glutamic acid)-g-poly(ethylene oxide) copolymers via electrostatic interactions. The hydrophobic form of DOX was physically entrapped within the core of the poly(γ-benzyl L-glutamate)-*g*-poly(ethylene oxide) unimolecular micelles. Doxorubicin was also conjugated to the poly(benzyl L-glutamate)-g-poly(ethylene oxide) unimolecular micelles via a pH-sensitive hydrazone bond. The unimolecular micelles exhibited pH-sensitive drug release behavior, with drug release profiles slow at physiological pH (7.4) but increasing markedly at pH 5.5. Given their unique structure, pH-responsive characteristics and biodegradability, arborescent polymeric micelles could be useful as nanocarriers for drug delivery applications.

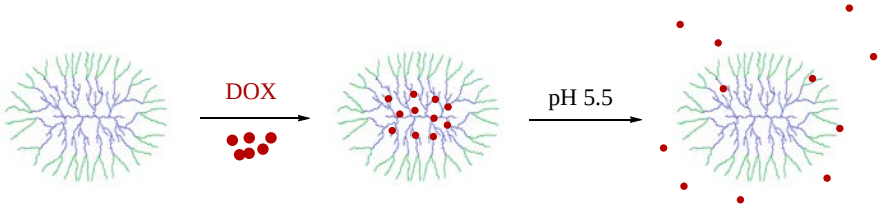

Figure 1. Loading of doxorubicin in arborescent copolymer micelles via physical entrapment, electrostatic interactions or labile hydrazone bonds, and pH-triggered release at pH 5.5.

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Facile preparation of light-weight biodegradable and electrically conductive polymer based nanocomposites for superior electromagnetic interference shielding effectiveness

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Abstract

Harmful electromagnetic radiations that are generated from different electronic devices could be absorbed by a light weight and mechanically flexible good electromagnetic interference (EMI) shielding polymer nanocomposite. On the other hand, different electronic wastes ("e-wastes") which are generally polymer building materials generated from wastes of dysfunctional electronic devices are not naturally biodegradable. Our recent effort has been employed to produce bio-degradable EMI shielding polymer nanocomposite. For that purpose, we had prepared a 50:50 ratio polylactic acid/thermoplastic polyurethane polymer nanocomposite by mixing the conducting carbon black with the blend following the facile and industrially feasible solution mixing method. Morphological characterizations by scanning electron microscopy and transmission electron microscopy analysis revealed the co-continuous morphology of the neat blend as well as polymer nanocomposites with the preferential distribution of conductive filler on a particular polymer phase. The polymer nanocomposites gave good mechanically with improved thermal properties. We got EMI shielding effectiveness around –27dB with a low percolation threshold at around 30wt% filler loading in the polymer nanocomposite at the X-band frequency domain (8.2–12.4 GHz). Later we had studied the biodegradability of the PLA/TPU along with their composites (TXPXCX) by employing the respirometry method and got a satisfactory result to ensure their biodegradability.

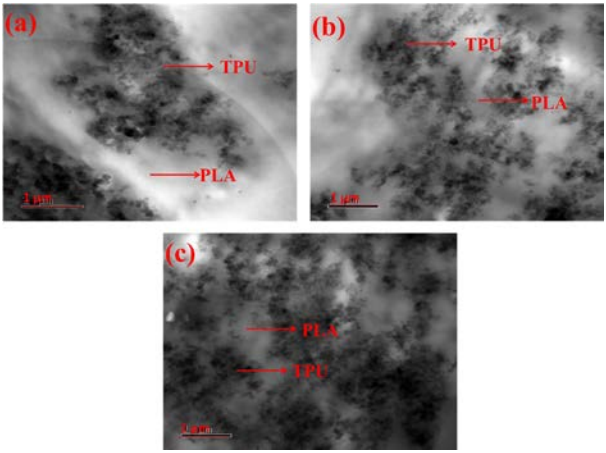

Figure 1. HRTEM images of PLA/TPU 50/50 blend with (a) 5 wt%, (b) 20wt%, and (c) 30wt% VCB loading. HRTEM, high-resolution transmission electron microscope; PLA, polylactic acid; TPU, thermoplastic polyurethane; VCB, Vulcan XC72 (conductive carbon black).

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Dielectric Investigation at Different Temperature Values on a Ready to Use Therapeutic Food Material Composed of Lipids

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Abstract

The focus is to evaluate the ability of dielectric spectroscopy to be used as a local probe to determine parameters related to molecular mobilities which must exist at different temperature values ranging from -20°C and 60°C in a very complex material mainly composed of lipids. This product is a Ready to Use Therapeutic Food with a consistency of paste at room temperature. It is obtained by mixing different ingredients as vegetable oils, milk powders, sugar, peanuts, minerals and vitamins. The final product appears as a mixture of different phases including, crystalline, vitreous, amorphous and liquid. Isothermal Dielectric measurements have been performed by measuring the impedance (real and complex part) by scanning frequency in the range 10^{-2}Hz to 10^{7}Hz. Measurements have been repeated by changing the temperature between -20°C and 60°C. The presence of minimum resonance at low frequency range is observed in all the impedance spectrum indicating the occurrence of orientation of temporary induced dipoles. It is found that the orientation of dipoles in the sample is ruled by the short-range motion or relaxation as the sample displays broad dispersion of relaxation times.

Keywords: food, temperature, impedance, dielectric, permittivity

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Fast and facile enhanced eco-friendly microwave synthesis of antibacterial polyaniline/chitosan based composites

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Abstract

Recently our research group introduced an ultrafast and easy enhanced eco-friendly microwave (MW) method for producing high yield advanced polyaniline (PANI) based materials at ambient temperature. In contrast with classic chemical synthesis (CS), for which the reaction duration can be several hours or even days, application of microwaves can greatly reduce the reaction duration so that product can be obtained in just 5 min with ca. 76 % yield in the form of nanostructured PANI. In this way, enhanced MW method can be used to fine-tune polymer synthesis reaction conditions, directing the morphological and structural properties of PANI based materials.

In this study, we successfully prepared composite products of PANI and different molecular weights of chitosan (Ch) in the presence of silver nanoparticles (AgNP) at room temperature. AgNP are used to enhance the antibacterial activity of the polymer composite matrix. The oxidizing agent potassium iodate (KIO_3) was used, as it is suitable for scalable bulk production of PANI based composites, achieving a good quality product from a wide range of polymer synthesis parameters. The physical integration of PANI/Ch and PANI/Ch-AgNP composites was confirmed using FTIR and SEM analysis. In addition, we report that all the composites had greater antibacterial efficacy against both Gram-positive and Gram-negative bacteria compared to PANI or Ch. The influence of AgNP on PANI formation in the composite using both CS and enhanced MW method was explored. The comparable study of PANI/Ch-AgNP composites prepared by CS and enhanced MW method showed that AgNP influenced the aniline polymerisation in the presence of Ch biopolymer in the PANI based composite. Enhanced crosslinking of Ch with PANI with some porous nanostructures was observed in PANI/Ch-AgNP composites prepared by enhanced MW method, with the compact Ch structure obvious in all CS PANI/Ch-AgNP composites. In contrast, the presence of AgNP during CS constrained PANI fibre formation. Our study showed that eco-friendly, facile, scalable and low cost enhanced MW method can produce PANI/Ch based composites, with alterations in composition able to tune antibacterial and physical properties toward particular applications.

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Extra high temperature resistant polymer nanocomposites from thermoreactive C≡N-containing resins

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Abstract

Novel polymer nanocomposites of cyanate ester resins (CER) and bisphenol A based phthalonitrile (BAPhN) resins have been synthesized and characterized. As nanofillers the functionalized silicon-containing nanoparticles –polyhedral oligomeric silsesquioxanes (epoxy-POSS, amino-POSS), silicate nanolayers of amino-montmorillonite (amino-MMT) or SiO_2 nanoblocks were introduced to the matrices in amounts from 0.01 to 10 wt. %. The SiO_2 nanoparticles were synthesized and incorporated into the CER matrix by the sol-gel technology.

The molecular structure and dynamics of polymer matrices were studied by spectroscopy in the mid- and far-IR region. Electron microscopy (TEM, STEM) in combination with energy dispersive X-ray spectroscopy (EDXS) was used for nanostructure analysis, elemental analysis of nanovolumes, Si nanodistribution in composites. The relaxation and deformation characteristics of the composites at temperatures from 20 to 600°C, the transition temperatures were studied by DMA, DSC and laser-interferometric creep rate spectrometry (CRS). Thermal and thermal-oxidative stability of nanocomposites were studied by thermogravimetric analysis (TGA).

As a result, a number of new effects and a uniquely high thermal stability for polymers of some of the studied nanocomposites with CER and BAPhN matrix were discovered:

The covalent incorporation of nanoparticles into the matrix (hybridization) and the need for high-temperature post-curing of the nanocomposites to achieve optimum properties have been confirmed.

X-ray spectra and histograms of Si (POSS or SiO_2) nanodistribution in BAPhN and CER matrices revealed the possibility of a quasi-regular distribution of nanoparticles in an amorphous matrix in the absence of their clustering at 0.1 wt. % SiO_2. At the same time, with an increase in the content of silica in the composite and its clustering, their divergence and even a sharp discrepancy are observed due to structural heterogeneity.

When MMT packs were introduced into the matrices, characteristic changes were observed in the degree of their splitting (exfoliation), the maximum at ≤ 0.1 wt. % MMT and decreasing with increasing content of these nanoparticles.

The glass transition temperature T_g of the CER nanocomposites reached ~300°C, of the cured BAPhN nanocomposites reached about 380°C, and after post-curing, in particular, by heating to 430°C at a rate of 3°C/min, the Tg of the latter varied from 460 to 570 °C.

The greatest positive effect on the dynamics and properties of the matrix was found with the introduction of ultra-small amounts of inorganic blocks (up to 0.02–0.1 wt. %. In the case of "embedding" SiO_2 in the polymer network, only subnanosized inorganic nodes were created. As a result, polymeric subnanocomposites were obtained for the first time. At the

same time, the superiority of the properties of subnanocomposites over the properties of both a pure matrix and nanocomposites containing nanoclusters was observed.

Comparative DMA of BAPhN nanocomposites in air and nitrogen media showed that the effect of the medium manifests itself starting from temperatures of ~500°C, when the processes of thermal oxidative degradation are "switched on". High-temperature treatment in a nitrogen environment led to complete suppression of the glass transition and a constant value of the dynamic modulus of the nanocomposite in the temperature range from 20 to 600°C, which was observed for polymers for the first time.

Comparative thermal stability of the best BAPhN nanocomposite (with 2% MMT) up to ~500°C in air and up to 900°C in nitrogen was found, while maintaining the integrity of the material, which is unusual for polymers and is important in some applications. An increase in thermal stability is shown when nanoparticles are introduced into the matrix.

The best of the investigated composites are promising for use as structural and functional materials under extreme temperature conditions in aerospace and other industries.

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Development of poly(3,4-ethylenedioxythiophene) based stretchable conductive polymers for flexible electronics

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Abstract

Flexible electronics is a new generation of electronic devices in which electronic components are integrated into flexible substrates. It is used in the fabrication of displays, solar cells, integrated circuits, and increasingly in the fabrication of electronic skin (E-skin), which can mimic the properties of human skin by being able to follow skin movements and flexures without loss of mechanical and electrical properties. E-skin is suitable for integrating various sensors to monitor personal health. Conductive polymers are used in flexible electronics due to their electrical conductivity, low mass, and stability. However, their main disadvantage is their brittleness, which is why they don't possess flexibility property without modification.

Therefore, in this work, the conductive polymer poly(3,4-ethylenedioxythiophene) (PEDOT) was used as the main chain and the side branches of poly(acrylate-urethane) (PAU) were grafted onto it by atom transfer radical polymerization (ATRP) onto it, obtaining the grafted copolymer PEDOT-g- PAU. In this way, the main chain of PEDOT retains the property of electrical conductivity without losing conjugation, while the side branches of PAU have the ability to crosslink non-covalently through hydrogen bonds with PAU side branches of adjacent polymer molecules due to the presence of oxygen in their structure. The presence of hydrogen bonds allows increasing the stretchability and flexibility of the material, and they also have the ability to spontaneously renew themselves when they break due to excessive stress. Three different synthesis conditions were used to obtain polymers of different structure, which were characterized by Fourier transform infrared spectroscopy (FTIR), nuclear magnetic resonance (NMR), scanning electron microscopy (SEM), thermogravimetric analysis (TGA), differential scanning calorimetry (DSC) and measurement of electrical conductivity with a four-point probe (4PP) method.

The obtained graft copolymer was prepared in the form of ink and printed on a polyurethane (PU) substrate using inkjet technique. The conductivity of the printed layer, its elongation and adhesion were investigated, while possible delamination of the printed polymer layer was also monitored. The results showed that the PEDOT-g- PAU copolymer was successfully synthesized and inkjet printing on PU film was successful. The obtained material has satisfactory electrical and mechanical properties and could be used for the integration of fully functional biosensors with further optimization of the composition.

Figure 1. Stretching (a) and twisting (b) of inkjet printed PEDOT-g-PAU

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Preparation and Characterization of Highly Conductive and Biorepulsive Polypyrrole/Polyglycerol Surface Films

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Abstract

Conductive polymers are frequently used as alternatives to metal electrodes as they are not only more flexible, but also do not release any potentially toxic metal ions and are thus inherently more environmentally friendly and biocompatible. They can therefore be used in biological systems for achieving electrical contact to cells and other bioentities to either measure or apply electrical potentials. Their biocompatibility nevertheless does not include the passivity against the unspecific adsorption of typical concomitants in biological media, such as proteins or bacteria (biofouling), which generally is not desired in defined biochemical set-ups.

Here we present a method to create highly conductive and biorepulsive polymer films which can be deposited onto gold by electrochemical polymerization of a polyglycerol-modified pyrrole derivative (PyEAPG) in aqueous solution. The growth of the polymer film is linearly determined by the current density and the time. Thicknesses of up to 400 nm can be obtained, where the polymerization is self-terminated due to the growth mechanism. Cyclic voltammetry and electrochemical impedance measurements were employed to characterize the film formation dynamics and the conductivity of the films at different thicknesses. Furthermore, the films and their growth were characterized by reflection/absorption infrared spectroscopy, quartz crystal microbalance, atomic force microscopy as well as contact angle measurements. The films are highly biorepulsive even at thicknesses as low as 10 nm, what could be demonstrated by using protein and bacteria adhesion assays, thus, opening the opportunity for their use in bioelectrical applications.

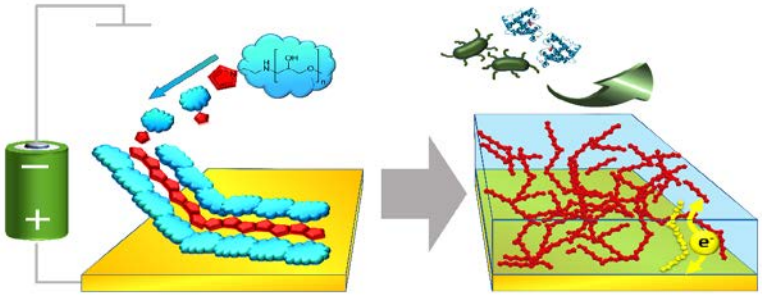

Figure 1. Electropolymerization of 1-(2-(1-Pyrrolyl)ethylamino)-polyglycerol (PyEAPG) onto a gold surface which leads to a highly conductive and biorepulsive surface film.

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Charge Transfer Polymers with Color-Tunable Solid-State Emission

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Abstract

Color tuning of fluorescent materials is of great interest for both fundamental study and practical applications. The development of structurally simple multicolor emissive polymers that do not require sophisticated synthetic methodologies is appealing, but rather challenging. Despite enormous efforts on molecular design and engineering, a general and facile polymer platform that offer high flexibility and broad extensibility in emission color tuning remains scarce.Here, we developed a versatile polymer platform with versatile color tunability via manipulation of through-space charge transfer (TSCT).Using a single-acceptor fluorophore as the initiator for atom transfer radical polymerization (ATRP), a series of electron-donor groups containing simple aromatic moieties were introduced by facile copolymerization or post-functionalization. The resulted TSCT polymer library showed continuously tunable emission color. This was achieved by fine-manipulation of donor-acceptor interplay via simple controlled polymer synthesis. Theoretical investigations confirmed the structurally dependent TSCT-induced emission redshifts. We further demonstrated this TSCT polymer platform can be used to design solid-state photoresponsive materials for information encryption (Figure 1).

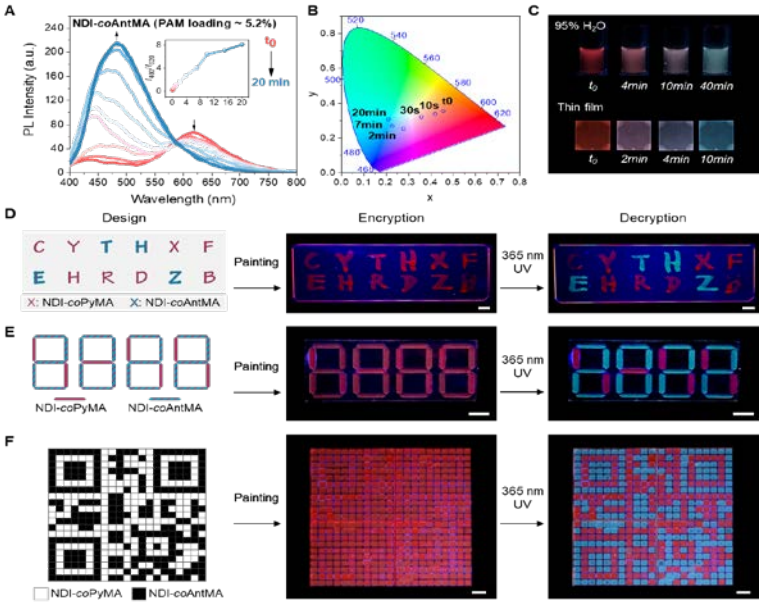

Figure 1. Information encryption using charge transfer-based polymers with tunable emission color

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Light-activated polymeric nanomaterials: from nature-inspired biomaterials to smart multifunctional face masks

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Abstract

Designing functional devices based on light-responsive nanomaterials constitutes a breakthrough approach in several scientific fields. The impact of this strategy is particularly significant on the development of efficient on-demand biomedical treatments thanks to the possibility of using near-infrared (NIR) light as a source of stimulation. With the aid of plasmonic hydrogels and nanofibrous materials, nanotechnology makes it possible to manipulate light at the nanoscale, thus triggering a cascade-like series of responses and new functionalities. The ability to respond to external stimuli is crucial to revolutionizing the biomaterials field since the human body's activities, and the necessary treatments are dynamic over time. Nature-inspired materials have achieved exceptional properties and functionalities that are still very challenging for manufactured engineered materials. Taking inspiration from natural structures, it is possible to develop nanostructured materials with unique features.

Here we present the development of two different nature-inspired nanostructured platforms based on electrospun and plasmonic hydrogels for advanced biomedical applications, which can be activated by light. Firstly, a smart drug delivery system inspired by the mesoglea structure of jellyfish is shown (Fig.1a). This multifunctional platform can be activated using a cascade of stimuli by NIR light, releasing bioactive molecules on demand. The second material is a glucose sensor with innovative functionalities such as bendability, wearability, reusability, self-sterilization, and the ability to respond to external stimuli, which are crucial to revolutionizing the biosensing field (Fig.1b). This nanoplatform, inspired by the chameleon skin's unique light-matter interaction, can detect glucose in human urine samples. Finally, the nanotechnology transition roadmap toward multifunctional stimuli-responsive face masks using the aforementioned approach will be introduced.

Figure 1. Electrospun nanofiber and hydrogel-based nanostructured smart biomaterials inspired by (a) jellyfish mesoglea and (b) chameleon skin.

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Chemical functionalization of cellulose and silica materials with ionic moieties: synthesis, characterization and applications

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Abstract

Chemical functionalization of materials either natural or synthetic with ionic moieties is attractive due to this procedure confers new properties for a versatile application for ionic interactions. Natural polymers as cellulose have been modified with zwitterions to reinforce interaction between cellulose fibers in papers and to uptake textile dyes from aqueous solutions with concentrations from 50 to 500 mg/L. Chemical structure and zwitterion interactions in these modified celluloses have been successfully studied by 13C ,15N CPMAS and REDOR NMR experiments. Furthermore, these zwitterionic cellulose can be used as a support to immobilize enzymes for environmental applications (unpublished work). However, the uptake of heavy metal ions in water streams requires more stable materials with enhanced mechanical and chemical properties with specific areas. Nowadays, the synthesis of hybrid materials with active organic ligand into inorganic matrixes as silicon dioxides have been increased considerably as an alternative for the treatment of polluted water bodies. The design and performance of these hybrids in the adsorption of heavy metal ions (i.e. Cr+6 and Pb+2) can be also evaluated by solid state NMR. The uptake efficiency and the interactions between ionic ligands such as phosphonates in the material with lead ions can be determined by ^{31}P NMR. This information is achieved using the phosphorus nuclei as sensors through their chemical shift isotropic signals and CSA components before and after lead uptake.6 Finally, zwitterionic active groups from L-glutathione and stable silicon oxide matrix were combined as a hybrid material to successfully remove As (V) ions (45 mg/g) from aqueous solutions as well as a more complex mixture of anions and cations.

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Application of viscoelastic polymer in wave isolation of stiffened panels

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Abstract

The wave isolation and vibration reduction of engineering structures have attracted more and more attention. The big challenge is how to change the dynamic performances of engineering structures without altering their structural strength and stability. Stiffened panels have been wildly applied in practical engineering for their high strength-to-weight and stiffness-to-weight ratios, designable flexibility, and other fantastic dynamic characteristics. In this paper, viscoelastic polymers are introduced to fill the gaps between stiffeners in a stiffened panel for isolating wave motion by their excellent damping properties. To investigate the influence of viscoelastic polymer fillers on wave motion of stiffened panel, the complex band structure with or without polymer fillers are calculated and compared, which is shown in Figure 1. In addition, the effect of polymer volume fraction is discussed for altering band gaps to isolate elastic wave propagation. There are two kinds of filling polymer strategies to be considered. One is each gap between two stiffeners with the same polymer fillers, and the other one is alternately filling the gaps with polymer fillers. Furthermore, the transmission spectrum of an aluminium periodic stiffened panel is experimentally tested. Results indicate that viscoelastic polymer fillers can isolate the wave motion at certain frequency range effectively, and the bandgaps can be adjusted by filling strategy to block the wave propagation at target frequency.

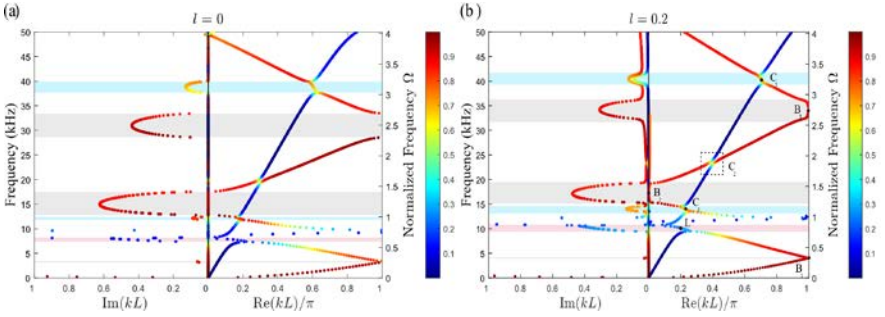

Figure 1. The complex band structure for stiffened panel (a)without and (b)with fillers.

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The enhancement of ionic conductivity of PVA based hydrogels by the addition of natural hydrocolloids as self-healing electrolytes

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Abstract

Ionic conductivity of the solid-state electrolyte is critical for applications involving prospective batteries. There were many attempts in achieving high ionic conductivity by the selection of appropriate salts. Regardless of the great progress in hydrogel electrolytes for flexible energy storage devices, it is still extremely difficult to put together a smart supercapacitor with strong ionic conductivity and efficient self-healing when damaged physically. Therefore, this study provides a solution in enhancing the ionic conductivity by the addition of natural hydrocolloids such as guar gum, konjac gum and apple fibers. Figure 1 shows a schematic illustration of the synthesis mentioned above, consisting of dissolving, mixing, and cross-linking processes. The ionic conductivity of obtained hydrogels was measured by Electrochemical Impedance Spectroscopy (EIS). These hydrogels are not only improving ionic conductivity but also improving thermal stability which is measured by thermal gravimetric analysis (TGA). Self-healing capability was achieved by using dynamic cross-linking with sodium tetra-borate hexahydrate (borax) and investigated by Brookfield RSO Oscillation Rheometer using time-dependent measurements in a shear strain mode. The effect of the addition of natural hydrocolloids to PVA network on the microstructure was studied by optical and scanning electron microscopy (SEM). The research that is being presented introduces a novel method for creating flexible, self-healing hydrogel that may be used for supercapacitors, wearable electronics, intelligent clothing, or flexible robotics.

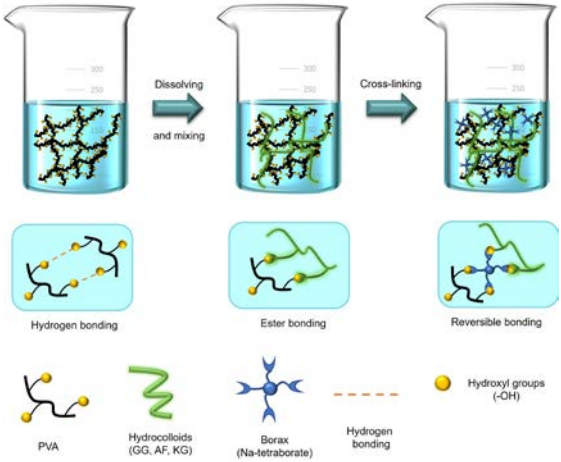

Figure 1. Schematic illustration of the synthesis process of ionically conductive hydrogels

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Investigation of the efficiency of polyethyleneimines modified with coordinating groups for the removal of corrosions products from aluminium surfaces

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Abstract

Nowadays, a responsible approach for use and handling of limited resources is more important than ever. Especially the efficient use of energy resources is in the economic and environmental focus. One material which is often used for parts in heat operating machines like heat exchangers or condensing boilers, is aluminium because of its good thermal conductivity (273 W/K·m). Despite its good chemical resistance, aluminium suffers from formation of surface-bound corrosion products after long term exposure to acidic medias, which lead to reduced heat transfer and a reduction of efficiency level. Harsh conditions such as mechanical abrasion and etching are traditionally used for removal, resulting in further damage to the surface. Therefore, a method is needed that works under mild conditions. The interaction of aluminium and its salts with chelating ligands could be used for this purpose. Multi-valent polymer-based chelate ligands should be able to disperse and solubilize surface-bound corrosion products, resulting in a removal without mechanical prework. In an analytical study we investigated the influence and efficiency of several polymer bound coordinating groups on the removal of corrosion products from aluminium surfaces. For basic investigations, a model system was designed based on defined aluminium sheets that were exposed to sulphurous acid for formation of surface-bound corrosion products. Commercially available polyethyleneimine was then modified with carboxylic, phosphonic and sulfonic groups by simple chemical reactions. Removal of the surface-bound corrosion products was tested through incubation of the corroded sheets in solutions of the modified chelating polyethyleneimines under various conditions (pH, polymer concentration). Furthermore, it was investigated whether the molecular weight of the polymers has an influence on the removal of surface-bound corrosion products. Evaluation of the experiments was carried out with digital optical microscopy. After determining the most efficient conditions for removal of the corrosion products, the experiments were repeated on corroded surfaces of a dismantled heat exchanger and evaluated for their effectiveness on real-life aluminium surfaces.

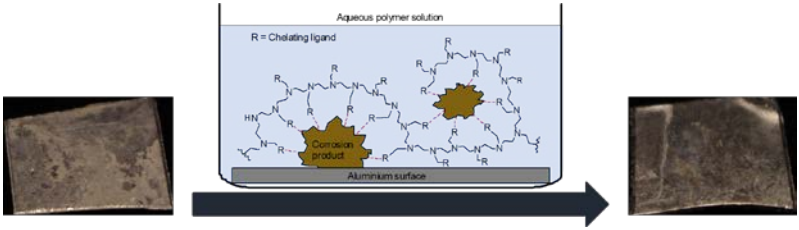

Fig. 1: Model system based on aluminium sheets (ca. 1 cm x 1 cm) with surface-bound corrosion products. After incubation in an aqueous solution of polyethyleneimine modified with coordinating groups, the corrosion products were removed, and a clean aluminium surface was obtained.

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Additive manufacturing of a recycled semi-crystalline polymer: Structure-property-printability correlations for PET

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Abstract

There is growing interest in developing manufacturing pathways for the upcycling of commodity plastics to address the global plastic waste problem. Additive manufacturing is a potential method for upcycling of waste plastic. In this work, extrusion-based additive manufacturing, fusion deposition modelling (FDM), is investigated as a means of converting waste plastic into value-added products. Specifically, changes in the molecular weight distribution, viscosity and degree of crystallinity of a semi-crystalline polymer are investigated. Polyethylene terephthalate (PET) has been chosen for this study. The thermomechanical and oxidative degradation of polymeric chains during extrusion affects the subsequent extrusion cycles through alterations to the viscosity and degree of crystallinity of PET. The present study investigates the effect of molecular and microstructural changes of PET on the 3D-printability as a function of the number of recycling iterations. The effect of repeated recycling and printing on the weight-average molecular weight (M_w), number-average molecular weight (M_n), peak molecular weight (Mp) and molecular weight distribution (MWD) of PET was measured using gel permeation chromatography. The melt viscosity of virgin and recycled PET was also measured for the effect on the printability of PET. The degree of crystallinity and crystal size were also determined using differential scanning calorimetry and X-ray diffraction, respectively. Tensile properties and thermal behaviour of the printed parts of virgin and recycled PET were measured after each reprocessing cycle using tensile testing and thermogravimetric analysis. Changes in the polymer structure of the virgin and recycled PET due to degradation were detected *via* Fourier-transform infrared spectroscopy. Reprocessing of PET *via* FDM-based additive manufacturing shows a significant change in polymer viscosity and degree of crystallinity due to the change in the MWD of PET. Variations in the viscosity and degree of crystallinity were found to affect the subsequent printability, particularly the dimensional stability of the printed object due to differential shrinkage. The study provides a fundamental insight into the structure and properties of recycled PET and its printability, providing key information for enhancing the printability of recycled semi-crystalline polymers.

Keywords: Semi-crystalline polymer, printability, extrusion, degradation, viscosity, molecular weight distribution, degree of crystallinity.

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Two-way Reversible Shape-Memory Polymers

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Abstract

Natural compounds such as bile acids have been used in the preparation of a variety of new polymers for biomedical and pharmaceutical applications. Bile acids are natural amphiphilic compounds that exist in the gastrointestinal tract and help in the digestion of fat by the formation of micellar aggregates. Degradable polyesters can be made from bile acid derivatives through entropy-driven ring-opening metathesis polymerization (ROMP) of macrocycles. Grubbs' catalysts based on ruthenium are used for both ring-closure reactions for the formation of macrocycles and for the ROMP reactions. The trace amounts of the transition metal catalysts left in the resulting polymers are undesirable and cause concerns for bio-related applications. To solve the problem, we used a solid-supported enzyme candida antarctica lipase B (CALB) in the preparation of macrocyclic monomers containing ester bonds, followed by an entropy-drive ring-opening polymerization using the same enzymatic catalyst. Both the ring-closure and ring-opening reactions are highly successful, yielding a collection of new polyesters. For the preparation of two-way reversible shape-memory polymers, we have designed co-crystallizable polyesters crosslinked through simple thiol-ene reactions. The reversible shape memory polymers may possess tunable actuation temperatures by changing the ratio of the comonomers. Such materials have been shown to exhibit light-actuated self-locomotion after the incorporation of polydopamine particles. The use of natural compounds and the good shape fixation and recovery make such polymers suitable for potential use as biomaterials.

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Sulfoxide Polymers: A New Class of Low-Fouling Polymers for Biological Applications

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Abstract

Poly(ethylene glycol) (PEG) has been used as the standard antifouling polymer for decades. However, increasing evidence has shown the limitations of PEG including especially its apparent immunogenicity. The PEG immunogenicity has significantly compromised its function as a safe stealth material and has been indicated as a possible cause for anaphylactic reactions to pegylated therapeutics such as mRNA-based vaccines for COVID-19.This has driven the development of other antifouling polymers as alternatives to PEG. The talk will present our research on investigating the potential of innovative sulfoxide polymers as a new class of antifouling polymers. I will talk about how the sulfoxide polymers can modulate the interaction between material surfaces and biological system, and their potential applications in constructing antifouling surfaces and long-circulating protein-polymer conjugates.

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Decomposition behavior of aliphatic polyesters under accelerated conditions for waste plastic treatment

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Abstract

Environmental issues caused by waste plastics are present worldwide. To solve this problem, biodegradable polymers that can be degraded by microorganisms have recently attracted considerable attention. Aliphatic polyesters, such as poly(butylene succinate) (PBS), are one of the most promising biodegradable polymers; however, most biodegradation studies on this polymer have been conducted in soil or composting conditions only. Biodegradation studies under water-based conditions, such as seawater, have not been reported till date. In this study, the biodegradability of the PBS fiber was investigated under seawater conditions. To accelerate the degradation under seawater, ultraviolet-C(UV-C) and surfactant were used. As biodegradation progressed, the weight average molecular weight and mechanical strength of PBS decreased, and the largest decrease was achieved when UV-C and surfactant were simultaneously treated. The surfactant made the surface of the PBS fiber hydrophilic to improve the adsorption of microorganisms and UV-C confirmed that the surface of the PBS fiber was cracked through photo-oxidation. To evaluate the reliability of the biodegradability measurements under seawater, the biodegradability of PBS was measured according to ISO 14855-2, and the results were compared. After 45 days, the degree of the biodegradability of PBS was 57%, and the weight average molecular weight was decreased from 153,000 to 44,000 g/mol. Results under seawater and ISO 14855-2 were compared, it was confirmed that the biodegradability under accelerated conditions was similar to the composting condition.

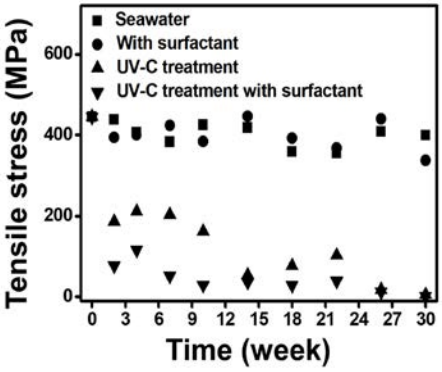

Figure 1. Tensile stress of PBS under different accelerated conditions.

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Functionalization of Metal-based Inorganic Nanoparticles with RAFT Polymer for Biomedical Applications

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Abstract

Metal based inorganic nanoparticles have received great attention owing to their potential applications in biomedical field.The current talk focuses on the surface modification of different inorganic nanoparticles using polymers synthesised through reversible addition-fragmentation chain transfer (RAFT) polymerization method. Through this approach, polymers with predictable molecular weight and precisely defined end groups can be obtained. Moreover, the resultant surface coating that renders them with both colloidal stability, biocompatibility and functionalisation. The obtained particles can be further used in biomedical applications including molecular imaging and theranostics. The current talk will focus on the fabrication of RAFT polymer on the surface of inorganic nanoparticles for the construction of multifunctional nanoprobes and the bioapplications in the diagnosis of tumor, thrombosis as well as type II diabetes.

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Study the Interactions of POM Based Binder System for Titanium Metal Injection Moulding (Ti-MIM)

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Abstract

Due to the multi-component binder system in MIM, obtaining a homogenous feedstock blend is difficult. Therefore, the study of interactions between binder system components is important for improving the processing properties of Metal Injection Molding (MIM) feedstock. This paper investigates the effects of different compatibilizers, EMA-GMA and EVA, on the interactions between polyoxymethylene (POM) and polypropylene (PP) blends. Contact angle measurement, Fourier Transform Infrared Spectroscopy (FTIR), and Atomic Force Microscopy (AFM) were carried out to identify the suitable compatibilizer that yielded POM/PP feedstock with excellent properties. It was found that the binder system based on EGMA, particularly EMA-GMA with 3wt%/% content demonstrates the lowest contact angle and best miscibility for the POM/PP blends compared to EVA. This enhanced interaction lies in the chemistry of EMA-GMA, having an active site that reduces the interfacial tension between the components of POM/PP binder system. Subsequently, this creates a positive interaction between the binder and metal powders, ensuring good adhesion within the feedstock.

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Nanoengineered membrane materials of energy and environmental applications

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Abstract

The emission of CO_2 to the atmosphere from the use of fossil fuels has been linked to global climate change. As estimated by the International Energy Agent (IEA), fossil fuels fulfilled 81% of the world energy demand in 2013. Among various CCS approaches, post-combustion CCS is the most urgent one since it can be directly retrofit to existing fossil fuel-fired power generators. Membrane technology has been considered as an economic and energy-saving alternative capture strategy to solvent scrubbing for the mitigation of CO2 from post-combustion exhaust gas (10-14% CO2 with mostly N_2). Permeance and selectivity are the two major criteria to evaluate the performance of any CO_2 separation membrane system. However, common dense membranes display insufficient capability for CO_2 capture due to their overall low flux (permeance) of CO_2.

Thin film composite (TFC) membranes can facilitate high CO_2 permeation and hence are of potential significance for large scale application which requires the treatment of high-volume flue gases in comparison with conventional membranes. The great challenge in assembling TFC membranes is to reduce the overall gas transport resistance without compromising membrane selectivity. In order to minimise the resistance, we designed and constructed a series of TFC membranes consisting of a porous MOF gutter layer and a nano-scale top selective layer. Such TFC membranes present extremely high CO_2 permeance with a good CO_2/N_2 selectivity. This performance is well above the boundary of the well-known target area for post-combustion CO2 capture applications.

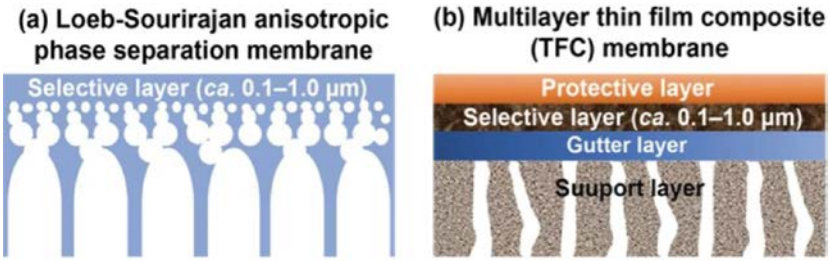

Figure 1. Configuration of (a) commercially used membranes and (b) multilayer TFC membranes.

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RAFT-based Networks as a 4D Polymer Platform

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Abstract

The advent of controlled polymerization techniques to polymer networks has allowed us and others to create "Living polymer networks (LPNs)". These combine the many advantages of RAFT and ATRP with macro-scale 3D networks to produce a network saturated with insertion points for new monomers. This results in a base polymer network which has the versatility to undergo a wide range of possible 4D transformations, only limited by what can be inserted.

Our work has had the primary focus of demonstrating the usefulness of LPNs as a potential 4D platform, which can be used to perform a multitude of post-production modifications. This has been facilitated by the use of visible light photo-RAFT techniques which provide a great deal of spatio-temporal control over the growth of the network. A key point of these networks is the symmetry of the RAFT agent within, which plays a great role in determining the growth behavior of the final network. We have explored the effects of this through two novel 4D transformations: growth-induced bending and crosslinker insertion for mechanical modification.

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How to quickly determine degradation rates of polymer materials?

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Abstract

Polymer materials have been widely used in various fields including aerospace, transportation, energy, and agriculture. The service lifetime and degradation period are thus concerned.

Conventional lifetime evaluation methods include natural exposure and lab accelerated aging. Physical and chemical changes during aging process are determined by various analytical methods to show the aging mechanism and kinetics. Natural exposure gives the real lifetime of a material in outdoor environment. But it is extremely time-consuming (months to years), and the evaluation results vary with climate conditions. Lab accelerated aging supplies repeatable evaluation result during shortened period of months. But sometimes the lifetime result is inconsistent with the real behavior, because of the difference between the instrumental condition and the service condition.

A novel method has been developed to quickly determine degradation rates of polymer materials. This method is based on the sensitive detection of trace volatile degradation products during the early aging period under flexible solar irradiation/temperature/humidity/atmosphere combinations. Therefore, the evaluation period can be shortened to hours, and the evaluation can be carried out under various photo- and thermal oxidation conditions. The results have been proved to have good correlation with that from natural exposure.

With this method, the degradation rates of a series of polyethylene (PE) and polypropylene (PP) composites under various climate conditions were determined. PE and PP have different sensitivities to different climate factors and thus their degradation rates depend on climate conditions. The aging activation energy were also determined. Evaluation of biodegradable polymers such as polylactid acid (PLA), poly(butylene-succinate) (PBS) and poly (butyleneadipate-co-terephthalate) (PBAT) under natural and compost conditions are under investigation.

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Effect of 3D printing settings and post-processing conditions on polyacrylate materials used in stereolithography

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Abstract

Production of 3D components with a wide range of customization options is made simple and affordable by additive manufacturing. Stereolithography (SLA), which enables the production of micro- and milliscale reactionware (Figure 1) utilizing transparent materials, is one particularly intriguing technological advancement. This study examines the effects of 3D printing parameters, including printing angle, layer thickness, post-processing conditions, test sample size, and form, on mechanical, thermal, and physico-chemical properties. Clear and High Temperature are two photocurable acrylate resins that were utilized for 3D printing. Several techniques and various treatment durations were used to post-cure the test samples. According to the results of the tensile test, a higher degree of cure yields a higher tensile strength and less elongation. Compared to some post-curing techniques, layer thickness and print angle have a greater impact on tensile strength. The toughest samples were discovered to be those printed at a 45° angle with a 25 μm layer thickness. Clear samples are reported to be able to take greater stress and strain than High Temperature samples, however High Temperature samples are more stiff and have a higher Young's modulus. Differential scanning calorimetry (DSC) measurements reveal that post-curing lowers the curing enthalpy while raising the glass transition temperature, a sign that the polymer chains have been crosslinked.

With an absorption of less than 2% over the course of 24 hours, the swelling test revealed that both resins can be regarded as water resistant. High Temperature resin was found to be more resistant to ethanol and acetone than Clear resin. The samples that had been post-cured in the SunTest chamber also displayed significantly less ethanol and acetone absorption. No matter how much post-curing has occurred or how the printing angle has been set, the contact angle test reveals that all samples are hydrophilic.

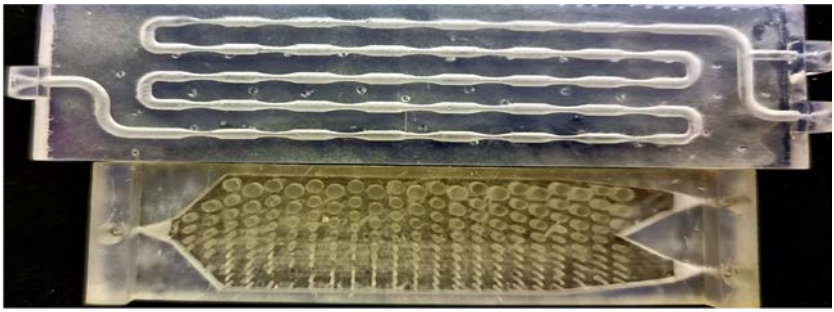

Figure 1. 3D printed transparent millireactor printed on a stereolithographic 3D-printer..

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Imaging the Molecular Orientation at the Disperse-Continuous Interface of a PP-PA6 blend by the Four-Polarization FTIR Method

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Abstract

Fourier-transform infrared spectroscopy (FTIR) is a well-known technique used to analyze the chemical composition of polymeric materials by measuring the absorption of infrared light over a range of wavelengths, where each absorption peak corresponds to a specific chemical bond. A chemical map image can be constructed by acquiring multiple IR spectra with a specified step distance over an area. Furthermore, it is possible to extract information about the molecular orientation by utilizing linearly polarized light, as the absorption intensity varies with the polarization angle of the incident radiation. Recently, a mathematical method was introduced which makes it possible to create a complete vector map of the dipole orientation of a selected vibrational mode by utilizing measurements of IR spectra in four different polarized orientation. In this work, we seek to gain insight into the molecular orientation near the interface between the disperse phase and the continuous matrix of a polypropylene-polyamide 6 (PP-PA6) blend by comparing an uncompatibilized blend with a blend compatibilized with the addition of maleic anhydride grafted polypropylene (PP-g-MA) [4] and another with the application of a novel in-situ plasma treatment. The goal of plasma treatment is to introduce polar oxygen groups such as C–O, C=O, and O–C=O, promoting stronger interactions between phases. Plasma treatment is widely used as a surface treatment to increase wettability and adhesion, but its use as a compatibilization method of blends is relatively new and has already provided positive results. However, the mechanisms behind the improvements in this context are mostly unknown so the current research will provide valuable data for further development of this novel polymer modification method.

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Direct-ink-write 3D printing of "living" polymer hydrogels via type I photoinitiated RAFT polymerization

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Abstract

In a world first, a direct-ink-write (DIW) 3D printer was used to prepare "living" hydrogels which were photopolymerized during the printing process via the type I photoinitiated RAFT polymerization mechanism.1 The "living" photoinks used in the DIW 3D printer consisted of acrylamide (AAm) monomer, poly(ethylene glycol) diacrylate (PEGDA) crosslinker, lithium phenyl-2,4,6-trimethylbenzoylphosphinate (LAP) photoinitiator, Carbomer 940 thickening agent and either symmetric 2,2'-[Carbonothioylbis(thio)]bis[2-methylpropanoic acid (2CBA) or asymmetric 4-((((2-Carboxyethyl)thio)carbonothioyl)thio)-4-cyanopentanoic acid (4CCA) as RAFT agent. Significantly, the "living" photoinks were water-based, which presents a crucial improvement in "living" 3D printing technology towards more environmentally friendly smart materials.

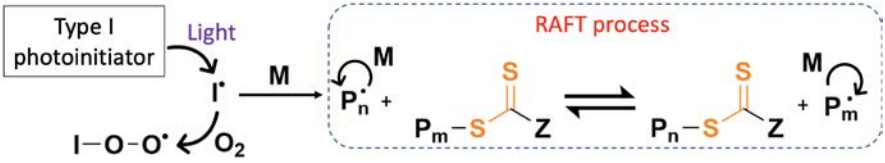

Figure 1. The photoinitiated RAFT process used to polymerize the "living" photoinks during DIW printing. The built-in photocuring module in the Cellink BIO X 3D printer provided the 405 nm light needed to initiate the reaction. Radical-scavenging oxygen molecules are consumed via the large radical flux generated by high loadings of LAP photoinitiator, allowing DIW printing to be carried out in open air.

The "living" quality of the 3D printed hydrogels was demonstrated by modifying the parent networks in the post-production stage with two new monomers ((N,N-dimethyl acrylamide (DMAm) and N-isopropyl acrylamide (NIPAM)) via the photoiniferter RAFT mechanism, which led to the creation of chemically-distinct daughter "living" networks.2 Furthermore, multimaterial "living" 3D printing was demonstrated by taking advantage of the multiple extruders of the DIW 3D printer to create multimaterial hydrogel objects from the "living" photoinks. This research showcases an important development in "living" polymer chemistry and additive manufacturing technology towards non-toxic multimaterial smart hydrogel production.

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Phase transitions at liquid-liquid interfaces

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Abstract

In recent years, with the fast development of microfluidic techniques, complex polymer emulsions have growing demand in interdisciplinary areas. For example, in broadly used water-in-oil-in-water (W/O/W) double emulsions, biodegradable polymers usually constitute the middle oil phase and load cargoes inside for various purposes in food, pharmaceutical, and cosmetics industries. Controlling polymer phase transitions at such complex liquid-liquid interfaces is the key to modulate the geometries and functions of polymer emulsions. Our study intends to understand the fundamental mechanism of polymer crystallization and phase separation at those double emulsion interfaces.

We find that crystallization of semicrystalline polymers drives the spherical liquid droplets to anisotropic solid microcapsules. Crystal growth shows a linear relationship with time, irrespective of flat-on, edge-on, or continuous twisting lamellar arrangement in the shell. The anisotropic shape and lamellar arrangement impart the crystallized microcapsule with orientation-sensitive birefringence. A representative feature is that all anisotropic microcapsules exhibit two types of Maltese cross, depending on the microcapsule orientation. We demonstrate that the poly(1,4-butylene adipate) shell with flat-on lamellar arrangement always shows positive birefringence, while the polycaprolactone shell with edge-on lamellar growth may present negative or positive birefringence at specific orientation angles.

We study liquid-liquid phase separation at double emulsion interfaces in a series of immiscible polymers. A generic phase diagram is revealed based on experiments and theoretical analysis. The role of interfacial tension in various systems is normalized by a linear relationship of spreading coefficients. Based on this theoretical guideline, the liquid-liquid phase separation can be modulated with a low fraction of amphiphilic block copolymers, leading the double emulsion droplets configurable between compartments and anisotropic membranes. We can further take advantage of phase separation and osmotic pressure to rupture microcapsules at specific locations. The theoretical analysis and experimental protocol in this study yield a generalizable strategy to prepare multiphase double emulsions with controlled structures and desired mechanical stability.

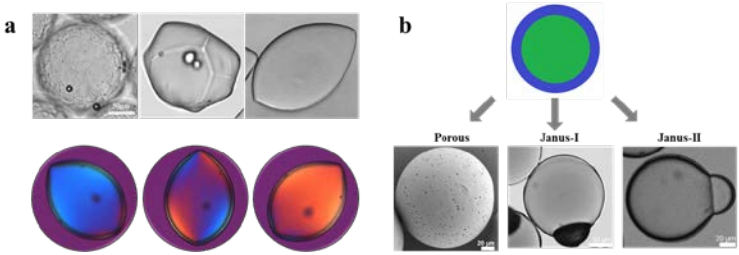

Figure 1. (a) Crystallized microcapsules and orientation-sensitive birefringence. [2] (b) Polymer microcapsules after liquid-liquid phase separation.[3]

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Novel Transformations in RAFT-based Living Polymer Networks

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Abstract

Our work revolves around living polymer networks (LPNs) and the exploration of their capabilities. Using RAFT-based LPNs we have recently demonstrated two novel examples of 4D modification, which can be linked to findings from our previous work.

In 2020 we demonstrated the first example of growth-induced bending, whereby we could use growth on one face of an LPN strip to induce stress and cause the sample to bend. Since then we have further studied the effects of different variables such as RAFT concentration, RAFT symmetry, crosslinking amount, and monomer composition. Through this we have been able to discern the likely mechanisms for bending and link that with our study of RAFT symmetry.

Previous mechanical modification of LPNs has always used monomer insertion to induce changes in the network's physical properties. In our work we demonstrate the first example of crosslinker insertion with the purpose of increasing the toughness of the daughter network. To do so we used the iniferter process by green light to activate the RAFT agent directly and avoid polymerization of the crosslinker separately. We showed that we were able to increase the toughness of a symmetric RAFT LPN which would typically be weakened by normal monomer insertion.

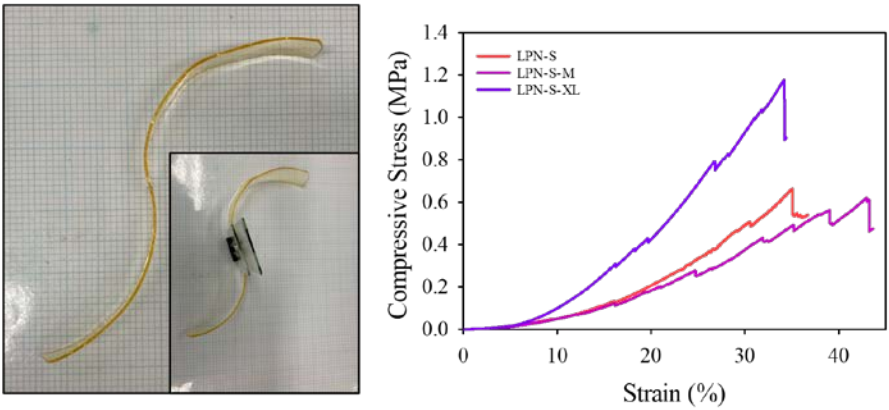

Figure 1. (Left) Image of sample bent into S-shape from original flat strip. (Right) Graph showing the compression testing results of a symmetric RAFT LPN parent, monomer growth, and crosslinker growth respectively.

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Living Polymer Networks

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Abstract

The introduction of controlled polymerization techniques to polymer networks has allowed us to create "Living polymer networks (LPNs)". These combine the versatile and adaptable nature of methods such as RAFT and ATRP with macro-scale 3D networks to produce materials capable of undergoing various 4D transformations. Typically 4D materials are restricted to particular transformations; however, these LPNs can perform either a single or multiple transformations, both sequentially and simultaneously.

Our focus has been on creating RAFT networks and demonstrating a number of the potential transformations. We use visible light photo-RAFT techniques to both produce and modify our networks, with the process driven by either photocatalysts or direct activation of the RAFT agent. Some of our published work includes 3D/4D printing, surface modification, stimulus-response, size and mass growth, physical property modification, self-healing, and growth-induced bending. Furthermore, the use of light allows us a great deal of spatial and temporal control over the growth process. Together this demonstrates the use of living polymer networks as a platform for performing 4D transformations.

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Polymerized small molecule acceptors for high performance all-polymer solar cells

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Abstract

The active layer of the all-polymer solar cells (all-PSCs) are composed of a *p*-type conjugated polymer (p-CP) as donor and an *n*- type conjugated polymer (*n*-CP) as acceptor, and the all-PSCs possess the advantages of mechanical flexibility, good thermal and photo-stability for the application of flexible PSCs. Therefore, all-PSCs have attracted great attention in the field of organic/polymer solar cells.

Actually, the first all-PSC was reported in the same year (in 1995) with the bulkheterojunction (BHJ) PSCs. However, the power conversion efficiency (PCE) of the all-PSCs was much lower than the PCBM (fullerene derivative)- or the narrow bandgap small molecule acceptors (SMAs)-based PSCs before 2016 due to the poorer photovoltaic performance of the n-CP acceptors. In 2016, my group realized the highest PCE of 8.26% for the all-PSCs based on the most representative n-CP N2200 as acceptor. But the weak absorbance of N2200 at long wavelength range limited the further increase of short circuit current density and PCE of the all-PSCs.

In considering the broad absorption and strong absorbance of the SMAs reported since 2015, in 2017 we proposed a strategy of polymerized SMAs (PSMAs) to synthesize a high performance *n*-CP PZ1 by copolymerizing the SMA IDIC with thiophene linking unit, and the PZ1-based all-PSC reached a higher PCE of 9.19%.The PSMAs have become a hot research topic in the field of PSCs in recent years[4], especially after the appearance of the SMA Y6. Recently, PCE of the all-PSCs with the Y6 derivative-based PSMA as polymer acceptor has rapidly increased to the level of 16~17%.

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Unveiling and Exploiting Thermally-Triggered Changes in Hydration State in LCST Polymer Brushes for Biomedical Applications

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Abstract

Stimulus-responsive polymers have been reported to afford essential functionality in various architectures and devices, not limited to biomedical applications. By exploiting the transition at the lower critical solution temperature (LCST), changes in important interfacial properties may be triggered. These include among others pronounced changes in swelling as well as mechanical and adhesive properties, and a more gradual change in wettability. In our contribution ultrathin polymer coatings of thermoresponsive poly(di(ethylene glycol) methyl ether methacrylate (PDEGMA) brushes are introduced as powerful platforms for culturing and selective purification of e.g. human induced pluripotent stem cells (iPS) from differentiated cells [1] and for the implementation of a triggered antibiotic release function in titanium-based implants afforded via the intelligent polymer brush coating [2]. In particular, the results of recent studies aimed at (i) broadening the scope of the cell release platforms to a broad range of substrates and (ii) obtaining a deeper understanding of the property changes associated to the transition at the LCST will be elucidated. This insight is afforded by time-resolved fluorescence microscopy analyses of the tracer dye Nile red, which serves as a local nanoprobe for the hydration state of the brushes, and atomic force microscopy (AFM) nanoindentation analyses performed in situ at various temperatures across the LCST. Similarly the temperature-dependent release of the fluorescent antibiotic levofloxacin from PDEGMA brushes was analyzed quantitatively, revealing a hitherto unreported 3 stage release behavior over more than of 4 orders of magnitude in time from 30 s until 174 h. This complex behavior observed indicates the presence of distinct environments within the brush layer.

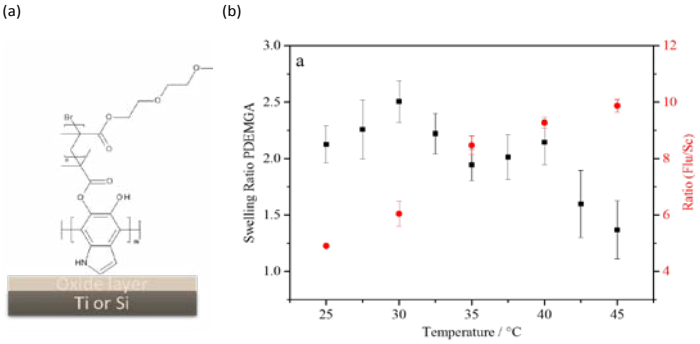

Figure 1. (a) Schematic structure of PDEGMA brushes polymerized from a polydopamine layer on oxidic substrates. (b) Comparative plot of swelling ratio and fluorescence intensity of Nile red revealing the changes of brush hydration associated to the transition at the LCST.

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Searching solutions for multilayered packaging recycling: dual modification of the polyurethane adhesive

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Abstract

Packaging accounts for most of the post-consumer plastic waste that accumulates in our environment. One of the most challenging problems is recycling multilayered packaging materials, which are multicomponent systems with multiple functionalities obtained by combining polymer films of different nature bound by adhesives. The separation for reuse of these complex systems is very difficult and most multilayer plastic packaging usually ends up incinerated or landfill. Finding solutions to increase the recyclability of these materials is of great importance and several routes have been proposed, including the development of innovative methods to separate the different components [1].

Recently, we have developed new sustainable polyurethane (PU) adhesives that incorporate thermoreversible functionalities in order to be reusable and employed in delamination of polymer-based multilayer systems [2]. Molecules with dynamic covalent Diels-Alder (DA) bonds, which can be reversibly opened and closed via temperature, were incorporated. The influence of the chemical structure and concentration of the DA adducts, the feed ratio between the different adhesive components and the adhesive type on the thermoreversible behavior and physical properties of the modified PU adhesives was investigated. It will be shown that the bonding/debonding properties of the adhesives are mainly controlled by the concentration of the DA adducts, with a minimum thermoreversible bond (TB) content required to have a significant influence on the physical properties of the adhesive. Moreover, depending on the adhesive type the breaking/formation cycle of the TB can be repeated up to ~ 20 times.

In a second stage, radiation absorbing nanoparticles such as graphene were also incorporated into the PU adhesive formulations. On irradiation with infrared light, these well-dispersed particles generated hot-spots in the material due to the photothermal effect leading to rapid and homogeneous heating of the adhesive, increasing the efficiency and rate of the DA bonds rupture. It will be shown that bond opening in the graphene-modified PU adhesive network can be remotely triggered using electromagnetic radiation in tens of seconds.

The combination of both modifications takes us a step closer to new reusable PU adhesives and offers a versatile strategy for the delamination of multilayered film packaging materials in order to recycle their components into clean waste streams and drive towards a circular economy solution for multilayer plastics.

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The key role of polymeric interactions in the eco-design of mechanically recyclable multilayered packaging

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Abstract

Multilayered packaging is one of the most important applications in the world of plastics, but it is also one of the most problematic, owing to a lack of compatibility between the various components. One of the most common multilayer assemblies on the market is made up of polyolefins (structural component), ethylene/vinyl alcohol copolymers (barrier component), and an adhesive or tie layer (usually an ethylene copolymer). These complex systems are difficult to recycle because they require a separation processes (which are both contaminant and expensive) or mechanical recycling (use of compatibilizers). The main goal of this communication is to investigate the interactions between the components in order to find the best design for subsequent mechanical recycling. For this presentation we have focused our attention in the system formed by polyethylene (PE), ethylene/vinyl alcohol copolymer (EVOH) and tie layers of different functionality (ethylene/ethyl acrylate –EVA– and ethylene vinyl acetate –EEA– copolymers, and ethylene/methyl acrylic acid sodium –EMAANa– ionomers).

Transmission electron (TEM) and atomic force microscopy (AFM), calorimetry (DSC), infrared spectroscopy (FTIR), linear rheology and computer simulations have all been used to investigate the interactions between the various components of a typical multilayer. The melting point depression Nishi-Wand approach was used to determine the compatibility of the multilayer's different partners. This method requires the presence of at least one crystallizable component. To avoid undesirable effects, single crystals (PE) or microcrystal aggregates (EVOH) were embedded in materials with different functionality (EVA, EEA, and EMAANa), which are commonly used as tie agents in multilayers. First, the morphological aspects of the single crystals and aggregates have been evaluated. Second, the compatibility of all tie agents with both PE and EVOH has been determined, in order to define the most effective system for a subsequent compatibilization during the recycling step. Finally, selected blends prepared to ensure interactions at the segment level have been studied by melt rheology. It will be seen that the polyolefin component will play a crucial and limiting role. The results indicate that the molecular architecture of these materials is of key importance and will be critical to the eco-design of multilayer systems when it comes to obtaining mechanically recyclable systems.

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Characterization of PET-co-PCL synthesized using catalytic transesterification

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Abstract

Copolymersing polyethylene terephthalate (PET) with an aliphatic polyester, such as polycaprolactone (PCL), may present an alternative recycling strategy for PET if the resultant copolymer is biodegradable. Limited success with creating a biodegradable blend between PET and PCL means a better understanding of the transesterification mechanism is needed to reach a degree of transesterification necessary for a biodegradable copolymer. This study investigates the effectiveness of various catalysts in synthesizing PET-co-PCL. Characterization using nuclear magnetic resonance (NMR) spectroscopy, differential scanning calorimetry (DSC), and gel permeation chromatography (GPC) was performed. PET and PCL were blended at 280°C under a nitrogen atmosphere using nine different catalysts, with different ligands and metal ions of varying acidity. Titanium ethoxide and titanium butoxide both show a high degree of transesterification and yielded a randomized copolymer suggesting an insertion-coordination mechanism. Structural information of the randomized copolymers was quantified by NMR spectroscopy and found to consist of di-blocks of PET and PCL, as illustrated in Figure 1. DSC results showed a single glass transition temperature with no prominent melting peaks, which suggests the titanium catalysts' synthesized an amorphous and monophasic PET-co-PCL polymer. Catalyst loadings substantially influence the degree of transesterification and the molecular weight of the copolymer. No significant difference was observed between 2 and 20 min reaction time using these catalysts, indicating that transesterification reaches equilibrium rapidly upon addition of catalyst, and the process would be adaptable to reactive extrusion. This study's results will help identify the catalytic mechanism and provide insights into the characteristics and properties of PET-co-PCL.

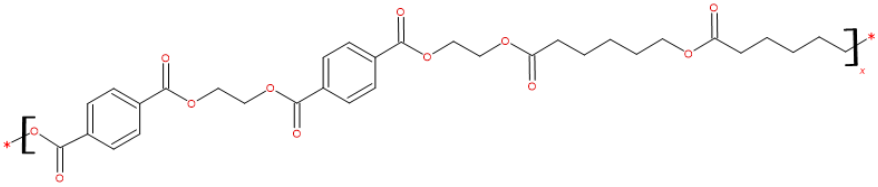

Figure 1. Structure and sequences of PET-co-PCL determined by NMR spectroscopy.

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Gallium Liquid Metal Nanoparticles Mediated 3D and 4D Printing

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Abstract

Gallium (Ga)-based liquid metal alloys, as metallic fluids at ambient temperature, possess fluidic flexibility and typical metallic characteristics, including high densities, outstanding thermal properties, and electrical conductivities. At present, liquid metal nanoparticles (LMNPs) as new generation soft nanomaterials have attracted significant attention in the field of polymer science. For example, surface-initiated atom transfer radical polymerization was performed at the oxide layer of LMNPs to produce nanodroplets.

In this study, LMNPs were directly prepared in the photopolymerization resins to fabricate polymeric materials using stereolithographic 3D printing. The manufactured items display high resolution, smooth surface, and homogeneous nanoparticle dispersion. The integration of LMNPs into 3D printing can reduce the glass transition temperature and mechanical properties of fabricated materials owing to the low melting point and soft nature of nanoparticles. In contrast to the synthesis of solid nanoparticles (such as gold, silica, and metal-organic frameworks), LMNPs are prepared in various stereolithographic resins using the one-pot approach. This straightforward method eliminates the time-consuming nanoparticle purification procedure and streamlines the 3D printing steps. Moreover, the extraordinary photothermal effect of 3D printed objects containing LMNPs provides a one-pass approach to initiating the 4D printing process under NIR light irradiation (λmax = 808 nm). These 3D and 4D printing techniques facilitated by LMNPs should provide access to a variety of multifunctional and stimuli-responsive materials.

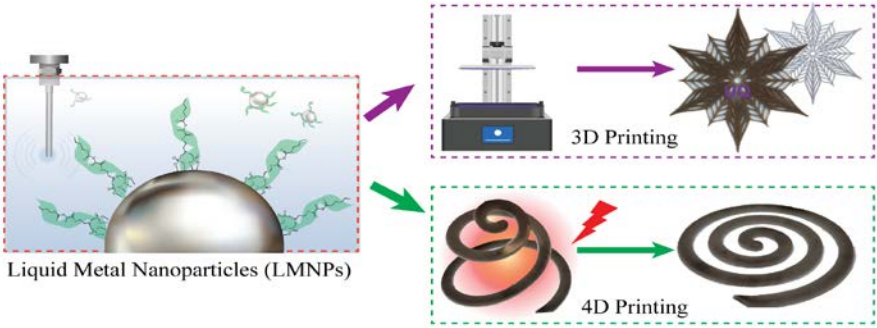

Figure 1. Schematic illustration of the preparation of LMNPs via one-pot approach and its use in three/four-dimensional printing.

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Conducting polymer biointerfaces and applications

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Abstract

The development of soft bioelectronics for applications such as stimulation of 3D cell constructs in tissue engineering or for in situ recording in organ-on-a-chip devices remains a challenge. Conducting polymers (CPs) are shown to be electroactive biointerfaces in such applications, as well as stretchable and soft skin bioelectronics.

In this talk, we will present several different approaches to electroactive biointerfaces based on conducting polymers. The first approach overcomes the issue of poor solubility and processability of CP by functionalisation of CPs with various moieties and provides these materials with various biomimetic properties, such as adhesion, stretchability and self-healing. The second approach addresses the issue that electrodes are commonly 2D and as such cannot fully probe the actual 3D cell environment within tissues and organs. Our approach to overcome that is based on a precise fabrication of individually addressable, high aspect ratio, 3D CP microelectrode arrays. We demonstrate several applications of such arrays. The third approach is based on the design and fabrication of flexible, microporous, electrochemically switchable membranes. We demonstrate the use of such membranes for fast, selective, non-destructive and efficient capture and subsequent release of intact extracellular vesicles (EVs) and cells.

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A preliminary investigation of the tacticity of some chain-growth polymers obtained through radial routes using high-field NMR spectroscopy

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Abstract

During the course of our investigations on chemical modifications of some acrylic- and styrenic-polymers with phosphorus-containing groups, we have synthesized polymethyl methacrylate (PMMA) and polystyrene (PSt) through a variety of polymerization routes, by essentially employing different initiator/solvent systems. These chain chain-growth techniques included, solution, aqueous-slurry, suspension, emulsion and bulk procedures. The formed polymeric products, after purification and drying, were subjected to detailed NMR investigations using a 600 MHz instrument. The resulting tacticity features of polymethyl methacrylate (PMMA) was obtained primarily from the fine structure of methylene, methine and α-methyl protons, whereas the ^{13}C signals of the ipso-aromatic carbons were utilized for polystyrene (PSt). A detailed spectral analyses revealed that, regardless of the nature of the initiating radicals and/or the media, predominantly syndiotactic PMMA and atactic PSt were obtained.

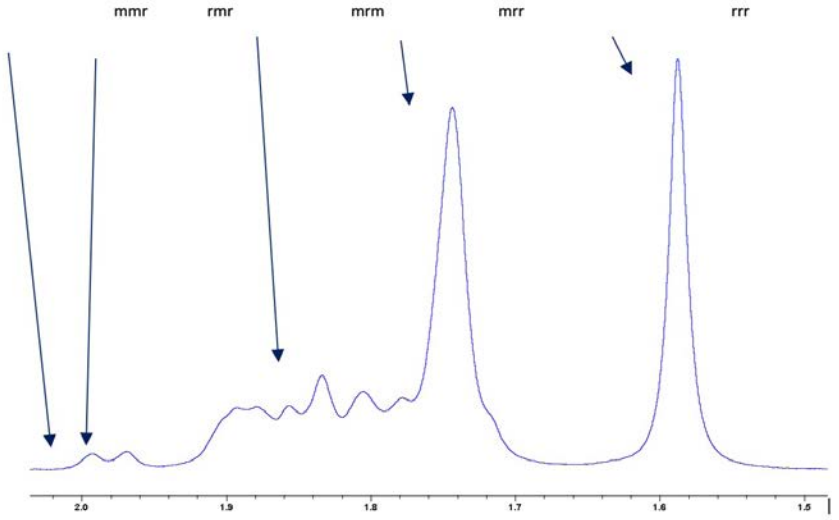

Figure 1. 1H NMR (600 MHz) spectrum of PMMA obtained through the aqueous-slurry route: region predominantly showing the syndiotactic placements of the β-CH2 protons

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Biomimic Self-assembly of Amphiphilic Helical Poly (phenylacetylene)s

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Abstract

Allostery can regulate protein self-assembly which further affects biological activities, and achieve precise control over the chiral suprastructures during self-assembly remains challenging. Similar to biomacromolecules, such as polypeptides and DNA, poly(phenylacetylene)s (PPAs) possess unique helical structures with tunable cis-cisoidal (*c-c)* or cis-transoidal (*c-t*) helical conformation and also display excellent circularly polarized luminescence (CPL) performance. Herein, to mimic the allosterical nature of proteins, the poly(phenylacetylene)s block copolymers PPA-*b*-PsmNap with the dynamic helical backbone were synthesized to investigate their conformational-transition-induced self-assembly. As the helical conformation of the PsmNap block spontaneously transforms from *c-t* to *c-c*, the decreasing solubility of PsmNap blocks in THF induced self-assembly of PPA-b-PsmNap. The self-assembly structures of copolymers can sequentially evolve from vesicles to nanobelts to helical strands during the process of conformation transformation. The screw sense of final helical strands were closely correlated to the helicity of the block PsmNap. This is helpful to understand the mechanism of allostery-modulated self-assembly.

To mimic a double helical DNA, amphiphilic PPAs homopolymers with branched hydrophobic alkyl chains and hydrophilic EO chains were constructed. Driven by hydrophobicity of alkyl sidechains and crystallinity of helical chains, the PPA homopolymers can be self-assembled into regular 2D hexagonal nanosheets in THF/EtOH mixed solvents. The sizes of 2D nanosheets has tunable diameters of 1~100 μm and tunable thicknesses closely correlated to the molecular weights. The polymers with different helical conformations can be self-sorted and assembled into 2D hexagonal nanosheets as distinguished on basis of their different fluorescent properties, whereas 2D self-assembly can occur in polymers with either *c-t* or *c-c* helical conformations. Under the restriction of highly ordered hexagonal lattice, the 2D lamellar structure can significantly enhance the CPL of polymers. The effects of molecular weight, helical conformation, side group structure, solvent and temperature on the self-assembly and its CPL properties were investigated systematically.

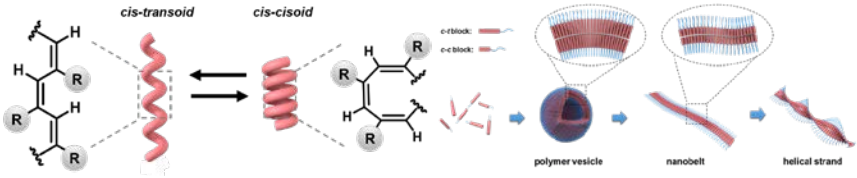

Figure 1. Allostery-Mimicking Self-assembly of Helical Poly(phenyacetylene) Block Copolymers.

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Self-assembling Block Copolymers as Base Materials for Vitrimers and Membranes: Preparation, Modification and Performance

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Abstract

Self-assembling block copolymers can be used for applications, which require the combination of different properties on small length scales. Due to microphase separation, well-controlled block copolymers can form regular nanostructured materials, where the different microphases contribute different properties to the material. In this contribution two areas will be addressed. In the first part block copolymers are presented as base materials for vitrimers, by introducing the thermoreversible chemical cross-links in one of the blocks of binary and ternary block copolymers. The thermomechanical properties of these nanostructured vitrimers will be compared with vitrimers made from random copolymers of similar total composition. The second of the presentation will deal with so-called isoporous membranes from block copolymers using the non-solvent induced phase separation process. The resulting membranes display an integral asymmetric structure with narrow-disperse pores in the top layer. This process is a combination of thermodynamically driven microphase separation of the block copolymer during evaporation of the solvent from the cast block copolymer solution film and subsequent macrophase separation of the block copolymer during the non-solvent solvent exchange when quenching (kinetically trapping) the structure in the precipitation bath. Alignment of the pores of the membranes can be enhanced by the exposure to electric field during processing [6]. Possibilities to manipulate the diameter, length and functionality of pores in block copolymer membranes will be presented.

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Proton and Redox Couple Synergized Aqueous Electrolytes for Low Voltage-Driven Amorphous WO_3 Electrochromic Devices.

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Abstract

WO_3 electrochromic film has a prospect of application in smart windows attributed to its excellent stability and high modulation rate. However, its further application is limited by the requirement of high charge density in the fully colored state and the environmentally unfriendly organic solvents. In this research, an eco-friendly aqueous solution and highly reactive protons were used as solvent and guest ion, respectively. A synergistic redox couple-catalytic counter electrode strategy (RC-CCE strategy) was designed to balance the charge change on the working electrode, where MoS_X was utilized as an efficient catalytic material to accelerate the conversion of TMTU/$TMFDS^{2+}$ on the counter electrode. High transmittance modulation (ΔT_{max} = 68% at 600 nm) and ultra-low voltage driving were achieved in the prepared devices. Furthermore, we have applied the electrochromic device as a smart window in a house model, which can effectively reduce the temperature inside the model under solar illumination and has promising futures for advancement and deployment.

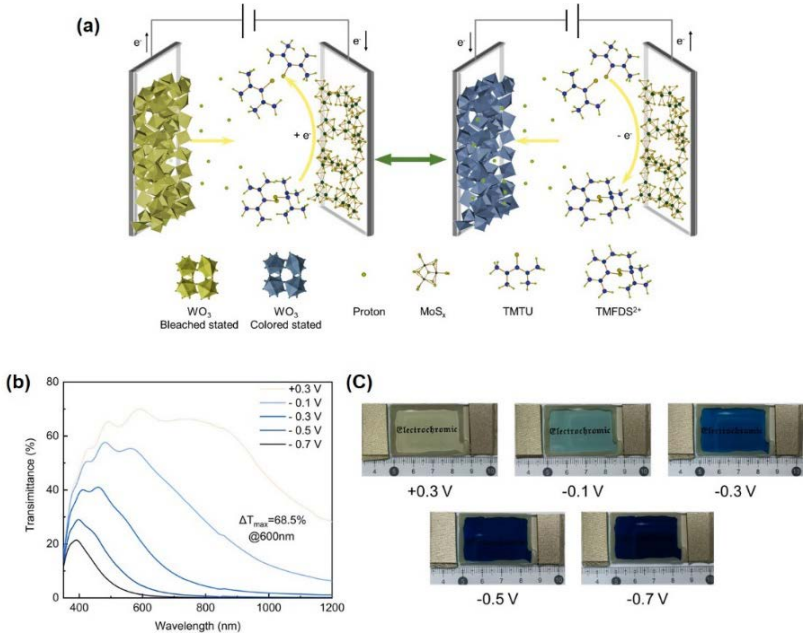

Figure 1. Schematic diagram of the structure of the electrochromic device (a), its transmittance spectra at various voltages (b), and the corresponding photographs (c).

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The physicochemical and antibacterial properties of chitosan-based materials modified with phenolic acids irradiated by UVC light

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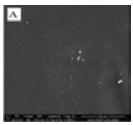
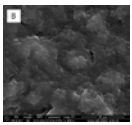
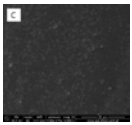
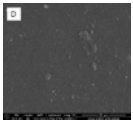
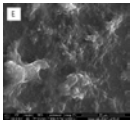
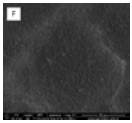
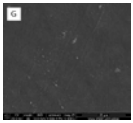
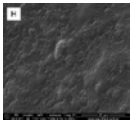
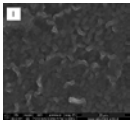
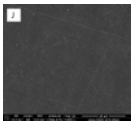
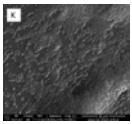
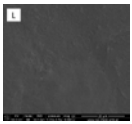
Abstract

Phenolic acids are naturally sourced compounds that may act as polysaccharides cross-linkers. The study concerns the physicochemical properties of chitosan/phenolic acid thin films irradiated by UVC light. Thin films based on chitosan with tannic, caffeic and ferulic acid addition were obtained by solvent evaporation and characterized as potential food-packaging materials. Such materials were exposed to UVC light (254 nm) for 1 and 2h to perform the sterilization process. Different properties of thin films before and after irradiation were determined by various methods such as FTIR, SEM, AFM, DSC, mechanical properties, and by surface free energy determination to consider the UVC light influence on the materials' properties. Moreover, the antimicrobial activity of the films and their potential to reduce the risk of contamination were assessed. The results showed that the phenolic acid improves the properties of chitosan-based films, that short UVC radiation may be used as a sterilization method for those films, and also that the addition of ferulic acid allows obtaining effective antimicrobial activity (Table 1), which has significant benefit for food packing applications.

Table 1. Comparison of bacterial adhesion to the films surface after 14 days of incubation in a bacterial suspension for films irradiated for 2h (SEM 5000×)

Specimen	Control	Staphylococcus aureus	Escherichia coli
CTS			
CTS+FA			
CTS+CA			
CTS+TA			

61

Understanding indentation creep in polymer materials. The new case of sustainable crosslinked polyurethane adhesives

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Abstract

Creep can be generally understood as the viscoelastic and/or viscoplastic response of a material under application of a constant load and appears to be quite fundamental for a comprehensive understanding of the material performance. Indentation testing represents a convenient method for the study of creep processes because it requires quite a small amount of sample and it can provide spatial resolution. Traditional indenter testers based on the optical imaging of the residual impressions analyse creep in terms of viscoplastic deformation. The advent of modern instrumented indenters allowed the separation of viscoelastic and viscoplastic creep. Early indentation creep studies on a wide variety of polymers suggested distinct mechanisms behind mechanical flow.

Recently, we have developed novel adhesives as binders for multilayer packaging that can facilitate the separation of the components. The strategy is based on the incorporation of Diels-Alder (DA) covalent bonds to a polyurethane (PUR) network. By heating above T » 90 ºC the DA bonds dissociate producing a breakdown of the PUR structure. Consequently, adhesion properties are lost and this can be used to facilitate delamination in multilayer systems. Different adhesives formulations were used and this was expected to influence the molecular architecture and in particular, the crosslinking density of the PUR network.

This presentation will offer a survey of the correlations found along the years between indentation creep resistance and molecular and structural characteristics of polymer materials of different nature (thermoplastics, elastomers, thermosets). The influence of crystallinity, crystal size, soft and hard fillers, branching and crosslinking will be discussed. The new case of sustainable PUR-DA adhesives will be thoroughly examined. It will be shown that the incorporation of adduct promotes viscoelastic flow. Parallel-plate shear rheometry results support this finding and suggest that it is associated to changes in the network crosslinking density.

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Synthesis and Multi-Mechanistic Characterization of Fluoro-polymers and High Yield Carbon Precursor Networks.

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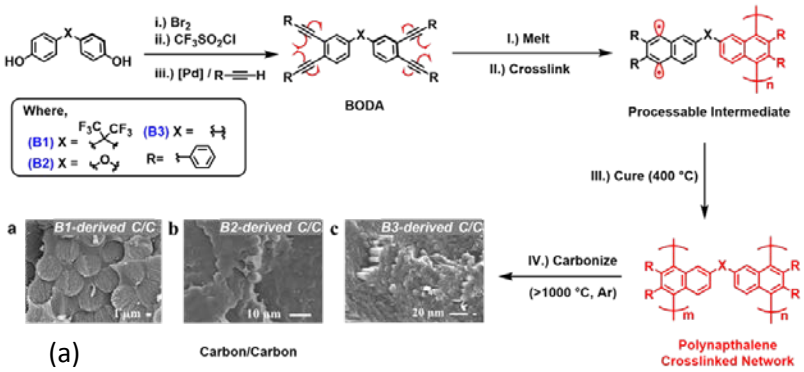
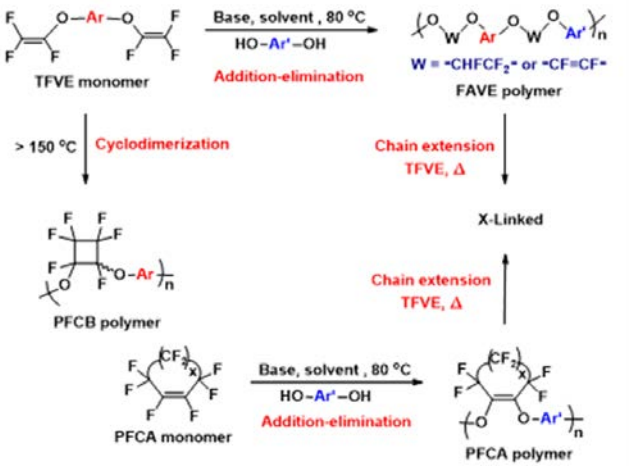
Abstract

Two platform technologies including (1) polynapthalene networks (Scheme 1) and (2) semi-fluorinated aromatic ether polymers (Scheme 2) are presented in addition to new approaches toward hexafluoro-i-propylidene (6F) polymers. Polynapthalene networks are produced via thermal cyclopolymerization of bis-o-diynylarene (BODA) monomers affording intermediate resins which can be melt processed, thermally cured, and pyrolyzed to high yield carbon-carbon composites. Perfluorocyclobutyl (PFCB), fluorinated aryl vinylene ether (FAVE), and perfluorocycloalkene (PFCA) aryl ether polymers are prepared via step-growth polymerization of fluoroalkenes affording optically tunable, thermally stable, and processable fluoropolymers. These fluoropolymers are solution processable, exhibit excellent thermal stability, and possess the ability to undergo thermal crosslinking without the use of post-curatives. In addition, a new advance on the condensation of diphenyl ether with hexafluoroacetone will be described. The synthesis, processing, and multi-mechanistic characterization for these platform technologies will be presented.



Scheme 1. Bis-*ortho*-diynylarene (BODA) monomers undergo thermal polymerization to branched processable reactive resins that further crosslink and carbonize to give high char yield carbon/carbon (C/C) composites with excellent consolidation.



Scheme 2. General synthetic routes to semi-fluorinated arylene vinylene ether (FAVE), perfluorocyclobutyl (PFCB), and perfluorocycloalkene (PFCA) materials.

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Functionalized nanocelluloses for advanced performance and applications

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Abstract

Nanocelluloses, either the rod-like cellulose nanocrystals (CNCs) or the thinner and longer cellulose nanofibrils (CNFs), are the most significant biologically derived nanomaterials and emerging renewable nano-building blocks for functional engineering materials. The crystalline core of nanocellulose intrinsic to native cellulose gives them superior strength whereas their nano-scale lateral dimensions and high length-to-width aspect ratios endow uniquely high specific surfaces. Nanocellulose surface chemistries and structures dictate how they behave in liquid phases, self-assemble from drying, and interface with other matter, as well as process into engineered products. Functionalized nanocelluloses carry specifically targeted surface chemical groups to enable and expand the design and development and performance of novel nanocellulose derived products. This presentation highlights rationally designed and streamlined processing approaches in one-pot synthesis of functionalized nanocelluloses to be efficiently and directly processed into products. Optimized one-pot synthesis in either aqueous or organic media following by in-situ disintegration with matrixes for streamlined fabrication into nanofibers,films,hydrogels, aerogels,and fibers with hierarchical hybrid, sheath-core, porous structures and targeted chemistries for applications in catalysis, separation, bioremediation, antimicrobial, chemical/drug-delivery, sensing, imaging, will be exemplified. Biological nanomaterial innovations from agricultural and energy crop residues can offer versatile solutions and opportunities to meet future demand in advanced materials while reduce demand on fossil fuel resources and minimize negative environmental impact from our food and bioenergy production systems.

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Development of Polylactide-based Sustainable Materials for Durable Applications

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Abstract

Both industry and academia have shown great interest in biopolymers in recent years, including polylactide (PLA). PLA, which is the main representative of the biodegradable and bio-resourced polymers, is a linear aliphatic thermoplastic polyester that is generally produced through ring-opening polymerization of the lactide monomer that is obtained from the fermentation of renewable resources, such as corn. Although it is expected to be a sustainable alternative to traditional petroleum-based plastics, its low flexibility, low impact strength, poor thermal stability during melt processing, low melt strength, and slow crystallization rates could limit its widespread application. This presentation focuses on the recent research effort to address the toughness vs. strength and heat resistance conflict inherent in PLA. Various types of PLA-based blends and composites designed to obtain desired mechanical and mechanical properties will be covered. In addition, the relationship between morphology and crystallinity with the toughness and stiffness of PLA-based materials will be established.

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Polymer composite membranes for molecular separations

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Abstract

Polymer composite membranes have been synthesized for various separation applications such as gas separation, water desalination and chiral separation. By incorporating nanomaterials and cage-shaped molecules, membrane structures can be tailored at the nanometer and subnanometer level to achieve desirable separation properties. For instance, amino functionalized boron nitride nanosheets were incorporated into a crosslinked, thermally rearranged polyimide to fabricate a nanocomposite membrane, which showed a small decrease in hydrogen gas permeability but a greatly increased hydrogen gas selectivity over other gases. Pristine graphene oxide laminate was integrated into a highly crosslinked network to produce membranes with anti-swelling behavior and excellent desalination capability. Furthermore, cyclodextrins (CDs) with their inherent truncated shape homochiral pores were directly utilized as building blocks to fabricate a microporous polyester layer superposed on a cellulose nanofiber (CNF) layer through a facile interfacial polymerization method. The as-obtained trimesoyl chloride (TMC) crosslinked β-CD-TMC-CNF composite membrane exhibited ultimate enantioselectivity (i.e., an enantiomeric excess (ee) of 100%) toward 2-phenyl-1-propanol and the highest flux of 4.08×10^{-3} mol m^{-2} h^{-1} compared with the membranes made with a-CD and g-CD. This enantioselective composite membrane with intrinsic microporosity is promising for further development for high-performance practical chiral separation.

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Multiple-traversing of the glass transition in amorphous polymers: Modeling the story of polycarbonate

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Abstract

Using an idea recently used by Lion, we develop a thermodynamic model for thermo-mechanic transitions through the glass transition (Tg). The model, based on the classical back-stress analog used by many, introduces two thermal expansion elements, one associated with the instantaneous elastic response and one associated with the back stress element. To this we add a nonlinear thermodynamic structure, and assume:

That shear viscosity is controlled by both temperature and elastic back strain, where the back strain is a potential surrogate for the concept of free volume.

That thermo-mechanical equilibrium defines an associated equilibrium temperature, a potential surrogate for the fictive temperature.

We use this to develop a model for the response of PC during pressure/dilatational imposed transitions through Tg, and to capture the effects of rate, path and aging. One of many examples, shown in Fig. 1, demonstrates the observation of asymmetric aging of the volume by Kovacs and others.

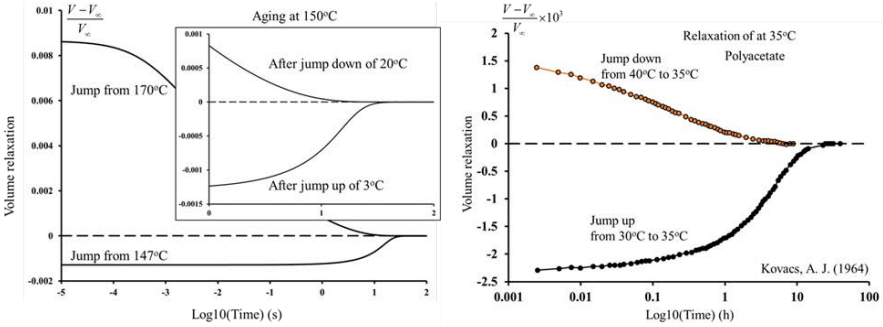

Figure 1. Simulated volume relaxation for PC after jumps to an aging temperature of 150°C from above (170°C) or from below (147°C) (left) and the observe relaxation on polyacetate by Kovacs [2]

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Design of an original Ni(II) ion imprinted polymer for highly selective remediation of Ni(II) ions in acidic and neutral solutions

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Abstract

In the last 2 decades, imprinting technology has been widely applied for the production of ion imprinted polymers (IIPs) to prepare selective adsorbent materials for the solid phase extraction (SPE) of environmentally hazardous metal ions in water solution1. The selectivity of IIPs is strongly dependent on the interaction between the functional chelating monomer and the template ion. To increase the efficiency of IIPs, it is therefore essential to produce new functional monomers that can interact in a highly specific way with the target ion. In this work, a chelating ligand, the 2-(aminomethylpyridine) (AMP) (Fig. 1a) was functionalized by a vinyl group to produce a new monomer for the synthesis of an original Ni(II) imprinted polymer for Ni(II) ions removal in acidic and neutral solutions.

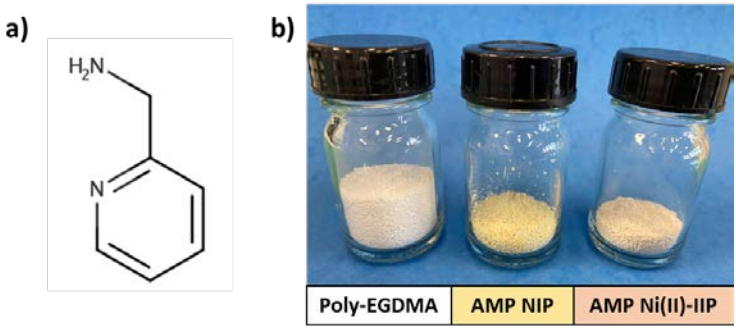

Figure 1. a) AMP ligand; b) Poly-EGDMA, AMP NIP and AMP Ni(II)-IIP beads

The selectivity of IIPs is closely linked to the stoichiometry of the functional monomer-target ion complexes. Therefore, the complex formation between the AMP monomer and Ni(II) ions was first studied *in-situ* in the conditions of the IIP preparation (solvent and temperature) to optimize the prepolymerization mixture. The optimum Ni(II)/AMP monomer ratio was then introduced in the polymerization mixture and the monomer/metal complex was copolymerized with ethylene glycol dimethacrylate (EGDMA) to produce the Ni(II)-IIP. The same polymerization was finally performed omitting the presence of Ni(II) ions to produce the corresponding non-imprinted polymer (NIP) to be used as reference material (Fig 1b). Both polymers were characterized with ^{13}C CP-MAS NMR, FT-IR, SEM and nitrogen adsorption/desorption experiments. The Ni(II)-IIP was then applied in the SPE of Ni(II) and evaluated at several pH values (from strongly acidic to neutral solutions) at different Ni(II) initial concentrations (0.2 and 1 g/L), and in the presence of competitive ions (Co(II), Cu(II), Cd(II), Mn(II), and Mg(II)). Finally, the reusability of the Ni(II)-IIP was assessed up to 5 adsorption/desorption cycles comparing basic and acidic solutions as Ni(II) eluents.

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Structure regulation and properties of cellulose materials under external fields

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Abstract

As the most abundant biomaterial, cellulose has been receiving increased attention due to its renewable and biodegradable properties. One of the challenges entailing the utilization of cellulose for various purposes is the difficulty of processing it, since it cannot be melted and is hardly soluble in common solvents due to the strong interaction of inter- and intra-chain hydrogen bonds. Therefore, green and efficient process that can help to shape cellulose into fibers and films is of significant importance. In recent years, room temperature ionic liquids (ILs) show great potential as green solvents, owing to their excellent dissolving capability, negligible vapor pressure, good thermal stability, and ease of recovery. With the development of the IL process, structural regulation of regenerated cellulose is highly desired from an industrial perspective. Therefore, the research on structure regulation and properties of cellulose materials is fundamentally significant.

We focused on the external fields such as pressure1, magnetic field, solvents, and stretching to systematically study the structure and properties of cellulose. Controlling water vapor diffusion into cellulose-ionic liquid solution induced a novel cellulose complex crystal in form of the spherulite as shown in Figure 1A. Its unit cell consists of one glucopyranoside unit and one molecule of ionic liquid as an asymmetric unit, revealed by the results of 13C solid state NMR spectroscopy in Figure 1C. The complex crystals exhibited exceptionally large size as indicated by the narrow peak width of X-ray diffraction in Figure 1B. This crystal reported in this work represents a new class of cellulose complexes after caustic alkali and amine complexes of cellulose. This study is potentially significant in understanding the molecular interactions of cellulose and leads to possible applications.

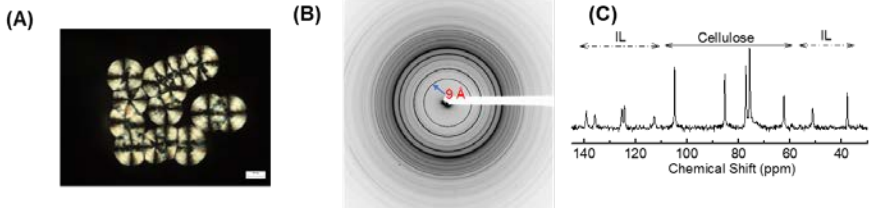

Figure 1. (A) Polarized optical microscopy image of cellulose spherulites. Scale bar 50 μm; (B) X-ray diffraction pattern of a spherulite; (C) 13C solid-state NMR spectrum of crystals in spherulite by CPRX method.

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Cooperative Supramolecular Polymerization of π-Conjugated Systems

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Abstract

Supramolecular assembly of π-conjugated systems into long-range-ordered nanostructures has received tremendous attentions because of their applications in sensing, anti-counterfeiting and optoelectronic materials. Our research group has self-assembled π-conjugated molecules into fluorescent supramolecular polymers via the cooperative nucleation–elongation mechanism, which display well-oriented π-aggregation, strong emission and ease of processability. The resulting high-molecular-weight supramolecular polymers are capable of forming electrospun microfibers with uniform geometry and smooth surface, enabling light propagation with extremely low scattering loss. Moreover, with the introduce of anthracene-endoperoxide photo-switching motifs, the resulting supramolecular polymers are served as a new type of high-performance anti-counterfeiting materials. The cooperativity principle has been also employed to direct the chirality-controlled formation of random or alternate supramolecular copolymers with distinct energy transfer behaviors. Overall, cooperative supramolecular polymerization of π-conjugated systems opens up new avenues toward functional supramolecular materials.

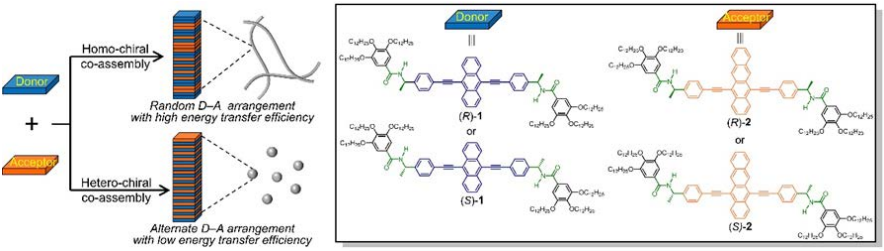

Figure 1. Schematic representation for chirality-controlled donor–acceptor organization and energy transfer in the resulting supramolecular copolymers.

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Refinement of SEC Analysis – The Final Frontier for Determination of Propagation Rate Coefficients in Radical Polymerization?

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Abstract

Of preeminent importance in radical polymerization kinetics are propagation rate coefficients (kp). These are best determined by size exclusion chromatography (SEC) used in conjunction with pulsed-laser polymerization (PLP). Much like prime numbers in pure mathematics, PLP-SEC has been a gift that keeps on giving: a beguilingly simple paradigm that seemingly eludes complete understanding, and consequently has given rise to a never-ending trail of publications. It is hard to believe that after a quarter century of intensive research and massive exploitation there could remain anything left to unearth about this simple concept, but discover something new we have. It is this: as illustrated in Fig. 1 below, it is well known that a molar mass distribution (MMD) changes shape when transformed, and that this change may serve to accentuate the features needed for k_p determination, thereby rendering such more accurate. Hitherto the only MMD transformations carried out for this purpose have been between the major known forms, viz. number MMD, n(M); weight MMD, w(M); and SEC MMD, w(logM). In mathematical terms one may say that only the values g = 0, 1 and 2, giving *w(logM), w(M)* and *n(M)* respectively, have been used in the transformation equation

$$g(M) = w(logM) / Mg$$

But what is there to prevent other values of g – including negative and fractional – from being used? Nothing! Our detailed simulation study [2] has found that almost regardless of the circumstances, there will be a g value that gives g(M) displaying features that yield accurate k_p in accord with established consistency criteria. Could this be the final frontier for k_p determination by PLP-SEC?

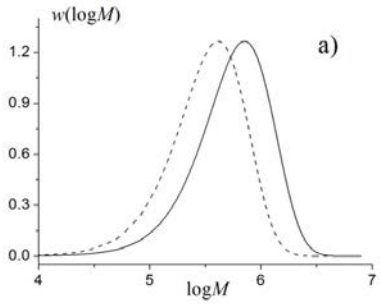

Figure 1. a) SEC MMDs from simulation of methyl methacrylate PLP near the low-termination rate limit. b) Same results after transformation to *w(M)* and then differentiation, with k_p features now abundantly clear.

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An electric field-driven one-dimensional assembly of polyelectrolyte complexes

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Abstract

Electrostatic interactions between polyelectrolyte (PE) ionized groups and dissociated counterions provide PEs with intriguing properties and significantly determine their conformation and dynamics. When oppositely charged PEs are mixed, the variety of the compositions spans from poorly processable, kinetically trapped PE complexes (solid) to coacervates (elastic liquid) to dissolved solutions with increasing salt concentration, pH level, or charge asymmetry. Creating fibers or films with controlled microstructure from PE complex typically requires a global network that will impart viscoelastic properties. Nonetheless, regulating the structure and dynamics of a global network comprised of PE complexes remains a research challenge.

In this research, oppositely charged PE macromolecules are self-assembled to form percolated networks (Figure 1). For bridging between PEs, it was necessary to adjust pH, charge density, and constituent concentrations below and above overlap concentration. Electrospinning of the PE-based network into nanofibers in the presence of a strong electric field induces the anisotropic assembly of the global network. As-spun fibers exhibit exceptional physical and mechanical properties.

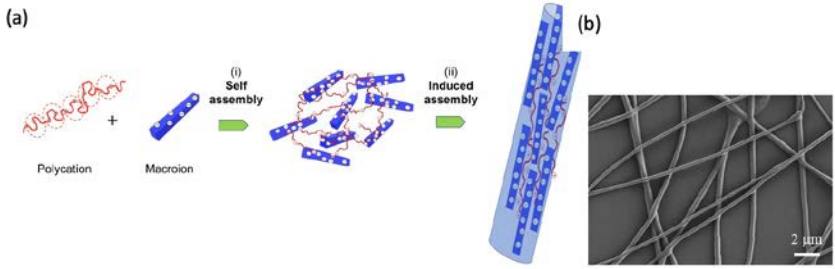

Figure 1. (a) A scheme showing the combination of oppositely charged polyelectrolytes into a global network and the subsequent assembly into nanoscale fibers, (b) SEM image of as-spun polyelectrolytes-based fibers.

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Investigation on Electrochromism of Transparent to Black Transition via Different Path

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Abstract

Electrochromism is a phenomenon that optical properties of materials change stably and reversibly under an applied electric field. Electrochromic (EC) devices have attracted the attention of scholars because of their advantages of multiple colors, high energy efficiency, environmental friendliness and intelligent adjustment. Blackness of EC devices with high optical contrast is desired in automobiles, electronic displays, anti-glare mirrors, switchable window, etc. There are several ways to reach this goal as the following.

Firstly, we attempted to obtain transparent to dark black EC materials in a relatively simple process by spraying method. By using green and purple as complementary colors, a mixed solution of polymer P1 and P2 was sprayed, and the functional film was obtained as shown in Fig.1 (a).

Secondly, using the easy-oxidization properties of N-methyl-phenothiazine (NMP) to match the charge capacity of WO3 thin films, we prepared a complementary EC device with good optical regulation and high stability (schematic diagram as shown in Fig.1 (b)). Thirdly, we selected benzothiadiazole viologen and triaminocyclopropene salt to prepare EC devices, which is unpublished yet.

Finally, using Ag as the functioal material, which has a good electrodeposition effect, we utilized electrodepositing Ag on PProDOT-Me2 to fabric functional devices (see Fig.1 (c)), which achieve excellent performance of a high optical contrast, a fast coloring speed and a strong cycle stability with colorless, blue and black three-state transition.

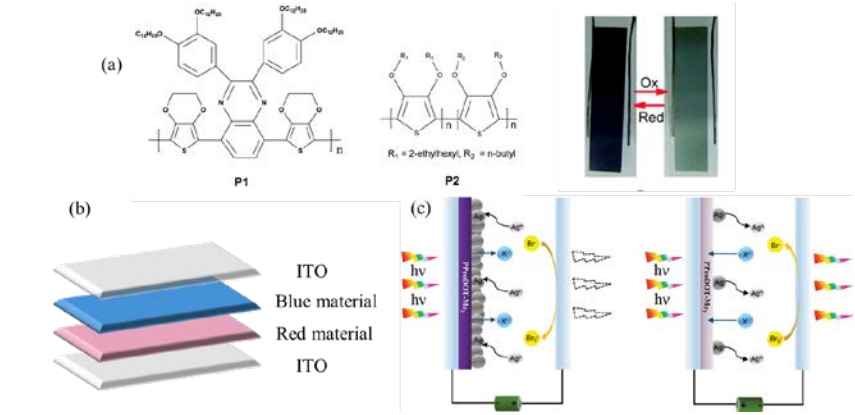

Figure 1. Composition and photo of mixed film (a), schematic diagram of spectrum complementary absorption device (b), and working mechanism of reversible Ag deposition electrochromism (c).

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Biodegradable porous microspheres by UV irradiation

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Abstract

Porous biodegradable microspheres were fabricated by successful RAFT polymerization of methyl vinyl ketone (MVK) onto polycaprolactone (PCL) and polylactide (PLA), which was first synthesized by ring opening polymerization of lactide followed by an oil/water emulsion-evaporation method, then finally photodegradation of PMVK blocks by UV irradiation. Macro-CTA (chain transfer agent) was synthesized by reacting carboxylic acid terminated CTA, S-1-dodecyl-S'-(α,α'-dimethyl-α''-acetic acid) trithiocarbonate (DDMAT) with hydroxyl terminated polycaprolactone, which was then used for the synthesis of triblock copolymer with methyl vinyl ketone (MVK). The synthesized block copolymers were characterized by FT-IR, 1H NMR spectroscopies. Gel permeation chromatography (GPC) was used to evaluate the molecular weight and molecular weight distribution and monitored the photodegradability of the block copolymers. The morphology of microspheres was spherical with smooth surfaces before UV irradiation. The average diameter was 8 μm, independent of the molar ratio between PMVK and PCL blocks. (Fig. 1(upper)), when fabricated under a stirring rate of 800 rpm. As shown in Fig. 1a (bottom), microspheres fabricated only from PCL homopolymers could retain their smooth surface after UV irradiation. However, those from PCL-PMVK triblock copolymers had rough surfaces and porous structures after UV irradiation due to the photodegradation of PMVK blocks as a porous template [Fig. 1b and c (bottom)]. The porosity and shape of the microspheres and shape of microspheres were dependent on the PMVK contents and size of microspheres.

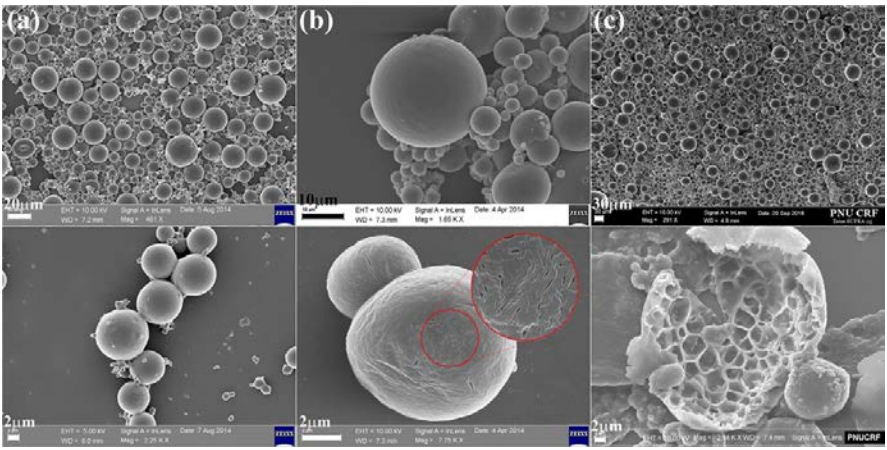

Figure 1. SEM images of microspheres before (upper) and after (bottom) UV irradiation. (a) PCL, (b) and (c) PCL-PMVK triblock copolymer [PMVK contents, (b) 16%, (c) 45%].

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The Application of Conductive Polymers in Lithium Rechargeable Batteries

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Abstract

Electrically conductive polymers are a class of polymers, which can conduct electricity. Conductive polymers have found niche applications such as anti-statics. The electrochemical energy storage devices, especially lithium-ion rechargeable batteries, have gained popularity in application in many areas in the past two decades. Multifunctional conductive polymers may play a significant role as electrode binders for Silicon (Si) based anode electrode. Si is an attractive candidate for lithium-ion batteries because it delivers 10 times greater theoretical (~4200 mAh/g) specific capacity than that of a traditional graphite anode (~370 mAh/g). However, the widespread application of silicon materials has remained a significant challenge because of the large volume change during lithium insertion and extraction processes, disrupting both the Si electrode surface and electrode mechanical integrity. This large volume change causes electrode failure, leading to loss of the electrical contact and drastic capacity fading. Conductive polymer binders can play multiple functions for Si electrode, including improved adhesion, lithium ion compensation, better ion and electric conductivity as well as surface and interface modification. Si electrode using on PFM conductive polymer binder has robust mechanical properties and very stable cycling capacity (Figure 1a,c,d) Organic and polymer chemistry have provided almost infinity possibilities to modify the polymeric binders to include the desired functionalities (Figure 1b). This presentation will discuss the specific molecular design principles and synthetic steps to realize the structures and functionalities of the binders, how these binders interact with different Si materials, and the electrochemical performances of the electrodes based on these binders.

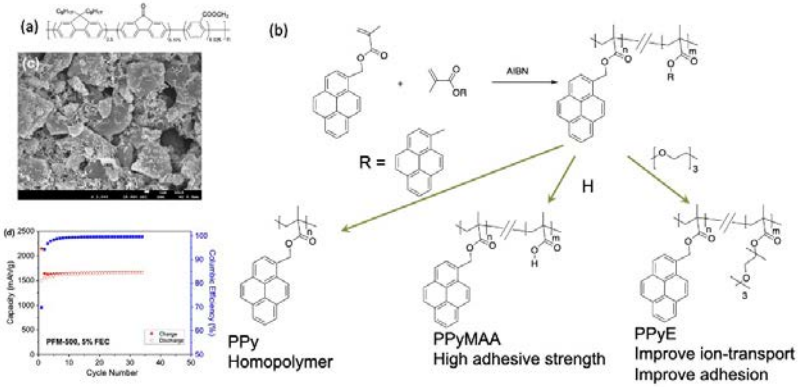

Figure 1. Designed multifunctional conductive polymers used as electrode binder for Si materials to enhance the battery performance. (a) Molecular structure of PFM binder. (b) using radical polymerization to build multifunctional conductive polymer binder. (c) SEM surface image of an Si based electrode using conductive polymer binder. (d) The Si with conductive polymer binder electrode demonstrates both high lithium-ion capacity and high interface stability.

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Shaping Polymer Self-Assemblies by Gas via Frustrated Lewis Polymers

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Abstract

The quest for a universal method to shape the vesicular morphology in dynamic and diversified manners is a challenging topic of cell mimicry. Here we present a simple gas exchange strategy that can direct the deformation movements of polymer vesicles. Such vesicles are assembled by a class of gas-based dynamic polymers, where CO_2 connects between the frustrated Lewis pair via dynamic gas-bridged bonds. Use of other competitive gases (N_2O, SO_2, or C_2H_4) to in situ exchange the CO_2 linkages can change the polymer structure and drive the membrane to proceed with three fundamental movements, including membrane stretching, membrane incurvation, and membrane protrusion, thus remolding the shapes of polymersomes. The choices of gas types, concentrations, and combinations are crucial to adjusting the vesicle evolution, local change of membrane curvature, and anisotropic geometrical transformation. This will become a generalized strategy to control the vesicular polymorphism and deformable behavior.

This gas-regulated self-assembly way can also be applied in other respects of supramolecular chemistry and polymer chemistry, such as gas-induced polymer self-assembly (GISA), gas-linked self-assembled materials, and gas-constructed nanostructures. This new strategy is considered as a powerful tool for materials construction.

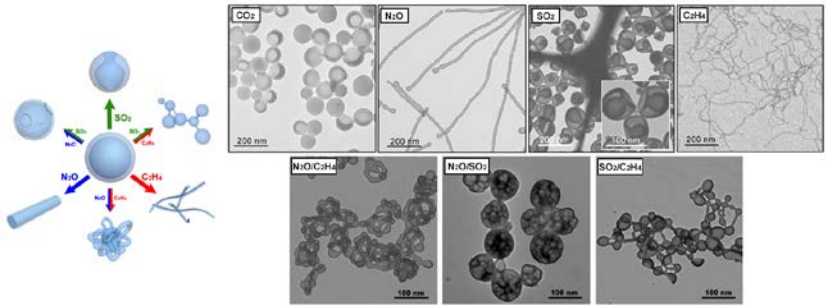

Figure 1. Dynamic Polymer Vesicular Deformation by Gas Exchange

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A Versatile and Scalable Strategy to Functional Polymers with Controlled Structures

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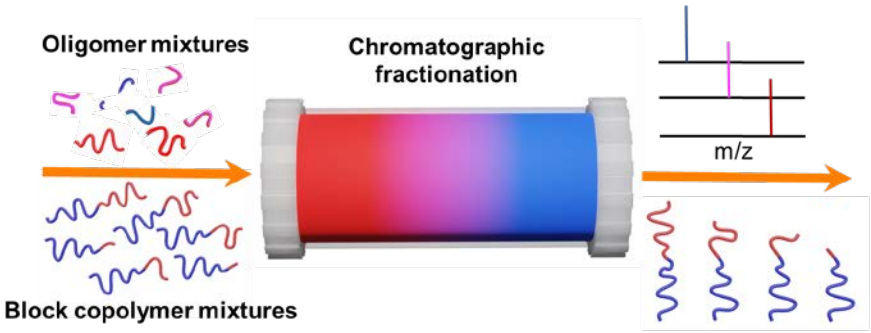
Abstract

The preparation of synthetic polymers with precise structures, compositions, and functions is a grand challenge in polymer science. Although synthetic polymers are often termed 'monodisperse', their primary structures are not as perfectly controlled as natural macromolecules, such as proteins and nucleic acid. The properties of the synthetic polymers result from the combination of individual molecules, each with unique performance. In this presentation, I will introduce a versatile and scalable strategy that is enabled by the combination of facile polymerization procedures (e.g., ATRP, RAFT) and ubiquitous purification processes (e.g., flash chromatography). This strategy is demonstrated to be applicable to a variety of polymer chemistries and structures on multigram scales with excellent mass recovery, and greatly simplifies the production of materials with increased control and homogeneity when compared to conventional strategies (Scheme 1). At the end of the presentation, I will show several examples of using these well-defined polymers in high-value applications, including energy, wastewater remediation, and theranostics.



Scheme 1. Illustration of automated chromatography separation.

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Novel conducting polymer sensor for the detection and analysis of biothiols

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Abstract

Biothiols (biological thiols) are extremely important molecules with a large range of diverse functions. These molecules are found in all parts of the body and are vital for processes such as cell-signalling and (anti)oxidation processes. Abnormal levels of biothiols can lead to, or be indictive of, a range of diseases and conditions. Biothiols can be highly reactive and unstable, as such detection of these molecules has proven to be extremely difficult and there are currently limited methods for their detection and analysis, all of which lack in accuracy, selectivity and/or efficiency.

The sensor developed and investigated in this work is based on a novel, conducting polymer (Figure 1). The method of detection relies on the formation of a electrochemically-reversible covalent disulfide bond between the biothiol analyte and the free thiol moieties on the conducting polymer sensor, which will induce changes in the properties of the conducting polymer.

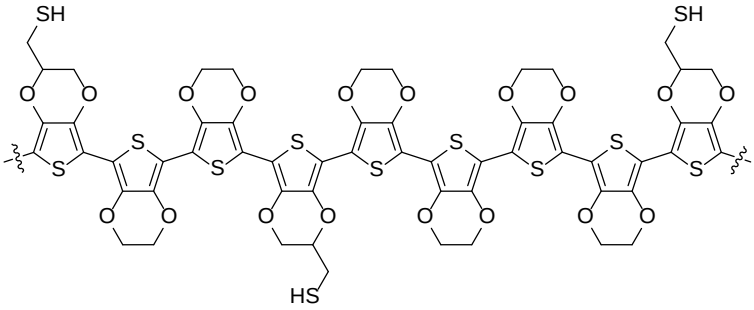

Figure 1: Structure of formed electrochemical conducting polymer sensor for the detection of biothiols.

This presentation will outline the synthesis, polymerisation, and characterisation of the novel thiol functionalised EDOT monomer and its co-polymer using NMR, HRMS, FTIR, SEM and XPS. Various parameters to form a co-polymer of the functionalised monomer and EDOT were optimised for sensing performance. The optimised co-polymer was used to create a sensitive glutathione sensor that does not interact with common biological interferents and is able to be recycled. This first-in-class electrochemical GSH sensor provides a platform sensing methodology for a rapid, sensitive and selective detection of biothiols for applications in medical diagnosis and health management.

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Synergistic effect of the combination of magnetite and molecular magnet for ethanol dehydration via pervaporation.

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Abstract

The alginate membranes filled with various proportions of mixed magnetite [Fe3O4] and tetranucleariron (III) molecular magnet [Fe4(acac)6(Br-mp)2] were prepared to improve the process of ethanol dehydration via pervaporation. We compared the results obtained for membranes with a molecular magnet (MM) and magnetite alone. The results show that the synergistic effect of combining the two fillers has a strong influence on improving the efficiency of the process.

MMs represent a new class of magnetic materials. The powder shows paramagnetic properties and has the capacity for excellent dispersion in the polymer matrix. On the other hand, magnetite exhibits superparamagnetic properties directly related to its regular structure but does not show good dispersion in the membrane. A beneficial synergistic effect was achieved by combining a substance with strong magnetic properties and a substance with excellent dispersion. It contributes to a homogeneous dispersion of the MM and the magnetite molecules in the polymer matrix. As a result, the filler particles do not form clusters in the matrix. Still, the particles are present in the membrane throughout the volume, which allows them to interact freely with the water molecules permeating the membrane. In the case of magnetite alone, such a strong interaction between the magnetic field and the water molecules does not occur, which translates into lower ethanol dehydration efficiency.

It was shown that properties, particularly flux and separation effectiveness have a massive correlation with each other. Additionally, a curious phenomenon of improving the dispersion of the fillers in the polymer matrix due to their excellent cooperation in the membrane was observed. All the results showed that the alginate membrane containing 2 wt% of magnetite and 8 wt% of MM displayed fabulous parameters of PSI and separation factor equaled 8438.90 $kg \cdot m^{-2} \cdot h^{-1}$ and 3425.53, respectively.

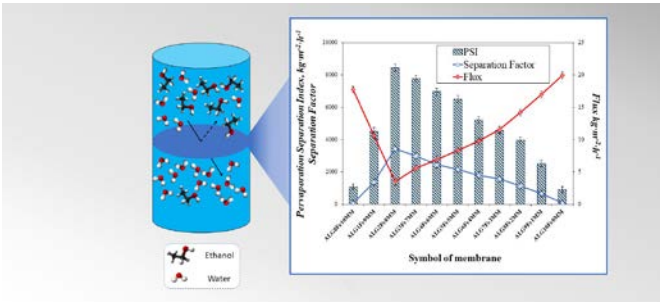

Figure 1. Model of separation water/ethanol mixture and a diagram showing the most important results of the respective membranes

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Preparation of PVC block copolymers via RAFT polymerization and their applications as PVC based additives

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Abstract

Poly(vinyl chloride) (PVC) is one of the most widely consumed polymers in our daily life. Conventional free radical polymerization (FRP) of VC is the only available industrial process to produce the polymer in large scale. PVC made via conventional FRP process lacks the potential of the functionalities and thermal stability due to the presence of structural defects. So controlled/"living" radical polymerization (CLRP) methods such as reversible addition-fragmentation chain transfer (RAFT) polymerization provide unprecedented tools for the synthesis of PVC.1-3 On the other hand, the performance and PVC is deficient in a number of areas and needs can be improved by different additives. Migration of additives is hardest to avoid and plasticizers such as dioctyl phthalate (DOP) which is one of the most widely used PVC plasticizers migrating out of the PVC matrix bring serious health hazards and loss of flexibility of flexible PVC products. VC monomer was polymerized by RAFT polymerization with a xanthate RAFT agent containing hydroxyl groups, which can be used as a ROP initiator in forming polymer plasticizers PVC-*b*-PCL. Low M_n 3 and 4-arm star PVC with the low T_g can be used as alternatives to phthalate plasticizers. Trithiocarbonates RAFT agents for more active monomers (MAMs) were attached on the PVC-$(OH)_2$ by esterification reaction, and these RAFT agents provide a universal stage to synthesize different types of additives.

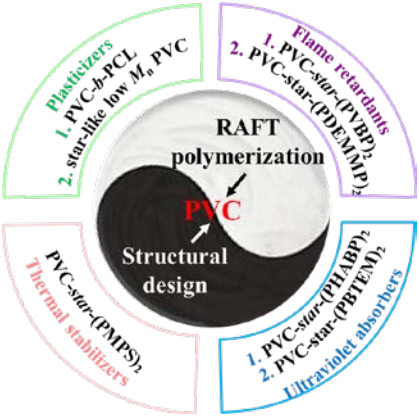

Figure 1. Preparation and application of PVC-based additives.

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Electrospun hybrid nanofibers: Morphology, micromechanics, and properties

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Abstract

As for all polymeric materials, the properties of electrospun nanofiber products that are relevant for target applications strongly depend on composition, processing routes and conditions as well as on the resulting structure (or morphology) [1]. Moreover, a tailored modifications to meet certain functional requirements become more and more important. Of course, the actual experimental setup (e.g., single nozzle, coaxial vs. multiple jet setup, nozzle-less spinning techniques etc.) and selection of spinning parameters play an important role. It is also very clear that the selection of polymers, solvents, additives, fillers, bioactive substances, etc. are crucial for the design of tailor-made nanofiber constructs. Nevertheless, the micro- and nanoscopic arrangement of the components, i.e., the nanofiber morphology, is an important factor to control mechanical properties, degradation rates, drug release profiles, porosity, conductivity, and many more of the properties and functions.

It is shown that there are special morphological, functional, and micromechanical effects that are directly connected to the small dimensions of (hybrid) electrospun nanofibers: 1) There is to mention the extremely *high surface area* compared to the volume of the fibers and the high porosity that make nanofiber scaffolds an excellent tool to mimic extracellular matrix and a perfect substrate for tissue engineering. 2) The limited fiber geometry acts as a *confinement* that has eminent influence on the arrangement of blend components, phase separated structures of block copolymers, orientation of fillers, localization of additives, and so on. 3) The small fiber diameter can influence mechanical properties. Below critical diameters, one may observe a brittle-to ductile transition that is comparable to the so-called *thin layer yielding* in lamellar and (nano-) layered polymer systems or to processes inside craze structures. 4) Electrospinning is a method of *forced assembly*, that means, one can "push" components that normally are subject to phase separation into a nanoscale arrangement. 5) Nanofibers can be firmly attached to material surfaces by *direct-to-shape* spinning processes, e.g., for case specific surface functionalization of 3D printed, patient specific implants.

Finally, some aspects of manufacturing 3D products from electrospun nanofibers will be discussed, as there are, for instance, production of nanofiber tubes by spinning on rotating substrates, production of micro-flakes and porous stents by means of laser processing, and manufacturing of self-reinforced mats by hot compaction of hybrid nanofibers.

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Comparative study of bulk and thin film morphology of multigraft (PS-g-PI) copolymer blends by Atomic Force Microscopy

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Abstract

Multigraft copolymers (MGCPs) are a special kind of macromolecules where thermoplastic grafts are connected to an elastomeric backbone via multifunctional branching points. The ability to vary their molecular architecture and nanoscale morphology has made MGCPs an interesting topic for fundamental research and industrial applications, especially as superelastic thermoplastic elastomers. In the present work, the formation of different morphologies in MGCPs containing 0.20-0.25 volume fraction of PS is explored with respect to the variation of sample preparation procedures and AFM imaging conditions. Different MGCPs with tetra-functional branch points consisting of polyisoprene (PI) backbone and polystyrene (PS) grafts and their blends were processed by a solution casting and slow drying procedure resulting in plates of 2 mm thickness. The morphology of both ultra-thin sections and smooth block faces prepared from the bulk by means of cryo-ultramicrotomy was compared to the morphology of thin films produced by dip coating and spin coating with and without subsequent annealing. Imaging was performed by means of dynamic mode Atomic Force Microscopy (AFM) with a variation of imaging modes, imaging parameters and cantilever specifications.

In all cases, it is shown that the investigated MGCP blends are miscible and form a nanophase-separated worm-like morphology close to a bi-continuous structure containing relatively short cylindrical PS domains in a PI matrix. In solution-cast thin films, the bi-continuous morphologies, in general, were retained along with a few regions of cylindrical domains either parallel or normal to the substrate, and these domains are strongly affected by film preparation and annealing parameters. These findings are compared with the Milner diagram for starblock copolymers (comparable to the structure/molecular architecture of macromeric units in our MGCP blends) predicting a transition from bi-continuous to cylindrical morphology.

Our comparative studies indicates that it is possible to use ultrathin cryo-sections and block faces to image MGCP morphology with excellent results comparable to results from more common solution-cast thin films. That is of importance since our technique allows the investigation of the morphology of samples that have been subject to relevant industrial processing routes as there are, for instance, extrusion, film blowing, and injection molding.

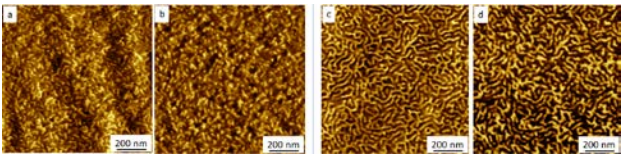

Figure 1: Representative micrographs of MIS-4-24.5-6 and MIS-4-22.3-1.8 (20:80) blend elucidating the bulk morphology (ultrathin sections, a, b) and the morphology of spin coated thin films (c, d). (a, c): topographical (height) images, (b, d): phase images; tapping mode AFM.

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Towards spatially Targeted Eradication of Antimicrobial-resistant Bacteria: Novel Polymer-based Antimicrobial Photodynamic Therapy

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Abstract

Photodynamic therapy (PDT) using photosensitizers has become an essential tool to treat various kinds of cancers and has been expanded to treat multi-resistant microbial infections. Herein we report the incorporation of novel Ru-based photosensitizers (PS) into block polymer-based micelles and vesicles to develop a biocompatible on-demand release system for the treatment of localized microbial infections. Different Ru-based PS are encapsulated into tailor-made PEG_{114}-block-PLA_X and PEG_{114}-*block*-PCL_X assemblies via the solvent-shift method (PEG: poly(ethylene glycol), PLA: poly(lactic acid), PCL: poly(e-caprolactone)). The release of the PS occurs via bacterial enzyme mediated cleavage of the capsules. In particular, PS encapsulation and release as well as the efficiency of singlet oxygen generation of various PS is studied for pure and encapsulated PS in aqueous and biological media irradiated with blue light to lay the foundation for the targeted eradication of *Pseudomonas aeruginosa* using the generated singlet oxygen from released and neat PS. This new approach overcomes key drawbacks of conventional PS, i.e. the limited biocompatibility and solubility of PDT complexes, by safeguarding high local concentrations inside the nanocarriers.

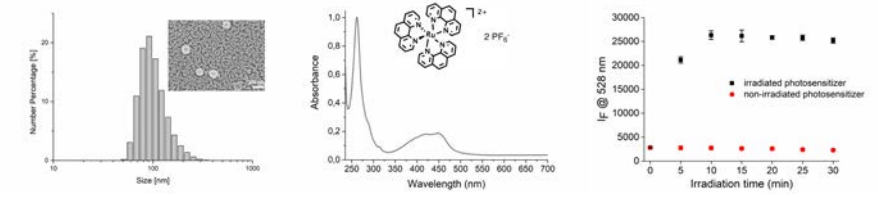

Figure 1. Size distribution (dynamic light scattering) by number of PEG114-block-PLA400 vesicles (left, inset: scanning electron microscopy (SEM) data), UV-Vis spectra of photosensitizer (middle), fluorescence emission of singlet oxygen sensing dye as a function of irradiation time (right).

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Porous Polymer Films Grown from Hydrogel Surfaces: towards Structural and Function Precision of Human Skin

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Abstract

Skin is the largest organ of human body. Its superior structure determines its unique functions. Human skin has three layers, epidermis, dermis and hypodermis (Figure 1). The top layer epidermis contains keratinocytes as the major building blocks that produce protein keratin. The vital function of the epidermis is a physical and biological barrier to the external environment, protecting against pathogens and excess water loss. Meanwhile, the epidermis generally has low electrical conductivity due to low water content on the surface. The dermis layer consists of connective tissue and cushion from stress and strain, providing tensile strength and elasticity to the skin. The bottom layer of hypodermis contains fat cells or adipose tissue that insulates the body and helps conserve heat. These three layers are tightly interconnected with seamless interfaces. Apart from providing flexibility and elasticity of the skin, self-healing property of the skin has been well-known and studied.

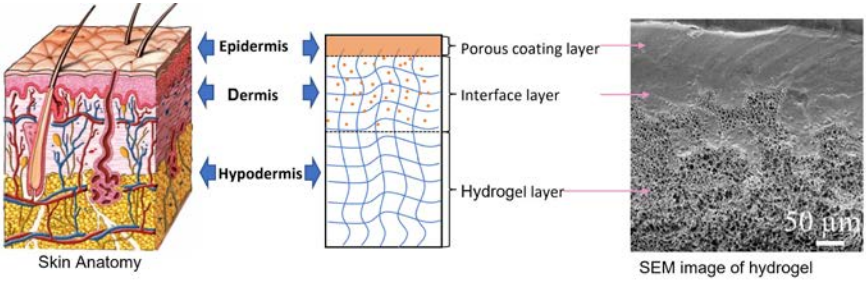

Figure 1. Comparison of human skin anatomy with three-layer structure of surface coated hydrogel developed in this Abstract.

Extensive efforts have been made so far to emulate human skin using synthetic materials which is also called artificial skin. However, these materials possess only one or two structural features or functions of skin, which will hinder their applications in multi-environment. In this study, we develop a material of surface coated hydrogel to precisely mimic human skin in multiple aspects of both structure and functions. The surface coated hydrogel possesses three layers of structure (Figure 1) that are interconnected seamlessly. The top layer with 10-500 um thickness is porous polymer film, which plays the role and has the properties and functions of epidermis of skin: (1) Protection against pathogens and transportation of small molecules; (2) Water loss control; (3) Insulation. Epidermis is generally regarded as low electrical conductivity. Conductivity decreases with the skin depth due to decreased water content with the skin depth.; (4) Self-healing through hydrogen bond and dynamic imine bond. This material has potential applications in flexible electronics, wearable sensors, and soft robotics.

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Polymer-assisted Transformable Magnetic Nanohybrids for T1/ T2 Switchable MR Imaging

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Abstract

Development of nanoparticulate systems as contrast agents for magnetic resonance (MR) imaging has shown great promise in non-invasive diagnosis and the monitoring of disease progression/response to treatment. Although the significant progression in nanomedicines, the insufficient tumour penetration is still the main obstacle to compromise the imaging and therapeutic efficacy. Of which, ultrasmall iron oxide nanoparticles benefit the deep tumour penetration and have been identified as novel T1 MRI contrast agents with bright signals. Herein, we demonstrated the facile synthesis of pH-responsive di-block copolymers and the fabrication of size transformable ultrasmall iron oxide nanohybrids to not only achieve "on site" T1-weighted and "off site" T2-weighted MR imaging, but also encapsulate ATM-3507, a potent tropomyosin inhibitor to modulate the mechanical properties of solid tumour. In this study, a series of pH-responsive di-block copolymers DiPA-P(PEGMA21-b-DPAx) were synthesized by the reversible addition-fragmentation chain-transfer (RAFT) polymerization and two step post-modification. We also synthesized ultrasmall iron oxide nanoparticles (USIONs) with a size of 3.42 $\pm$ 0.54 nm via thermo decomposition method. The polymer/ ATM-3507/USIONs nanohybrids disassemble upon acid tumour microenvironment and release the USIONs and ATM-3507 to trigger the "on site" T1-weighted MR imaging and disrupt the solid tumour stiffness. Besides, the polymer/ATM-3507/USIONs nanohybrids exhibited outstanding colloidal stability (up to 28 days). The preparation of polymer/ inorganic nanohybrids provides a facile approach for the construction of smart delivery systems and can potentially be used for the alternative of Gd-based MR contrast agents.

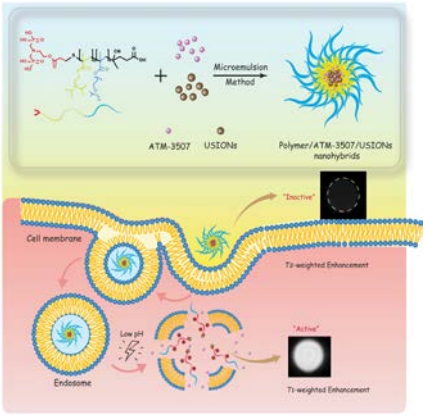

Figure 1. Schematic illustration of the pH-responsive nanohybrids.

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Polymer Nanomaterials Using Porous Templates

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Abstract

Template wetting methods have been widely applied in the preparation of one-dimensional (1D) polymer nanomaterials. We study the fabrication and characterization of different polymer-related nanomaterials by wetting porous templates. The templates we choose are anodic aluminum oxide (AAO) templates because of the regular pore distribution, high pore density, and high aspect ratio of the pores. Using AAO templates, we report novel smart nano membranes (SNM) by grafting AAO templates with spiropyran molecules. The ultraviolet and visible light responses of the SNM under acid vapors are investigated. Under UV irradiation, the ring-closed spiropyran on the AAO templates transform to ring-opened merocyanine, which contains phenolate oxygen and can be further protonated by acids. We also present a facile light-induced nanowetting (LIN) method to fabricate patterned nanoarrays. Photoresponsive azobenzene-containing polymers (azopolymers) that exhibit light-induced reversible solid-to-liquid transitions are used. Notably, using designed photomasks, the patterns of the nanoarrays can be ingeniously controlled with the characteristic of erasable and rewritable nanostructures. In addition, we demonstrate photoresponsive composite polymer electrolytes, consisting of gel polymer electrolyte (GPE) and spiropyran-immobilized nanoporous anodic aluminum oxide (SP-AAO) templates. We also present versatile and on-demand photocontrollable ionic conductive nanocomposite hydrogels via host-guest chemistry.

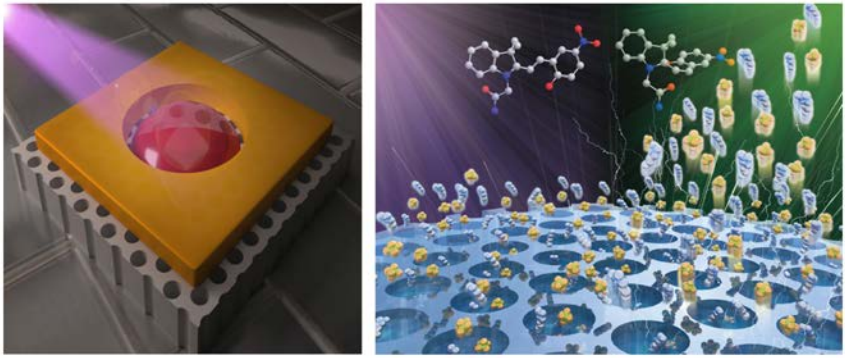

Figure 1. Illustration of the Lin method and light-responsive composite membranes.

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Formation and characterization of bowl-shaped polymer vesicles and their applications as nanomotor system

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Abstract

Amphiphilic block copolymers can self-assemble into classical morphologies such as micelles, nanofibers, polymer vesicles, and tubes, depending on the selective solvents and polymer hydrophilic-hydrophobic balance. Among these polymeric nano-objects, polymer vesicles, normally called polymersomes have recently gathered considerable research attention because of their promising potential in the field of nanomedicine, tissue engineering, bioimaging, and nanoreactors. However, most of the research interests are focused on spherical polymersomes. Polymersomes themselves are highly adaptable, and they are able to form various morphological structures by modulating the polymer composition or regulating the self-assembly process. Here, we reported a kind of bowl-shaped polymeric vesicles, namely stomatocytes. We found that the well-defined spherical polymersomes were obtained upon dialysis against pure water, while the introduction of salt can give rise to the shape-transformation of polymersomes into stomatocytes, with an opening mouth. The nanostructures of stomatocytes were characterized by dynamic light scattering (DLS), scanning electron microscopy (SEM), transmission electron microscopy (TEM), cryo-TEM, and asymmetric flow field flow fractionation (AF4). More interestingly, these osmotic pressure-induced formation of stomatocytes demonstrate potential in the nanomotor system.

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Effect of Hydrogen-Bonding Organization on Crystal Form Transition of PA1012 and Its Block Copolymers

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Abstract

PA1012 is a kind of polyamide with even and even long carbon chains and synthesized via condensation polymerization between dodecanedioic acid and decanediamine. Dodecanedioic acid and decanediamine can be obtained by biological fermentation methods. Long chain polyamide-based thermoplastic elastomer (LCPAE) composed of long chain polyamide (LCPA) as hard segment (HS) and polyalkoxyether as soft segment (SS) is prepared by melt polycondensation. LCPAE exhibits excellent mechanical and thermal properties, as well as high impact strength at low temperatures, therefore, it has been used in a wide range of applications, including high-grade sports shoes, polar clothing, and medical devices. PA1012 has a typical Brill transition behavior. The α-crystal form (triclinic crystal system) can be completely transformed to γ-crystal form (pseudohexagonal crystal system) with increasing temperature at room temperature. In this study, polyamide 1012 and its multiblock copolymers were prepared by lowering the temperature above the equilibrium melting point to room temperature at different rates. The differences of hydrogen bond organization among the samples were evaluated by the crystal perfection index (CPI). The temperature dependence of crystal plane spacing and wafer thickness of different samples was compared by variable temperature X-ray technique. It was found that high cooling rate could inhibit the formation of hydrogen bond surface structure and effectively reduce the Brill transition temperature. The Brill transition temperatures of polyamide 1012 and its multiblock copolymers showed a linear relationship with CPI at room temperature. It is proved that the initial hydrogen bond organization of the sample is an important factor affecting the Brill transition temperature, and the influence of the presence of soft chain segment in block copolymer on the Brill transition of hard segment of polyamide 1012 is further revealed.

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Polycaprolactone encrusted bioactive glass antibiotic nanohybrid through drug mediated surface initiated polymerization: an overcoat approach for modulated burst release

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Abstract

Antibiotic impregnated bioactive therapeutic biomaterials highly useful due to the risk of infection associated with bone replacement surgeries and musculoskeletal injuries. In this study, we report the synthesis of antibiotic nanohybrid having an aqueous sensitive sheddable polycaprolactone (PCL) shell grafted over gentamicin sulphate (GS) loaded bioactive glass (BG) nanospheres via surface initiated polymerization. This study indeed shows the additional role of GS, an aminoglycoside antibiotic, as an initiator for the ring opening polymerization of ε-caprolactone. The ^{1}H NMR and MALDI- ToF analysis of the unbound PCL confirmed the part of GS with the hydroxyl end group served as the surface anchoring group. The successful grafting of PCL was confirmed by TGA, FTIR, TEM, XPS, AFM and contact angle measurements. The effective shedding of the shell in response to aqueous environment and the subsequent release of GS was confirmed by the TEM analysis and zeta potential measurements. Importantly, the drug release was modulated with controlled burst release with only 15 wt% and 14 wt% release in the nanohybrids in the first 8 h while it is 29 wt% for the unmodified BG nanoparticles. Hence this study shows a distinct overcoat approach towards sustainable and modulated burst release of drugs. Furthermore, studies of growth inhibition of E. coli and S. aureus culture indicated that the GS released from the nanohybrid retained antibacterial activity. Thus the GS initiated polyester functionalization of drug-loaded BG nanoparticles which enables an environment responsive as well as modulated release is considered beneficial for further progresses in drug-loaded scaffolds.

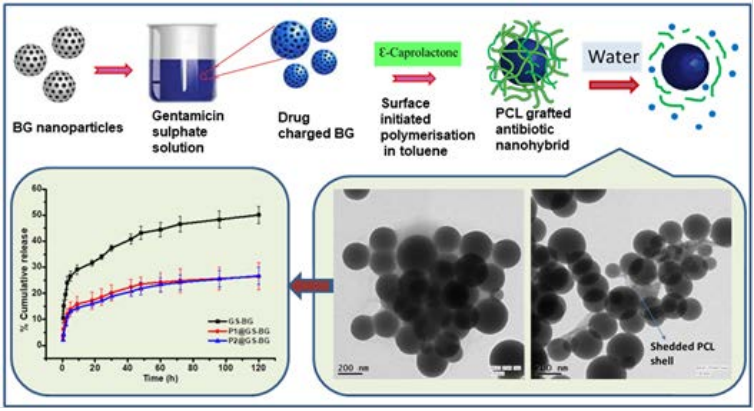

Figure 1. Graphical abstract

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Model Amphiphilic Polymer Conetworks with Large Domain Size & Long- range Order Based on Inverse Pluronics: Synthesis & Characterization

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Abstract

We present the preparation and structural characterization of a model amphiphilic polymer conetwork (APCN) with the longest reported domain spacing of ~40 nm and long-range ordering. These unique structural features were engineered into this material by carefully designing its constituents, both the elastic chains and cross-linker. Regarding the former, long (40 kDa, ~800 monomer repeating units) and rather hydrophobic (~50 mol%) BAB (hydrophobic end-blocks, minimizing frustration and avoiding domain size fragmentation upon self-assembly in water) triblock copolymers were employed as the elastic chains, whereas a cross-linker of rather low and precise functionality of 4 was utilized, allowing sufficient freedom for orderly self-assembly. Figure 1 illustrates the APCN characterization results both in the bulk and equilibrium-swollen in D_2O using scattering and microscopy techniques. Small-angle X-ray scattering (SAXS) and atomic force microscopy (AFM) on bulk APCN samples indicated a spheroidal morphology with a 25-26 nm spacing. Upon sample transfer into D2O, SAXS indicated an increase in spacing to 37 nm, accompanied by a morphology change to lamellae, as evidenced by the (nearly) equally-spaced higher-order peaks in the small-angle neutron scattering (SANS) profile, and clearly visualized in the cryogenic scanning electron micrograph. Not only is the observed structure a rare example of lamellar morphology with long-range order in cross-linked amphiphilic gels, but it also represents the one with the largest domain size of 37 nm, compared to previously reported lamellar domain sizes of 20 nm.

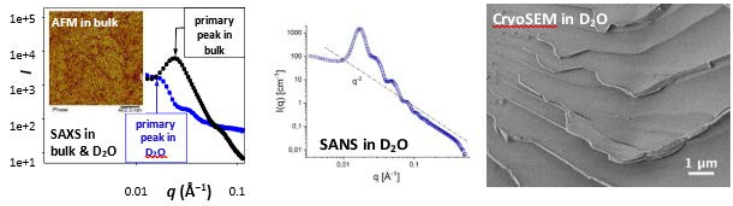

Figure 1. Scattering (SAXS and SANS) and microscopy (AFM and cryoSEM) characterization of the model amphiphilic polymer conetwork in the bulk and in D_{2O}.

[1]

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Beyond classical hydrophilic-hydrophobic amphiphiles: triblock poly(2-oxazoline)s with a fluorinated block as a new platform for self-assembly

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Abstract

The synthesis of defined triphilic terpolymers with hydrophilic, lyophilic, and fluorophilic blocks is an important challenge as a basis for the development of multicompartment self-assembled structures with potential for, e.g., cascade catalysis and multidrug loading. The synthesis of fluorophilic poly(2-oxazoline)s generally suffers from a very low reactivity of fluorinated 2- oxazoline monomers in cationic ring-opening polymerization (CROP). In the first part of my talk I will report a systematic study on overcoming the extremely low reactivity of 2-perfluoroalkyl-2-oxazolines in CROP by the insertion of methyl and ethyl hydrocarbon spacers between the 2-oxazoline ring and the trifluoromethyl group. The kinetic studies showed the gradual increase of the rate of polymerization with increasing of the hydrocarbon spacer length. The monomer with an ethyl spacer was found to have similar reactivity as 2-alkyl- 2-oxazolines and allowed the synthesis of defined triphilic triblock copolymers.

In the second part of my talk, I will focus on the synthesis and self-assembly of triphilic poly(2-oxazoline) triblock copolymers with high fluorine content toward our future aim of developing poly(2-oxazoline) magnetic resonance imaging (MRI) contrast agents. A highly fluorinated 2-substituted-2-oxazoline monomer, namely 2-(1H,1H,2H,2H-perfluorooctyl)-2-oxazoline, was synthesized using the Grignard reaction. The polymerization kinetics of the synthesized monomer was studied, and it was used for the preparation of triblock copolymers with hydrophilic 2-methyl-2-oxazoline, hydrophobic 2-octyl-2-oxazoline, and fluorophilic blocks by cationic ring-opening polymerization yielding polymers with low relatively dispersity (1.2–1.4). The presence of the blocks with the different nature in one copolymer structure facilitated self-assembly of the copolymers in water and dimethyl sulfoxide as observed by dynamic light scattering, cryotransmission electron microscopy, and small-angle neutron scattering. The nanoparticle morphology is strongly influenced by the order and length of each block and the nature of solvent, leading to nanoparticles with core–shell structure as confirmed by small-angle neutron scattering. The reported poly(2-oxazoline) block copolymers with high fluorine content have high potential for future development of MRI contrast agents.

Biocompatibility studies confirm that all copolymers obtained are noncytotoxic and, at the same time, exhibit high sensitivity during in vitro 19F MRI studies. The gradient copolymers provide the best 19F MRI signal-to-noise ratio in comparison with the analogue block copolymer structures, making them most promising as 19F MRI contrast agents.

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Permeate flux control of a conductive membrane through redox switching

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Abstract

The permeate flux control through a smart filtration membrane, using a pH or temperature switch, has been of significant interest in recent years. However, both stimuli could cause possible composition changes of permeate in the beverage filtration and clarification. A redox-active coating on a filtration membrane could provide a redox switch as an alternative for the permeate flux control with the least effect on the beverage's quality. In this work, we modified a polyethersulfone (PES) microfiltration membrane with poly(3,4-ethylenedioxythiophene) (PEDOT) coating through vapour phase polymerization. The conductive membrane (PES/PEDOT) showed a good performance in both permeate flux and electrical conductivity after optimizations on the polymerization parameters. The redox activity of the PEDOT coating was investigated by Raman spectroscopy mapping. A flux switching behaviour was observed after oxidizing and reducing the PEDOT coating. Force curve mapping in atomic force microscopy confirmed the actuation of the PEDOT coating during the redox cycles, providing a redox switch performance of the permeate flux of the PES/PEDOT membrane.

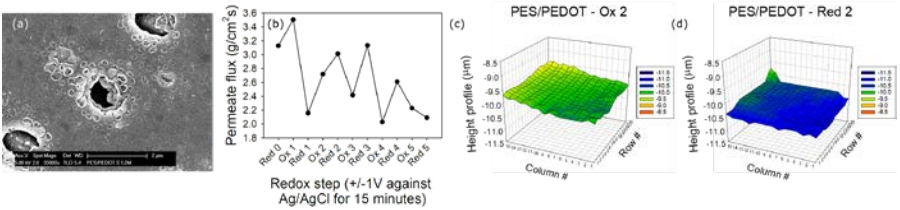

Figure 1. (a) Surface morphology of the PES/PEDOT membrane. (b) Permeate flux control of the PES/PEDOT with redox switching. Height profiles of (c) oxidized and (d) reduced PES/PEDOT membrane from the force curve mapping.

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Effect of processing conditions on suspension polymerization reaction of molecularly imprinted adsorption media

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Abstract

Molecularly imprinted polymers (MIP) is a class of novel material where a polymer mixture is polymerized around a compound, e.g. a trace contaminant or valuable compound, resulting in aan adsorbent which is specific for that compound. At present, MIPs have only been applied on the laboratory scale as a separation media, so MIP production is mostly carried out on the small-scale using bulk or precipitation processes, and typically have small particle sizes in the micro- or nanometer range.

Suspension polymerization involves polymerizing the MIP as droplets in a solvent (dispersed phase) in an immiscible or partially immiscible continuous phase such as water. This enables larger MIP resin beads to be produced which are suited for large scale, high throughput adsorption columns due to their lower pressure drop. MIP production using this method is also easier to scale up due being able to readily control reaction rates.

In this work, suspension polymerization of molecularly imprinted polymer (MIP) specific for catechin hydrate was carried out using different ratios of crosslinker, monomer and initiator in a single phase, with water as the continuous phase. Using identical reactor conditions, the effect of monomer, crosslinker and initiator ratio on size distribution, resin morphology, and adsorption characteristics was investigated.

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Towards the methylation analysis of heparan sulfates

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Abstract

Understanding the detailed structure and function of heparan sulfate (HS) is crucial to utilising this valuable biomaterial for tissue regeneration and drug delivery applications. The biological activity of HS is attributed to specific sequences within the chain, with variable arrangement of sulfated disaccharides, that interact with proteins. A common approach for analysis of HS structure is using chemical depolymerisation or enzymatic digestion methods to obtain disaccharide constituents or oligosaccharide fragments. However, determination of HS structure is extremely difficult due to the chemical heterogeneity and instability of sulfate groups.

The aim of this research is to develop a chemical characterisation methodology for characterisation of HS. This method involves permethylation, desulfation and labelling of the sulfation sites with deuteromethyl groups, followed by depolymerisation of HS by acid hydrolysis or alcoholysis. The resulting disaccharides are further derivatised to make them amenable for gas chromatography-mass spectrometry (GC-MS) analysis.

Sequential derivatisation and depolymerisation opens the possibility of using GC based separation which offers high sensitivity of detection, high resolution, and fast speed of analysis compared to other chromatographic techniques.

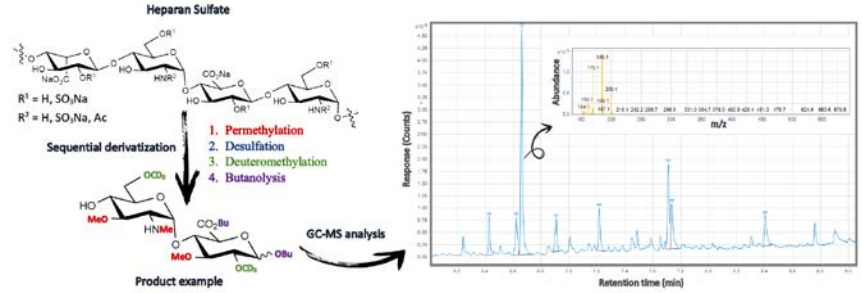

Figure 1. Characterization of heparan sulfate by chemical derivatization and GC-MS

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Heparan sulfate, the next polymer paradigm in therapeutics

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Abstract

The anticoagulant heparin is the most widely used natural product human therapeutic. Application as an anticoagulant commands an international market worth US$ ~10 B. Heparin is the most negatively charged natural polymer and arguably the most information-rich biomolecule in nature. However, while only mast cells produce heparin, and it is present in our body in very small amounts, every cell generates the closely related, less sulfated heparan sulfate.

Our research focuses on the chemical composition of heparan sulfates. The goal is to generate, for the first time, a therapeutic based on heparan sulfate that capitalises on this molecules ability to bind selectively to specific growth factors. As heparan sulfate is ubiquitous in the body it exhibits perfect biocompatibility; therefore, such a technology could direct cellular repair and speed tissue regeneration without undesirable side-effects.

The characterization of this highly complex class of molecule, its application in a wound repair technology and research towards synthetic variants will be presented.

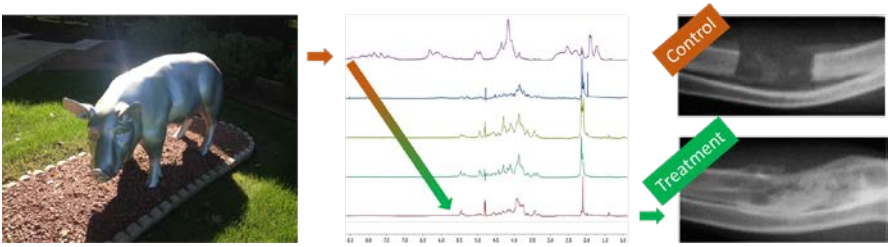

Figure 1. Porcine derived heparan sulfate with processing can promote rapid bone repair.

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Direct Observation of Active Species in Radical Polymerizations using Electron Spin Resonance (ESR/EPR) Spectroscopy in Higher Sensitivity

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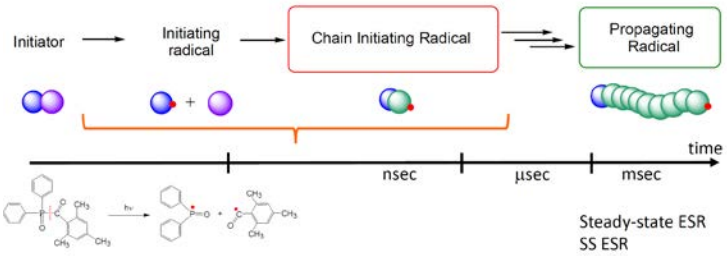
Abstract

Electron spin resonance (ESR, aka electron paramagnetic resonance, EPR) investigations have been conducted on radicals formed during radical polymerizations and provide a detailed characterization of the active radical species (Fig. 1)1,2. Active propagating radicals can be observed during actual radical polymerizations by ESR/EPR. When the active radicals in actual radical polymerization can be observed, not only structures of the radicals, but also physicochemical properties, molecular dynamics, kinetics and so on would be discussed in detail. Fortunately, radicals in radical polymerizations of styrenes, dienes, and (meth)acrylates were observed very clearly. On the other hand, unfortunately, monomers containing nitrogen like (meth)acrylamides and *N*-vinyl monomers have not been observed clearly. This difficulty is due to faster relaxation of nitrogen nucleus than those of carbon and oxygen nuclei.



Recently, novel temperature variable flow ESR observation system was developed for increasing of the sensitivity. Results were dramatic. Fig. 2 shows comparison of before and after introduction of the flow system. When a flow system was used in the same condition, signal intensities dramatically increased. Some of the spectroscopic lines were overflown. Spectra in Fig. 3 are chain initiating radical of *N*-tert-butyl methacrylamide. Chemistry of radical polymerization would progress based on these results. 102

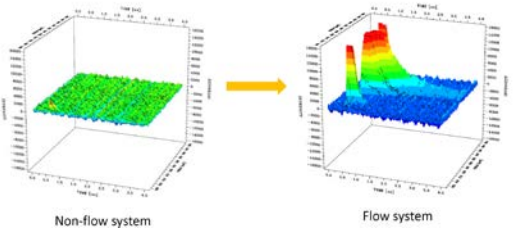


Fig. 2 3D-images of TR ESR spectra of *N*-vinyl pyrrolidone with new flow system (right) and without the flow system (left).

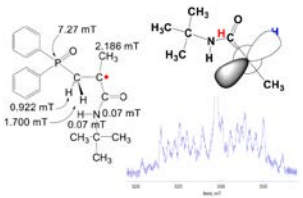


Fig. 3 TR ESR spectrum of *N*-tert-butyl methacrylamide along with its structure and Newman projection.

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Cellulose from Macroalgae Cultivated in Municipal Wastewater

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Abstract

Bio-based polymers and their nanocomposites provide sustainable alternatives to petroleum-derived polymers and materials. Cellulose and cellulose composites provide an important example, and the raw cellulose feedstock can be sourced from bacteria, algae or terrestrial plants. Cellulose from freshwater algae is unique, typically possessing high crystallinity (Knoshaug *et al*., 2013), high specific surface area (Jmel *et al*., 2019), and high purity due to the absence of lignin or ease of extraction from the biomass (Moral *et al.*; Roesijadi *et al*., 2010). These unique properties are suitable for applications in new materials with unique physical and thermal properties. Our group uses the freshwater macroalgae, *Oedogonium calcareum*, for the bioremediation of nutrients (nitrogen and phosphorus) from municipal wastewater and is interested in developing cellulose products from the cultivated biomass. However, the effect of cultivating *O. calcareum* biomass in municipal wastewater and other post-harvest treatment (e.g. biostimulant production/sanitisation and drying) on the yield and quality of cellulose have not been determined. Therefore, in this study, we determined the effects of biostimulant production and other pre-pulping steps on the yield and quality of cellulose from *O. calcareum* using a factorial experiment. Constituent sugar analysis, elemental analysis, mineral content, FTIR, XRD, TGA and SEM were used to characterise the *Oedogonium calcareum* cellulose and compare it with standard microcrystalline cellulose (MCC). This talk will cover the optimum processing conditions for the production of high-quality cellulose from a native New Zealand freshwater macroalga.

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Construction and Mechanical Properties of Woven Polymer Networks

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Abstract

As one of the oldest and most unfailing technologies in human history, which is intimately correlated to the advancement of human civilization. Through a synergistic relationship, highly ordered warp and weft threads impart intriguing topological structure and rich mechanical properties to woven materials. Inspired by the artistry and practicality of artificial fabrics, molecular scale woven polymer materials were constructed via the introducing of woven nodes in polymer networks. Under stress, the dynamic woven cross-linking points can dissociate for energy dissipation and enhance network toughness. At the same time, due to the existence of woven topology, the warp and weft threads will slip relatively after the dissociation of dynamic nodes, so that the stress can be transferred to the whole polymer networks, and the strength and resilience of the networks are improved while maintaining the woven topology. Thus, woven polymer networks (WPN) combine the mechanical strength of traditional covalent polymer networks (CPN) with the dynamics of supramolecular polymer networks (SPN).

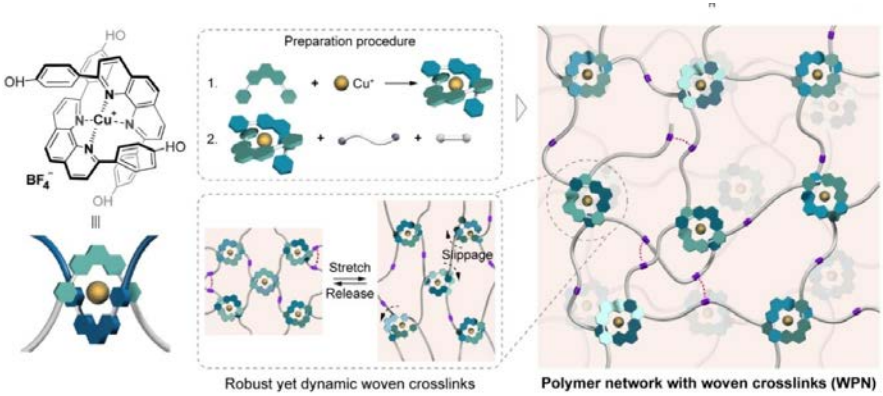

Figure 1. Woven polymer networks.

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Chiral Inorganic Nanostructures from Achiral Platforms: A Universal Synthesis Route via Supramolecular Self-Assembly

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Abstract

The chirality of nanostructured systems has gained growing attention in catalysis, biotechnology, and optoelectronics owing to their exotic enantio-/spin-selective interactions and intriguing chiroptical features. However, large-scale fabrication of chiral inorganic nanostructures still remains a challenge. Herein, we report a simple but generalized route for the synthesis of diverse chiral inorganic nanoparticles (NPs) such as Au, Ag, PdO, and TiO_2 NPs using block copolymer (BCP) templates. The self-assembled BCP inverse micelles offered a specific environment, wherein DL-alanine induced left-handedness via hydrogen bonding with the pyridines of polystyrene-*block*-poly(4-vinyl pyridine) (PS-*b*-P4VP). The BCPs were then used as a chiral host to transfer their handedness to the anchored inorganic NPs, resulting in an anisotropy factor of -8.6×10^{-4} for the Au NPs. Our design concept pinpoints the steps required to construct an extended library of viable chiral nanostructures, and will aid in the development of artificial chiral materials.

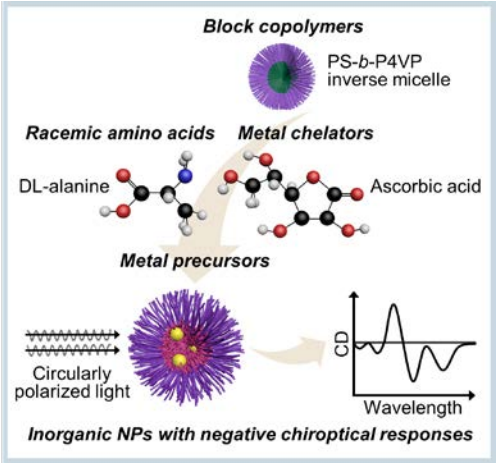

Figure 1. Schematic illustration of the synthesis of chiral inorganic NPs.

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Palygorskite/polymer nanocomposites as drilling fluid additives

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Abstract

Drilling fluids are essentials tools for drilling oil well efficiently, their main roles are: carry generated cuttings from the bottom of borehole to surface; suspend cuttings while drilling operation is paused; balance underground pressure; stabilize formation's walls; lubricate and cool both column and drill bit; reduce friction between formation wall and drilling column; and, provide information about drilled formation. Around 80% of drilled borewells use water-based muds (WBM), because of their low cost, environmental friendliness, easy preparation, and better performance in logging geological formation when compared with oil-based muds (OBM). Interaction between water and shale by hydrogen bonding can be a problem when WBM are used, causing well instability and formation damage [3,4]. Furthermore, deeper borewells are found with harsh conditions (high temperature, pressure, and salinity). To avoid such problems during this operation, additives such as polymers are included in WBM. Polymers as polyacrylamide, xanthan gum, polyethylene glycol and polyvinylpyrrolidone are widely applied as thickening agents and form a thin film on formation surface, reducing filtrate loss, although, most polymers have low thermal stability and low salt tolerance. Recent studies show that nanoparticles as CuO, ZnO, Fe_3O_2, SiO_2 and clays could also be demonstrated to be able to form a thin, compact, and stable mud cake, obstruct shale pores, besides increase heat transfer and thermal stability of drilling fluids. Those characteristics lead to reduction in filter loss as well as shale swelling. Research on polymeric nanocomposites applied to drilling has increased in recent years. Palygorskite $[(Al,Mg)_5Si_8O_{20}(OH)_2(OH_2)_4.4H_2O]$ is a clay mineral with fibrous morphology, has interesting physicochemical properties like melting point at 1550°C, high cation exchange capacity (CEC of 20-50 meq/100g) and dynamic viscosity ~11000 cP in 6% aqueous suspension. Therefore, this work aims to synthesize three different polymeric nanocomposites, using polyacrylamide, polyethylene glycol and polyvinylpyrrolidone as polymer matrix, with different concentrations of Palygorskite as nanoparticle. This research has three main steps: beneficiation and comminution of Palygorskite; study on its behavior in aqueous dispersion; and polymeric nanocomposites synthesis. Beneficiation and comminution of Palygorskite happened as follows: a 635 mesh sieve was used for wet granulometric separation, then filtration was carried in 20 L filter press, cake was dried in industrial oven for 4 h at 65 °C, material disaggregation was made in jaw crusher and later in disc mill, homogenized by using a conical and longitudinal pile, finally, quartering was carried out in a rotary sample divider whereupon ten samples with ~ 50 g of clay were separated. X-ray diffraction and thermogravimetric analysis confirm the presence of Palygorskite with a good thermal stability. The average particle size was 46.45 nm, confirming Palygorskite nano size, CEC was 34.00 $\pm$ 0.25 meq/100g and BET surface area 129.16 $\pm$ 0.73 m^2/g. Ultrasonication treatment optimization of 0.5% wt/v Palygorskite dispersion in water was studied before use it in polymeric nanocomposites synthesis, by using a factorial experimental design 2^2 with amplitude (20-40%) and time (5-20 min.) of ultrasonication as factors, and particle size measured immediately, 24 h, a week and a month after by dynamic scattering light as

response. It was observed for all samples that immediately after ultrasonication treatment is the best moment to use the Palygorskite dispersion since there was just one phase. Best data set was acquired on first day, which was evaluated by ANOVA, concluding that particle sizes were statistically different. Smallest particle size was 240.0 nm for the sample ultrasonicated with 20% of amplitude for 5 min., while the biggest particle size was 269.9 nm for the sample with 40% of amplitude and 5 min. It could be noticed that for all samples the supernatant particle size reduces with time, that could be justified by the fact that probably the biggest clay particles settled down at bottom of the tubes. Sample ultrasonicated with 20% amplitude for 20 min. showed better stability over time, with 39% of reduction in particle size. Another important observation is that all samples presented a large particle size distribution, that could be great given that rock formation have different pore sizes. In general terms, best responses were obtained with lower amplitudes and higher times of ultrasonication. Next step is to synthesize polymeric nanocomposites and evaluate their properties due to increase in Palygorskite clay concentration.

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Reversible cross-linking of microgels into a macrogel by dynamic bonds

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Abstract

Polymeric materials which can dynamically respond and adapt to various external stimuli are currently attracting much attention due to their vast possible applications. Polymer hydrogels are widely employed as stimuli-responsive materials triggered by the changes of pH, temperature, addition of various substances etc. Many gels respond to such stimuli by changing their volume, e.g. undergoing reversible swelling-collapse transition. However, for many applications, a strong change of mechanical properties (viscosity and elasticity) of polymer gels is required without any volume change. For instance, such an effect may be implied in oil industry for developing "smart" hydraulic fracturing fluids. Fracturing technology consists in pumping of the gel with suspended proppant particles (several mm in size) into the oil well and thus creating fractures, thorough which the oil can flow out. Fracturing fluids should possess high viscoelasticity when pumped into the oil well, but should be easily broken into a liquid after the fracturing operation. One of the ways to create such fluids is the reversible cross-linking of microgels into a macrogel.

In this work, we have obtained microgels of a biopolymer (hydrohypropyl guar, HPG) of different sizes ranging from several hundreds of nm to hundreds of microns. Small microgels were synthesized by emulsion cross-linking of HPG modified by photo cross-linkable groups, while larger ones were obtained by grinding macrogels. A second dynamic cross-linker (borate ions) was used in addition to covalent cross-links, and dual-cross linked microgels were obtained, which was proven by measuring their mechanical properties. It was shown that dynamic cross-linkers can re-distribute inside the microgel suspension and cross-link macromolecules within one microgel as well as different microgels together. It was shown that a key factor controlling the cross-linking of microgels together is the rigidity of their surface: "rigid" microgels do not have enough contact points between the surfaces and cannot be cross-linked, while "soft" microgels easily form a macrogel. A thus obtained macrogel can be reversibly destroyed into a suspension of microgels by breaking of the dynamic bonds, which happens very fast (in seconds) and results in a reduction of the viscosity and elasticity.

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Microporous cyanate ester resins: effect of boron nitride content

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Abstract

Nowadays porous polymers are widely used in filtration, separation, and purification processes as membranes, adsorbents, ion exchangers, catalysts, permeable materials, etc. At the same time, many different methods on generation of porous polymer materials mostly concentrated on the usage of porogens of different chemical nature followed by removal of the latters have appeared [1]. However, significant drawback of such methods consisting in significant irregularity of pore structure formed together with the presence of many large and irregularly shaped holes still remains. One of the possible solutions to this problem lies in creation of porous polymer materials using radiation technologies.

Our previous research has shown the fundamental possibility of obtaining porous cyanate ester resins (CER) using a thermal nuclear reaction of hexagonal boron nitride (BN) induced by neutron irradiation [2]. The present communication discloses the effect of BN concentration in the CER-based film material on pore size and structure of the final material obtained.

For that purpose CER/BN composite film materials were successfully synthesized by high temperature in situ polycyclotrimerization of the mixtures of 1,1′-bis(4-cyanatophenyl) ethane containing from 0.1 to 2 wt.% BN in the presence of specific catalytic system. Generation of porous structure occurred according to the following scheme:

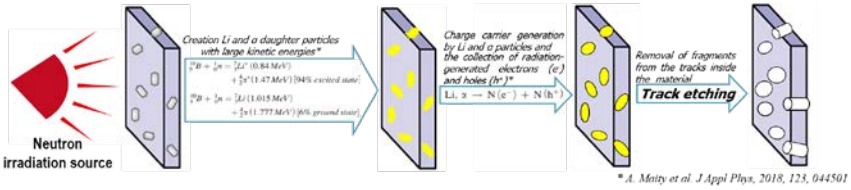

Figure 1. General scheme of producing porous CER films.

The pore structure of the film materials produced was estimated using SEM and Hg porosimetry measurements. Formation of micro-sized pores in all the obtained samples was confirmed. Strong dependence of the initial CER/BN ratio on pore dispersion and porosity of the films produced was affirmed. Thermal characterization was accomplished using DSC and TGA studies. It was found that thermal properties of the final microporous CERs were not inferior to non-porous analogues.

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Polycyclotrimerization of cyanate ester resin. Effect of boron nitride filler

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Abstract

Boron nitride (BN) is used as a nanofiller in polymer compositions in order to develop polymer nanocomposites with high thermal conductivity [1, 2]. Usually, 40-50 wt.% of BN is introduced for this purpose. In this study, we investigated an influence of small amounts of BN particles on the kinetic peculiarities of cyanate ester resin's polycyclotrimerization.

Dynamic DSC measurement at a constant heating rate was used to characterize the effect of boron nitride (BN) on the exothermic curing reaction and thermostable cyanate ester resin (CER) formation via high temperature polycyclotrimerization of dicyanate ester of bisphenol E (DCBE) with BN microfiller loading of 0.1, 0.5, 1.0, and 2.0 wt.%. Figure 1a shows the DSC thermograms for the neat DCBE and all the blends of different compositions. It was found that the peak temperatures shifted to lower temperatures with increasing BN content from 261 °C for individual DCBE to 218 oC for the composition with 2 wt.% BN. The enthalpy of the cure reaction for the neat DCBE was calculated to be ≈ 842 J·g-1 and it decreased significantly to 744 J·g-1 with increasing BN content to 2 wt.%. These facts indicate the effect of BN on the polycyclotrimerization of the DCBE in the compositions studied. Fig. 1b depicts the DCBE conversion values versus reaction time for individual DCBE and all the compositions studied. One can see that with increasing BN content the induction period of DCBE conversion decreases and the reaction occurs faster. One can conclude that the thermal polycyclotrimerization of DCBE is catalyzed by BN.

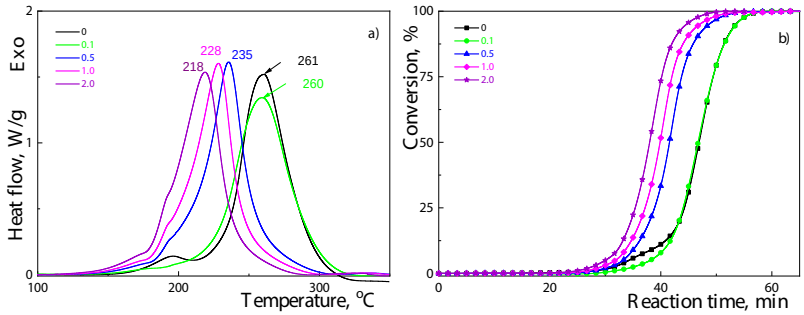

Figure 1. DSC thermograms (a) and conversion versus reaction time dependence (b) for the individual DCBE and DCBE/BN compositions (BN content indicated in the plot)

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Synthesis and rheological properties of self-healing magnetic hydrogels with anisotropic nanoparticles

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Abstract

Magnetic nanoparticles are widely used to obtain nanocomposite materials responsive to the magnetic field. In many cases, cylindrical nanoparticles are preferable because they can impart anisotropy to the material. As a result, material's properties can be controlled by magnetic field, e.g., by changing the anisotropy direction. To ensure the strong responsiveness to the magnetic field, a labile polymer matrix with dynamic cross-links between macromolecules can be used. In the present work, cylindrical nanoparticles of magnetite (Fe3O4) and cobalt ferrite (CoFe2O4) were obtained. They were embedded in hydrogels of carboxymethylhydroxypropylguar (CMHPG) polysaccharide cross-linked by labile dynamic covalent bonds - borate ions.

Cylindrical Fe3O4 or CoFe2O4 nanoparticles were obtained by reverse co-precipitation in a constant magnetic field, which was used as a template for anisotropic growth. The following mechanism of formation of cylindrical particles was proposed: 1) formation of small (a few namoneters) spherical nuclei at the initial stage of the reaction, 2) their self-organization into a columnar structure in the magnetic field and subsequent merging into a cylinder. The introduction of such nanoparticles into CMHPG/borate hydrogels leads to an increase in the elastic modulus, since they are embedded into the polymer matrix and serve as additional cross-linking between macromolecules. In an external magnetic field, the particles in the gel are arranged in columns, which leads to a significant increase in the elastic modulus and is much more pronounced for cylindrical particles than for spherical ones. The presence of bonds between nanoparticles and the polymer matrix leads to the fact that the gel can move and deform in an external magnetic field. The gels are capable of complete self-healing, which can be accomplished remotely by an inhomogeneous magnetic field. Finally, the parallel alignment of anisotropic nanoparticles in the external field allows preserving the anisotropy of the mechanical properties after the field is removed.

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Re-entrant swelling and redissolution of polyelectrolytes at high salt concentrations: The role of underscreening i

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Abstract

In colloidal systems the range and strength of electrostatic interactions has a profound effect on a range of properties including the stability of colloidal dispersions and the phase behaviour of surfactant and polymer systems. The Debye length has proven to be a very effective measure of the range of electrostatic interactions as confirmed by direct force measurements at low to moderate salt concentrations over many years . However, recent force measurements on ionic liquid systems has revealed that at high electrolyte concentration the electrostatic interactions are much longer ranged than expected from the Debye length. This has implications for all colloidal systems at high electrolyte concentrations, in particular the reentrant solubility of polyelectrolytes[6].

With regard to polyelectrolytes the effect of salt valency on reentrant solubility will be examined as will the mechanism for polyelectrolyte collapse and reexpansion. I will also discuss measurements on other colloidal systems that can be attributed to an increasing electrostatic decay length at high salt concentrations.

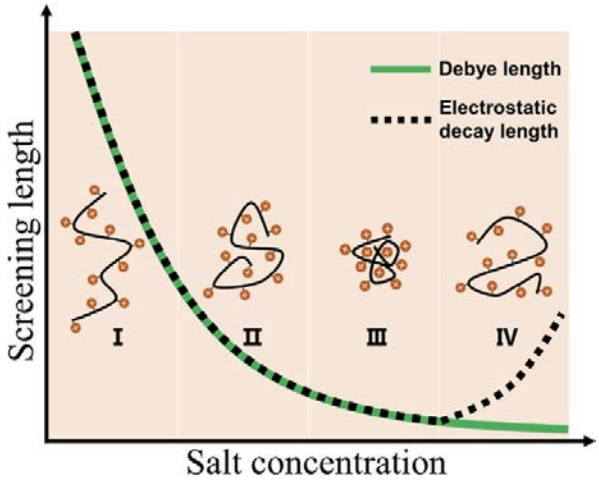

Figure 1. Schematic illustration of the effect of electrolyte on polymer conformation

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Electrochemistry of radical polymer gels and polyelectrolytes

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Abstract

Redox reactions are very common in many chemically driven life processes and have been used to synthesize new molecules and materials. Many different types of organic groups that can undergo reversible redox reactions have been classified into organic redox systems. When these redox-active groups are incorporated into a polymer, the corresponding polymers demonstrate similar electrochemical redox behaviour. Tuning the electrochemical properties of redox-active polymers provides opportunities to develop new organic and polymer materials designed for various applications, including transistors, organic magnetics, organic catalysts, energy storage, biomedicine.

Nitroxide radical polymers are polymers consisting of nitroxides such as 2,2,6,6-tetramethylpiperidyl-1-oxy (TEMPO) radical. Such radical polymers have now been widely used as so-called organic radical batteries (ORBs). While direct radical polymerization of TEMPO-consisting monomer is impossible, using anionic polymerization or the post-polymerization modification method, we have created different redox-active radical polymers and gels (Figure 1). The corresponding electrochemical properties were tuned through different chemical modifications. We detailed the structure impacts on electron transfer kinetics and found the improved performance of these redox-active polymers in polymer-based energy storage.

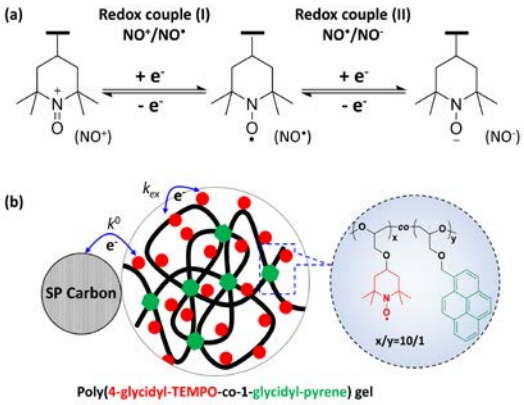

Figure 1. (a) Redox reaction couples of nitroxide radicals and (b) poly(4-glycidyl-TEMPO-co-1-glycidyl pyrene) gel used in this work to study the electron transfer kinetics.

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Alginate composite membrane filled with silver and nickel nanowires – characteristic and application in pervaporation dehydration of ethanol.

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Abstract

In era of exhausting non-renewable energy sources, new alternative are looked for. One of such replacement substances is ethanol. However, the use of ethanol as a renewable energy source requires its dehydration. Using typical dehydration techniques, the process of ethanol dehydration involves high costs. An alternative to these types of processes seems to be pervaporation. Applying the pervaporation process, it is possible to almost completely dehydrate ethanol at a lower cost. Nowadays, the investigation of biopolymers as a material of membranes is very popular. The main disadvantage for such materials is their excessive swelling. In order to improve mechanical properties of such biopolymers membranes, dispersion of filler into polymer matrix is used. In our study we propose to use sodium alginate as a matrix and silver (AgNWs) and nickel (NiNWs) nanowires as a filler. To the best of our knowledge nanowires have not been applied as a filler of membranes investigated in separation processes. The special features of the mentioned nanomaterials are biocidal and energy-saving characteristic of nanosilver and tribological and catalytic properties attributed to nanonickel. We expected that the addition of the nanowires impacted on the efficiency of ethanol/water mixture separation thanks to the shape of the nanowires, their hydrophilicity and magnetic properties of NiNWs.

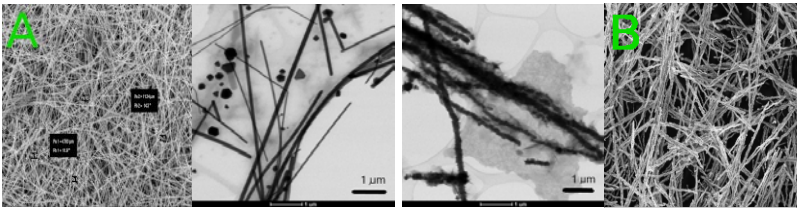

Figure 1. SEM and TEM images of nanowires (a) AgNWs; (b) NiNWs

The effectiveness of pervaporative ethanol dehydration was tested for three different cases: the change in amount of filler, different ethanol content and temperature of the feed. In all cases, the composite membranes showed a significant improvement in water/ethanol mixture separation. For 90 vol% ethanol concentration, used as a feed, the Alg membranes filled with 5ml of nanowires with a density of 10mg/ ml proved to be the most efficient. The separation factor equals to 1415 (NiNWs) and 878 (AgNWs), and the value of flux was 1.65 $kg \cdot m^{-2} \cdot h\text{-}1$ (NiNWs) and 2.08 $kg \cdot m^{-2} \cdot h^{-1}$ (AgNWs), respectively. For comparison the neat alginate membrane was characterized by a separation factor of 12 and a flux equalled to 0.8 $kg \cdot m^{-2} \cdot h^{-1}$.

In our research we confirm that presence of AgNWs and NiNWs in alginate matrix increased hydrophilicity of material and also it significantly improved separation properties of membrane for ethanol/water binary system. Moreover alginate – nanowires composite stands a great potential for future applications due to the simplicity of fabrication.

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Biomass-based and compostable polymer composites: structure-properties correlations

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Abstract

Polymers have become not only an indispensable part of present-day civilization but also have created a kind of threat to the natural environment and lives of several living beings. There is thus a challenge for polymer scientists of developing new materials using renewable resources and sustainable technologies for converting wastes into useful and environmentally benign products. In this context, polymer composites utilizing natural fibres and agricultural wastes as reinforcing fillers into various polymeric materials have gained enormous research interest during the last decades. In this paper, we will shed light on structure-properties correlation of composite materials comprising thermosetting resins (such as epoxy resin), thermoplastics (such as copolyester and polyolefins) and elastomers (such as natural rubber) and some locally available natural fibres (such as lignocelluloses, chitin, chitosan) and nanofillers. The biodegradable poly(butylene adipate-co-terephthalate) (PBAT) has been found to offer particularly interesting alternatives to producing compostable composites materials. Also, the influence of fibre treatment on the properties of the composites was studied. It was shown that the morphology and mechanical properties of the composites can be tailored over a wide range although the materials were found to be suited for low load bearing applications.

Keywords: biopolymer, polymer composites, compostable polymer, electron microscopy

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Natural polymer derived mesoporous structures regulated via temperature control and nanocomposite addition

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Abstract

Natural polymers are increasingly used to produce porous carbons due to their abundance, availability, cost and sustainable sourcing. Routes to synthesize these materials include the conversion of lignocellulosic biomass via HTC and activation to more sophisticated methods that include the controlled gelatinization, retrogradation and lyophilization of starch, alginic acid, pectin etc. These strongly compete with non-sustainable traditional commercial production that employs silica templates and their subsequent removal with toxic/hazardous reagents. The resulting sustainable mesoporous materials are very suitable for a variety of applications in catalysis, adsorption and energy storage etc., uses that depend upon efficient mass transport of substances to the surface.

We report on the synthesis of starch-based sustainable mesoporous structures, the control of their pore structure via temperature regulation and the influence of nanoparticle addition on their textural properties. By varying the gelatinisation temperature, surface area and pore volume could be controlled. This was found to be reversible, whereby changing back to the optimised temperature resulted again in good properties. Furthermore, on the addition of graphite nanoparticles, it was found that they selectively locate within the fibrous pore wall assembly (see Figure 1). This resulted in a >21-fold increase in conductivity of the final carbonaceous material, from 0.007 to 0.148 S cm^{-1} for the sample with 20 %w/w graphite, along with control over the pore size distribution, with higher NP concentration generally leading to larger pores.

The implications of the results are that versatility of the sustainable materials developed allows them to be employed in targeted high value application areas.

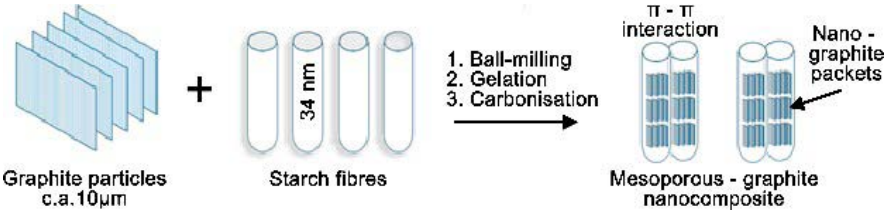

Figure 1. Graphite incorporation into the MC structure and its size reduction (final size approx. 20- 30 nm).

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Sustainable Polymers and Polymeric Materials based on Plant/ Vegetable Oils

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Abstract

For last few decades industry is looking for new oleochemical materials as an alternative to crude oil-based counterparts. Since the early 90s renewable raw materials, most commonly vegetable oils, became increasingly attractive for making oleobased materials, particularly biobased polymers. Some of the biobased polymer materials can surpass existing petroleum-based polymers in various applications on a cost-performance basis.

We developed one-step method that converts fatty acid esters of plant/vegetable oils into biobased acrylic monomers for free radical polymerization. Current library of fifteen monomers from oils broadly varying in fatty acid esters chemical composition can be applied in the synthesis of polymers (including latexes) that utilize acrylic monomers. Plant oil-based monomers (POBMs) offer unique functionality due to combination of fatty acid fragments of varying unsaturation with saturated ones, which allows "on-demand' cross-linking, as well as may facilitate formation of crystalline domains, thus providing an ability to tune thermomechanical properties and performance of resulted polymeric materials.

This presentation discusses synthesis of POBM-based latexes, their potential to be used in adhesives, coatings, personal care products etc., as well as how incorporation of plant oil-based ingredients into bioplastic materials broadens an opportunity to substitute petroleum-based counterparts, and not only improve product sustainability but also enhance its performance.

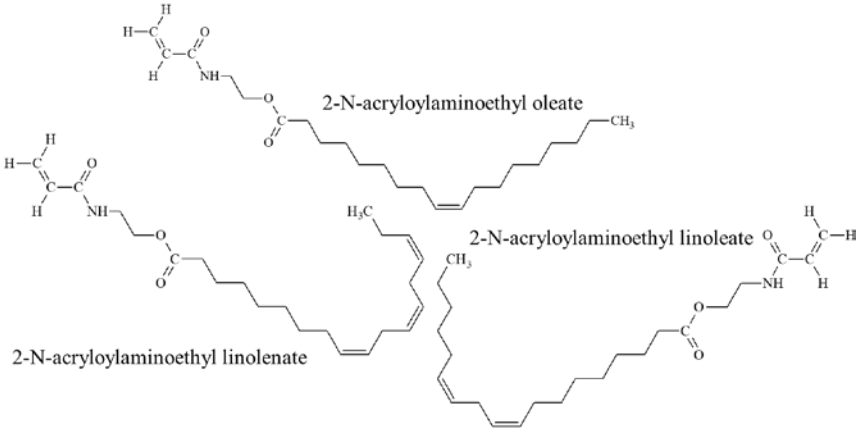

Figure 1. Chemical structure of POBM mixtures.

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Recent Applications of the Successive Self-nucleation and Annealing (SSA) Thermal Fractionation Technique

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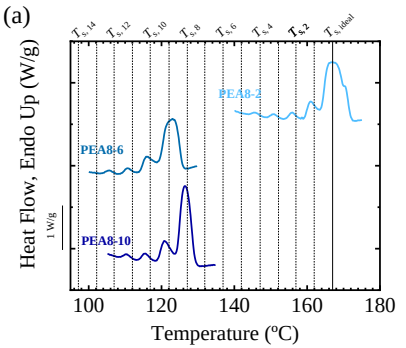
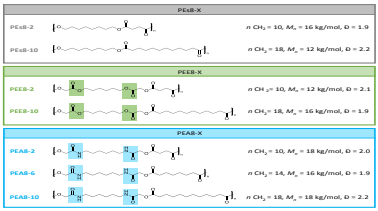
Abstract

Successive Self-nucleation and Annealing (SSA) is a thermal fractionation technique easily performed by Differential Scanning Calorimetry (DSC). Through the combination of non-isothermal and isothermal (self-nucleation and annealing) steps, efficient molecular segregation is achieved during polymer crystallization. Such molecular segregation magnifies the effect of defects in polymer chain crystallization, thereby providing information on chain structure. The technique was created by Müller and co-workers in 1997.



Examples of SSA Fractionated polyester amides. Intermolecular interactions act as intrinsic defects interrupting the crystallizable chain length, thus facilitating thermal fractionation (see ref. 3f)



This presentation explores the most recent applications of SSA of the past decade. First, the principles of the technique are briefly explained, covering all the relevant variables and the novel information that could be gained by using chip-based fast scanning calorimetry. Next, selected different cases will show how the technique is employed in various novel fields, like studying crystallization modes in random copolymers, solid-solid transitions, intermolecular interactions in homopolymers and nanocomposites, memory effects, topological effects, pre-freezing phenomena, and the evaluation of polymer synthesis variables, among others.

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Bioinspired Supramolecular Chiral hydrogels

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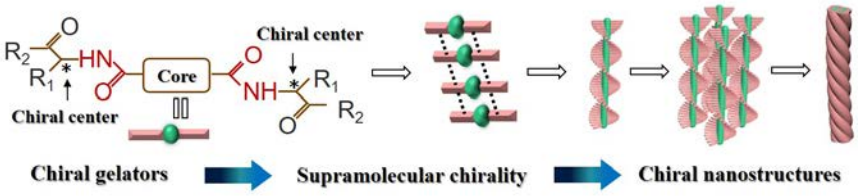
Abstract

Chirality is a ubiquitous phenomenon in life, which can be observed in many living matters (e.g. DNA, RNA, proteins, enzymes with helical fibrous structures. Why does life require chirality, which is one of 125 scientific questions published by Science Magazine and urgently needs to be explored. To reveal the importance of chiral structure in life, researchers have focused on the construction of biomimetic chiral micro/nano-fibers for a long time. However, only a small number of researchers represented by Prof. Feringa, the Nobel Prize winner, have successfully prepared chiral structures at supramolecular level. How to construct chiral structures at nano/micro scale is still facing great challenges. The fundamental reason is that it is difficult to achieve long-range ordering, precise assembly, and controllable adjustment of structures, which are also the challenges for the molecular design. Our group created the molecular design principle of constructing chiral structure, firstly put forward the molecular design concept of C2 symmetric monomers, achieving the precise construction and regulation of chiral fibrous structures in supramolecular hydrogels. Furthermore, a universal strategy of preparing chiral structures in general materials is proposed, which realizes the customization of chiral structures on non-chiral materials via multiple hydrogen bonding interactions. Notably, the biological function of chiral structures is firstly discovered. It is found that chiral structure of nanofibers can efficiently regulate cell adhesion and proliferation, as well as differentiation direction of stem cells. The mechanism of cell adhesion, proliferation, and differentiation behaviors regulated by chiral structures is revealed. The stereoselective interaction between cell membrane protein and chiral fibers is the origin of the bio-effect of chiral structures, which is closely associated with physiological functions of chiral fibers. This research not only provides interesting insights to precisely construct chiral nano/micro-structures in artificial materials, but also helps us to comprehensively understand chiral effects on cell biological behaviors.



Scheme. The C2 molecular structure and their self-assembly into supramolecular chirality and chiral nanostructures through highly efficient hydrogen-bonds and π-π interactions.

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Using Living/Controlled Radical Polymerization in 3D printing

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Abstract

Reversible addition-fragmentation chain-transfer (RAFT) polymerization is a powerful tool for synthesizing macromolecules with controlled topologies and diverse chemical functionalities. However, the application of RAFT polymerization to additive-manufacturing processes has been hindered due to their slow polymerization rates.In this talk, we report a rapid visible light mediated RAFT polymerization process and applied it to a 3D printing system. The photosensitive resins contained a photocatalyst and a trithiocarbonate RAFT agent to afford polymerization without prior deoxygenation. Following the optimization of the resin formulation by varying the ratio of photocatalyst, a variety of 3D printing conditions were investigated to prepare functional materials. The mechanical properties of these 3D printed materials were investigated under different conditions, showing that the addition of RAFT affect the performance of these materials. Furthermore, the trithiocarbonate species incorporated in the polymer networks were able to be reactivated after the initial 3D printing process, which allowed the post functionalization of the printed materials via secondary photopolymerization processes. Finally, the incorporation of polymers terminated by RAFT agent was employed for the preparation of 3D printed multimaterials with a precise control of the nanostructure of these materials.7 We will discuss the effect of nanostructure of 3D printed materials on their mechanical properties and present their applications.

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Tailoring Chitosan Bio/smart Materials via Water-based System

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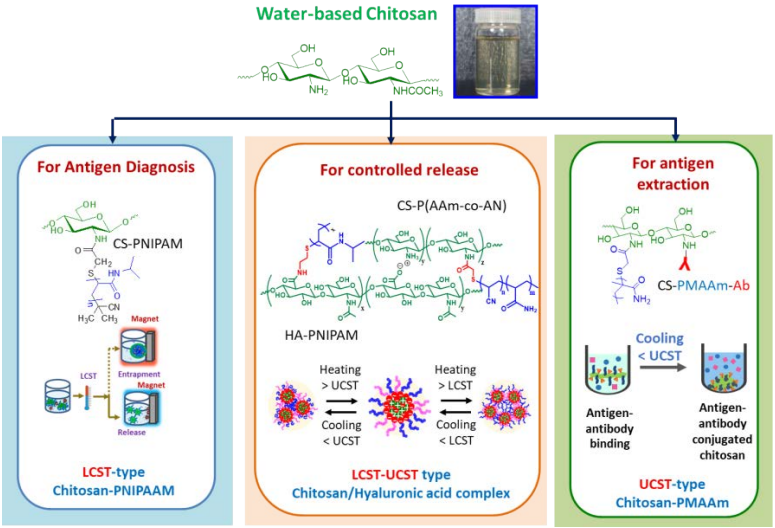
Abstract

Chitosan is the only natural abundant polysaccharide that contains reactive amino and hydroxyl groups for further chemical modification to be potential bio/smart materials. The fact that chitosan is under the strong inter- and intra-molecular hydrogen bond, basically, chitosan is soluble only in acids, either mineral acids or carboxylic acids. In other words, the tight packing structure of chitosan obstructs not only melting (as other polysaccharides) but also the solubility in most solvents including water. In general, chitosan needs to be modified to be soluble species to favor the functionalizing with other molecules and/or polymers. However, the multi-step reactions as well as the low yield limits the practical development of chitosan. This comes to our challenges to develop chitosan from water-based system. The use of water-based chitosan by simply forming the complex with N-hydroxysuccinimide (NHS) or hydroxybenzyltriazole (HOBt) allows us the effective and efficient conjugating reaction with thermoresponsive polymers to obtain chitosan-LCST(lower critical solution temperature), and or chitosan-UCST (upper critical solution temperature) -LCST for selective antigen extraction (Scheme 1 (a)) and for temperature dependence-controlled release system (Scheme 1 (b)), respectively. The combination of chitosan-LCST with magnetic nanoparticles provides us the magneto-thermo- responsive smart chitosan material (Scheme 1 (c)). Apart from thermoresponsive chitosan, the presentation will demonstrate the use of water-based chitosan for several types of bio/smart materials.



Scheme 1

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Advanced Polymeric Materials Based on AIEgens

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Abstract

Polymers with aggregation-induced emission (AIE) characteristics are a class of materials that show weak light emission in dilute solutions but become intensively emissive in the aggregate state. They have attracted tremendous attention in the past decades due to their good processability, efficient solid-state emission, high sensitivity, unique mechanical properties, diverse topological and morphological structures, etc. This talk will introduce the recent research progress on the synthesis, structures, and functionalities of AIE-active polymers. Moreover, new AIE-active systems without conventional chromophores (e.g., clusteroluminescent polymers) will also be discussed. A general method for synthesizing AIE-active polymers is to incorporate AIE-active luminogens (AIEgens) into the side chain, main chain, or center/terminal of a polymer structure. By using different polymerization or post-modification strategies, a large variety of AIE-active polymers with linear, star-shaped, dendritic, hyperbranched, cross-linked, or three dimensionally ordered structures have been constructed. The combination of AIE effect and the polymer characteristics enables AIE-active polymers to find a wide range of practical applications, including fluorescent chemosensing, bioprobing, bioimaging, and light-emitting devices. We hope this talk could provide some insight into the design strategy and the structure-property relationship of advanced polymeric materials based on AIEgens, to benefit the further advancement of this area and to show a picture of the bright future of AIE-active polymers.

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Synthesis and Semiconducting Properties of π-Conjugated Polymers Containing Resonance Assisted Hydrogen Bonds

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Abstract

The resonance assisted hydrogen bond (RAHB) is a special type of hydrogen bonding (HB). With the influence of the π-electron delocalization, the RAHB is stronger than normal HB which is solely based on an electrostatic interaction. A series of RAHB-containing building blocks of CTZ, CBTZ and TTPY have been synthesized. Single-crystal X-ray diffraction analyses of the building block revealed that the RAHB interactions were formed between the carbamate hydrogen and imine nitrogen of the thiazoles or pyridines. The hydrogen donor and acceptor were connected by π-conjugated molecular framework and the hydrogen-bridged quasi-aromatic rings locked the conformation of the building block. In these single crystals, the building blocks of CTZ and TTPY adopted a lamellar packing, and CBTZ adopted a layered sandwich packing. The new π-conjugated polymers of PCTZ-T, PCBTZ-TT and PTTPY-DPP based on CTZ, CBTZ and TTPY were also synthesized, and were applied in organic field effect transistors (OFET), These polymers all showed p-type transport character, and the maximum hole mobility were 2.30, 0.96 and 0.17 $cm^2 V^{-1} s^{-1}$ for PCTZ-T, PCBTZ-TT and PTTPY-DPP, respectively. New polymers of PCTZ-B, and PTTPY-BDT were synthesized for organic solar cells (OSCs) applications. The energy conversion efficiencies were 12.7% (PCTZ-B), 13.6% (PCBTZ-TT) and 10.8% (PTTPY-BDT) based on polymer:Y6 blends. These results demonstrated that thiazole, pyridine, and other nitrogen containing aromatic heterocycles, combined electron deficiency, less steric hindrance, and especially capable formation of RAHBs could be useful building blocks for organic semiconducting materials.

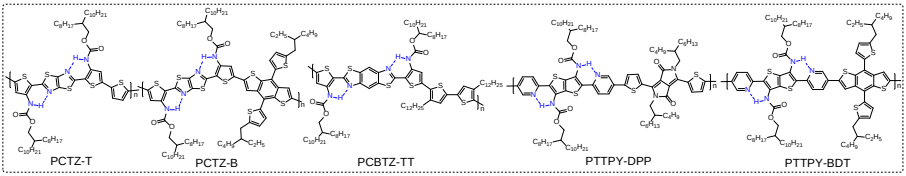

Figure 1. The chemical structure of polymers.

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Superionic polymer electrolytes with tailored intermolecular interactions

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Abstract

Charged polymers are promising materials for next-generation battery technologies and soft electronics. Key factors in this research area are the type of ionic additive and coulombic interactions between ions and polymer functional groups. By understanding these interrelated factors, conductive and robust polymer electrolytes can be prepared. The development of acid-tethered polymers is one route to prepare elaborate nanostructures and establish new structure–transport relationships. In this talk, I would like to introduce the latest results of our groups on acid-tethered polymers by focusing on the design and synthesis of bifunctional polymers. Through the introduction of two types of functional moieties to precise positions of polymer backbones, ion distribution at distances of several angstroms, ion aggregation at several nanometers, and microphase separation at a few tens of nanometers could be modulated (Figure 1). Computational and experimental analyses have provided insights into how to improve the ionic conductivity across multiscale self-assembled structures of bifunctional polymer electrolytes without compromising mechanical strength, which is crucial for practical applications.

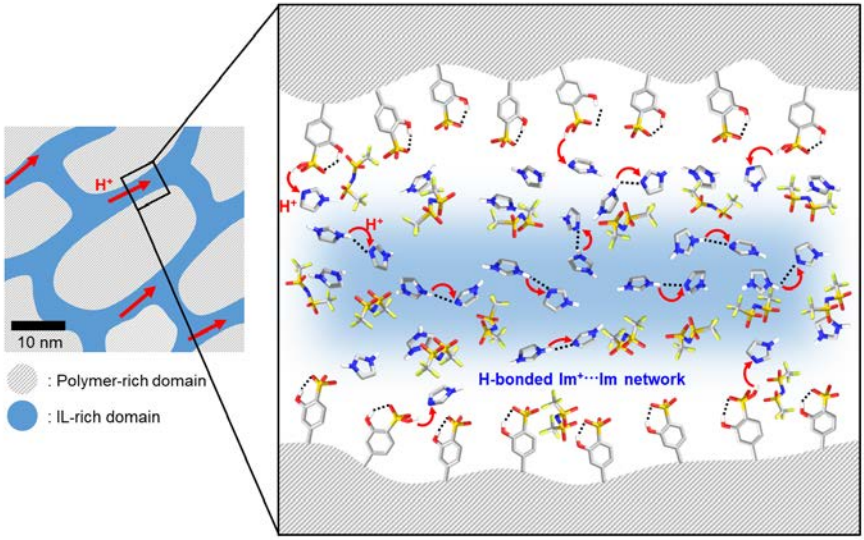

Figure 1. Ion channel formation in bifunctional polymer electrolytes

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Harakeke Reinforced Furan Bio-Composites

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Abstract

The rising importance of factoring sustainability into the use of composite materials has seen an immense upsurge in the popularity of natural fibre reinforced polymers within industry and research surrounding their potential uses for non-structural to semi-structural applications. However, the current dependance on petroleum-based thermosetting polymers, such as epoxies, detracts from the attractiveness and sustainability of these materials. Additionally, there is a great benefit in 'carbon- mile' by using locally cultivated natural fibres rather than imported materials grown and processed overseas. The current research project surrounds the study of a fully bio-based composite material relying on using native Harakeke (New Zealand Flax) fibres for the reinforcement of a polyfurfuryl alcohol matrix.

Within this work constituent materials have been processed and mechanically characterized. Processing has included the resinification of monomeric furfuryl alcohol and the alkaline treatment of mechanically processed Harakeke fibres. Manufacturing methods for producing high quality long-fibre composites have been developed, incorporating partially cured polyfurfuryl alcohol in a compression moulding process. Potential mechanical performance has been determined, along with durability. These properties have been benchmarked against traditional NFRPs relying on petrochemical thermosetting polymer matrices. This work quantifies the feasibility of using local grown Harakeke fibres in a fully bio-derived high-performance composite.

Figure 1. (Left) Harakeke Fibre Mat Production, Figure 2 (Centre) Neat Furan Matrix Tensile Testing, Figure 3 (right) Bio- Composite Preparation

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Organic nanoparticles for sensing, imaging, and therapy

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Abstract

There is an increasing trend of using organic nanoparticles and especially light-harvesting conjugated polymer nanoparticles as active materials for sensing, imaging and therapy applications. The recent results show that conjugated polymer nanoparticles could be fabricated to have tunable sizes and emission, with over 10-fold brightness as compared to inorganic quantum dots with a similar dimension. In addition, their large absorption cross-sections have also enabled them to be used as photoacoustic contrast agents and for photothermal and photo dynamic therapy. In this talk, I will discuss different strategies to form water-dispersible conjugated polymer nanoparticles and their applications as signal reporters or signal amplifiers for chemical and biological sensing/imaging and therapy. In addition, I will also briefly introduce our recent progress in organic nanoparticles with aggregation-induced emission features as replacement for quantum dots in various applications.

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Rheological Behavior And Microstructural Study Of A Ready-To-Use Therapeutic Food

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Abstract

Plumpy'Nut® is a Ready-to-Use Therapeutic Food (RUTF): a complex blend formulated for the nutritional rehabilitation of children suffering from severe acute malnutrition. The main ingredients usually included are peanut, sugar, vegetable oil, skimmed milk powder and a blend of vitamins and minerals. Because this RUTF is used all over the world, it undergoes many different stresses: climate, transportation, or storage but these conditions must not disturb the product properties when used and consumed. We need to understand what influence the thermomechanical parameters on this product to keep the best storage conditions during its shelf-life.

In this presentation, we are going to present lipid extractability and its impacts on calorimetric measurements and rheological experimentations to determine the role of lipids in crystallization and rheological behavior of Plumpy'Nut®. These results show that liquid lipid fraction participation in crystallizations and meltings is limited whereas it plays a key role in RUTF viscosity. A comparison with phases composition have been made to associate this behavior with the RUTF ingredients.

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Bismuth (III) complexes of maltol analogues and their application as antimicrobial ring-opening polymerisation catalysts

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Abstract:

Polylactic acid (PLA) is a commonly used polymer, formed from the ring-opening polymerisation (ROP) of lactide using tin (II) octanoate as the catalyst which has been shown to have some toxic effects. Bismuth however has a low toxicity for a heavy metal so has gained interest as an alternative metal centre in these ROP catalysts.

Some interesting nonbenzenoid aromatic compounds derived from natural sources include: maltol, tropolone, thujaplicin and kojic acid. These have shown a range of biological activities such as bacteriostatic and bactericidal, so would be suited to use as ligands in a bismuth complex to be used as a catalyst system to yield antibacterial polymers.

Bismuth tris-maltol compounds were formed from both bismuth acetate and bismuth nitrate obtaining yields of 66 % and 63 % respectively. Tropolone and thujaplicin bismuth complexes were formed from bismuth acetate in yields of 81% and 71% respectively. Complexation was concluded to have happened in all species due to the shift of the aromatic and alkyl protons in the ligand and the disappearance of the hydroxyl proton (HA) in the product.

Polymers catalysed using Bi(Mal)3 reached a complete conversion of over 95%, from Bi(Trop)3 and Bi(Thuj)3 conversion was slightly lower at 89% but still high considering the short reaction time.

Microbial testing in the form of minimum inhibitory concentration (MIC) on the complexes and disc diffusion assays on the polymer films is currently underway. As the ligands employed have been report as having antimicrobial activity, particularly thujaplicin for cosmetic applications, it is has been found in this work that these properties have been imparted to the polymers by maintaining the bismuth complex at the polymer chain ends and so yielding antimicrobial polymers to be employed in medical devices.

Keywords: ring-opening polymerization, antimicrobial polymers, bismuth catalysis, functional polymers, biomaterials, medical polymers, sustainable polymers

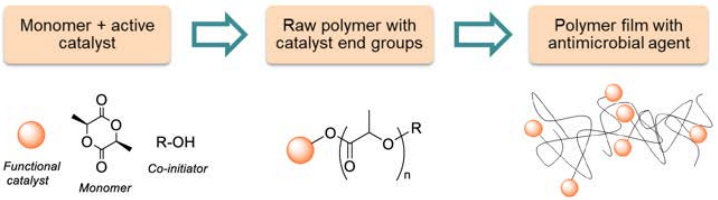

Figure 1: Steps to forming a polymer film with antimicrobial end groups from a functional catalyst

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Branching PLA with Aniline Pentamer: An Approach to Develop Antistatic Biodegradable Packaging

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Abstract

Antistatic packaging is essential for electronic parts, and devices to protect the damages from electrical environment. At present, PE and PP blended and/or composited with conductive materials are the choices to choose. In fact, the utilization of polyolefin leads to the problems of plastic wastes whereas the addition of conductive particles, such as carbon, leads to colored or opaque products. On this viewpoint, the development of biodegradable antistatic packaging with transparent appearance is a challenging theme.

As PLA is the most reliable biodegradable plastic resin with good clarity, the question is how to tailor it with the as-desired properties, especially the toughness and conductivity. The present work proposes a simple approach to apply branched poly (lactic acid) terminated with aniline pentamer (b-PLA-AP) as conductive segment. The b-PLA-AP obtained is expected to perform not only the conductivity but also function as the plasticizer for toughness. The presentation will cover the molecular design and synthesis of branching PLA terminated with aniline pentamer (b-PLA-AP) including the structural analysis. The work also extends to the studies on properties and performances of PLA blended with b-PLA-AP to demonstrate the potential antistatic biodegradable packaging.

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Thermoresponsive Catalyst Microcapsules for Tailoring PLA Biodegradability

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Abstract

At present, environmental issues related to petroleum-based materials call for alternative choices of renewable resource-based ones. Although PLA is commercially available with price competitiveness, biodegradability of PLA relies on the specific conditions to be satisfied with the standards and this limits the goal of reducing plastic wastes. Therefore, tailoring its biodegradability in general composting area, in water, and in marine becomes a challenging theme [1]. To our viewpoint, enzymatic degradation is an effective pathway, however, the incorporation of enzyme in PLA products requires thermal resistance during the processing condition and a ready-to-function degradability during compost. On this viewpoint, we propose a new strategy of PLA-degrading enzyme encapsulated in thermoresponsive microparticles coated with water soluble polymers. The polymer coated on microcapsules favors the survival of enzyme under processing steps whereas the UCST (upper critical solution temperature) polymer allows the release of enzyme during composting. The presentation covers the enzyme culture, microencapsulation of enzyme with UCST polymer and coating, including the investigation of thermal stability and the release of enzyme.

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Challenges and Opportunities of Hydrogels

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Abstract

Soft materials are a class of relatively novel materials comparing with hard materials such as metals, ceramics. Soft materials, especially hydrogels, possess various unique functions that hard materials do not have. Soft materials have promising applications in many fields, including medicine and robotics. Over the last two decades, remarkable progress in soft material development has been achieved by looking to nature for inspiration. However, in contrast to biological soft tissues, which have elaborate structures from molecular to macroscopic scales and sophisticated functions, synthetic hydrogels only have very simple structures and functions. We have great opportunities to develop hydrogel materials through learning from nature. This talk will discuss the opportunities and challenges in developing hydrogels by mimicking biological principles and structures.

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Glycopolymers for Drug Delivery: Opportunities and Challenges

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Abstract

Glycopolymers are synthetic polymeric backbones featuring pendant and/or terminal saccharide moieties [1]. Interest in these materials stem from their inherent bioactivity, as they can bind to lectins, carbohydrate-binding proteins, in a specific manner. Depending on the type of sugar attached, glycopolymer are known to interact specifically with surface receptors found on cell membrane. This allows the researcher to target specific cells, such as cancer cell, selectively, while non-cancerous cells do not engage with the specific carbohydrate structure. This has raised interest in the field of nanomedicine as nanoparticles prepared from glycopolymers were proposed as a vehicle to deliver drugs safely to tumors. However, before this can be achieved, we need to understand the relationship between the polymer structure and the ability of glycopolymer to become bioactive. For that purpose, we have developed a range of self-assembled micelles and other aggregates based on glycopolymer diblock copolymers (Figure 1). The aim was to understand how polymer length and aggregation can influence the interaction with cancer cell, thus the cellular uptake. We found that this is not trivial as the change of the nanoparticle properties not only affected the specific interaction with the surface bound receptors, but also non-specific protein binding with blood proteins was encountered (Figure 1) [2]. Once we gained some understanding of suitable nanoparticle morphologies to achieve the highest cellular uptake, we found that the loading of anti-cancer drugs into the nanoparticles could again shift the physico-chemical properties [3].

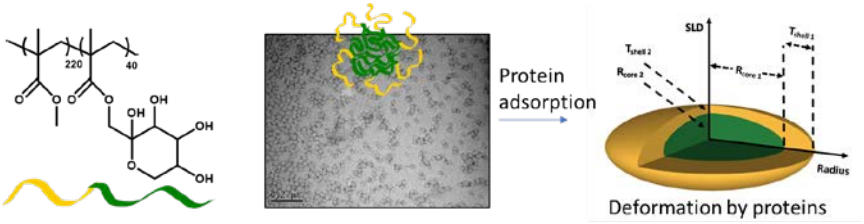

Figure 1. Amphiphilic glycopolymers and their self-assembly into micelles, which can be deformed by proteins found in blood

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Polyvinyl alcohol-graphene oxide membranes for removing microbial and chemical contaminants from wastewater

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Abstract

A series of electrospun polyvinyl alcohol (PVA) nanofibrous graphene oxide (GO) membranes containing copper and zinc oxide nanoparticles were made as a proof-of-principle filtration device for wastewater depollution. In this work, the membranes were assayed to kill and remove waterborne pathogens and a range of chemical compounds. The nanofibrous membranes were produced using a PVA (10% w/w) with citric acid (30% w/w) as the cross-linker to provide stability in water. Then GO, copper oxide-graphene oxide (CuO-GO), and zinc oxide-graphene oxide (ZnO-GO) were incorporated to the material synthesis (1% w/w). As indicated by scanning electron micrographs, the membranes were nanofibrous and produced a microporous structure. The GO varieties were successfully attached to the surface of nanofibers making active surface membranes. The PVA control membranes were found to be more hydrophilic than the nanoparticle/GO membranes. These filters were optimised following a series of fundamental studies involving pathogen kill and chemical removal; achieving a multilayered hybrid filtration system. It was found that the best results were achieved by sandwiching the membrane layers in the following order: PVA> GO/PVA> CuO-GO/PVA> GO/PVA>PVA. The optimised filtration system removed >5-log reductions for bacteria, *Escherichia coli* 0157:H7; and fungi, *Candida auris* from 1x106 CFU/mL cell numbers. Additionally, 99% of the textile dye Rhodamine-6G (R-6G) and 76% of the antibiotic amoxicillin (AMOX) from 10 ppm concentrations were removed as part of a simulated wastewater system. The membrane system was re-used 5 times with consistent performances, with 99% regeneration capacity. This optimised sandwich membrane prototype is effective in the removal of microbes and chemical contaminants as a water depollution application.

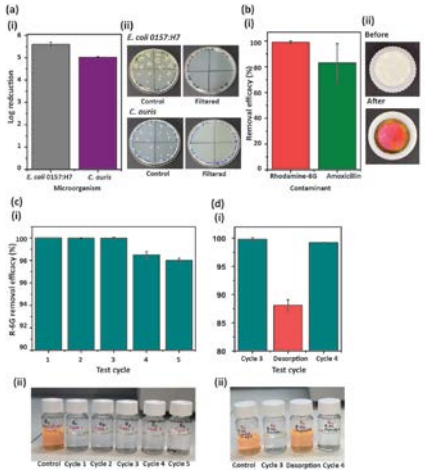

Figure 1: The waterborne pathogen and chemical removal performance of proposing membrane prototype. (a) (i) *E. coli* 0157:H7 and *C. auris* pathogens removal, (ii) Respective agar plates. (b) (i) R-6G and AMOX chemical removal, (ii) Photographs of membranes before and after use.

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Thermoplastic Starch Vitrimer through Thermoreversible Diels-Alder

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Abstract

Thermoplastic starch (TPS) is noted as a promising biodegradable plastic with natural abundance and cost competable with the commodity ones. Therefore, a wide range of applications. e.g., compost bags, packaging materials, coatings, mulch films, and disposable diapers were proposed. In fact, TPS products have their own limitations related to phase separation and retrogradation. Currently, polymers with dynamic covalent bonds, so-called vitrimer[1], are recognized as a new type of materials combining thermoset networks with thermoplast performances. To our idea, based on the concept of vitrimers, the dynamic crosslink covalent bonds between glycerol and starch might enable the stability of TPS. Herein, thermoreversible Diels-Alder (DA) reaction [2,3] to construct the dynamic covalent bond is considered. By simply modifying thermoplastic starch (TPS) with furan and maleimide, thermoplastic starch vitrimer (TPSV) can be obtained. TPSV shows the melting in retro Diel-Alder regime (above 120 °C) and this allows the crosslink networks generated during TPSV film fabrication via Diel-Alder cycloaddition. TPSV can be reprocessed as film through compression process of heating and cooling for several cycles. The presentation will cover the preparation of TPSV including the structural analysis, the properties, and

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What makes mussels stick?

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Abstract

The farming of bivalves, such as oysters and mussels, is heavily dependent on the surface interaction of juveniles (spat) with farming surfaces. Often the vast majority of spat are lost from farms through detachment resulting in significant losses in farm productivity and efficiency. New Zealand green-lipped mussel farming is fully reliant on the long line farming method using non-biodegradable polypropylene plastic ropes. The macro-scale (mm scale) roughness and bulk chemical composition of the plastic mussel ropes have already been optimised to their full potential by mussel rope manufacturers, however, micro and nano-scale properties and surface chemistry have not been controlled or assessed for their effect on spat settlement success.

Several studies have demonstrated a significant influence of surface morphology and chemical cues of seaweed on the settlement success of spat. However, the studies contradict each other on their relative importance. Spat attach throughout plastic mussel ropes, from filamentous outer strands to the inner core.

A recent study took one of the most common seaweed species found on Ninety-Mile Beach in northern New Zealand (Pterocladia lucida) and added it to mussel farming ropes which resulted in a significant improvement in the attachment of spat to these ropes compared to the plastic ropes alone. A range of seaweeds as well as Pterocladia will be tested for their effectiveness in encouraging spat settlement. Extracts from the seaweeds that attract spat will be analysed with GC-MS and/or LC-MS for identification of the active components and potential compounds suitable for surface deposition. Once promising chemical compounds have been identified, this research will experiment with several methods for depositing these extracts on the surfaces of mussel farming ropes, while maintaining the chemical structure, functionality and encouraging properties of the extracts. If spat attachment is even slightly improved (say from the current 1% success to 5%), this would provide significant economic benefits to the industry (five times the export potential), as well as a considerable reduction in wasted spat and plastic ropes which are known to degrade into micro and nanoplastics. Nanoplastics have increasingly been shown to cause many detrimental effects for aquatic life. They can be toxic on their own or become carriers of other toxic environmental contaminants through the "trojan horse effect".

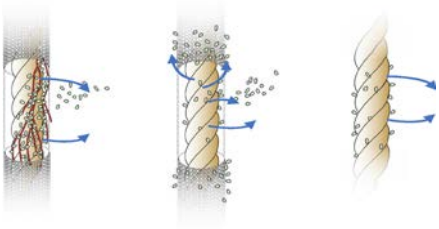

Figure 1. Diagram showing the seeding out process on Greenshell™ mussel farms [5]. Seaweed with spat attached is seeded alongside a fibrous polypropylene culture rope before being encased in a layer of protective stocking. Over time, the stocking and seaweed degrade and the spat either attach to the polypropylene rope or depart.

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POLY-CHAR 2024: POLYMERS FOR OUR FUTURE

It is a pleasure to announce the upcoming POLY-CHAR 2024 conference in Madrid that will take place from Monday 27th to Friday 31st of May, 2024. Following our long-established POLY-CHAR meetings, the schedule will include one short course on the first day and four day-sessions including a social tour day.

POLY-CHAR 2024 will follow the spirit of earlier conferences bringing together scientists from diverse areas including polymer chemistry, polymer physics and polymer engineering & applications. The Madrid edition will place its emphasis on polymers that can provide answers to urgent societal demands including sustainable polymers, recyclability, energy storage & generation, biomaterials, nanomaterials, etc. and their applications, amongst others, health, energy and the environment.

Madrid is a lively and cosmopolitan city with direct flights from over 150 destinations and a large and diverse offer in accommodation. The city has an excellent public transport system with high velocity train connections to several important Spanish cities in only a few hours. Madrid also enjoys a rich and abundant artistic and cultural heritage with over 150 museums and cultural centres and six UNESCO heritage sites only a stone's throw from the city.

The venue of POLY-CHAR 2024 will be the central campus of the Spanish National Research Council (CSIC) conveniently located close to the Madrid city centre. It is a relevant historical site that includes the National Historical Archive, the Rockefeller building and the "Residencia de Estudiantes", which in the early 20th century hosted illustrious figures such as the poet Garcia Lorca, the painter Dali or the film director Buñuel, and was a forum for debates with iconic personalities including Einstein, Marie Curie, Le Corbusier, Keynes and many others. Some POLY-CHAR 2024 sessions will take place in these historical buildings. Anecdotically, the main building of the CSIC came to recent fame in the TV series "La Casa de Papel (Money Heist)".

The Rockefeller building as part of the CSIC central campus.

We will be very happy to welcome you to our home town and are looking forward to meeting you all!

Araceli Flores (CSIC), chair

Organizing committee: Gary J. Ellis (CSIC), Marta E. G. Mosquera (Univ Alcalá), Javier Ramos (CSIC), Horacio J. Salavagione (CSIC), Peter S. Shuttleworth (CSIC), Juan F. Vega (CSIC)

Advisors: Marián Gómez-Fatou (CSIC), Alejandro J. Müller (Univ Basque Country)


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