
Microstructural evolution of dental glass-ionomer cements during setting reaction followed using SANS and USANS

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Glass-ionomer cement (GIC) is a biocompatible material which is clinically used for dental filling. The main challenges for further developing GIC in dental applications are improving the mechanical strength and controlling the setting reaction. During the setting reaction, poly (acrylic acid) attacks the fluoroaluminosilicate glass particles to form a siliceous hydrogel layer, glass core and polyalkenoate matrix in paste form. The siliceous hydrogel layer undergoes dehydration to yield a strong cross-linkage to bind both polymer and glass particles into a cement structure.

This study presents the application of small angle neutron scattering (SANS) and ultra small angle neutron scattering (USANS) with contrast variation techniques to study the microstructure evolution of a complex GIC paste during 48 hours of the setting reaction. A few GIC pastes are prepared from medical grade poly (acrylic acid), SiO₂-Al₂O₃-P₂O₅-Na₂O-CaO-CaF₂-based fluoroaluminosilicate glasses and a mixture of H₂O:D₂O solvent following the ISO9917-1:2007 cement preparation method.

The combination of SANS (Bilby@ACNS) and USANS (Kookaburra@ACNS) provides microstructure information of GIC paste over the length scale of 1 nm to 10 μm. The microstructure change of each phase in GIC pastes is investigated at different contrast conditions by varying the H₂O:D₂O ratio for both neutron scattering experiments. The macro- and nano-scale features of the polymer-glass-hydrogel phases in GIC paste during the setting reaction as well as their impact on mechanical strengths are presented in this study.