Investigating HPA functionalized mesoporous silica materials for use as high temperature proton exchange membranes

K. Lamb[a], R. De Marco[a], S. P. Jiang[b], and V. Peterson[c]

[a] Faculty of Science, University of the Sunshine Coast, QLD 4556, Australia.

[b] Fuels and Energy Technology Institute and Department of Chemical Engineering, Curtin University, WA 6845, Australia.

[c] Bragg Institute, Australian Nuclear Science and Technology Organisation, Locked Bag 2001, Kirrawee DC, NSW 2232, Australia

High temperature (>100°C) proton exchange membrane fuel cells (HT-PEMFC) are solid energy conversion devices that electrochemically convert chemical energy (eg. from alcohols) into electricity. HT-PEMFCs are more efficient than low temperature PEMFCs due to elimination of carbon monoxide poisoning and faster oxidation kinetics. Various types of proton exchange membranes have been explored, such as nonfluorinated hydrocarbon polymers [1], or hybrid Nafion-based membranes [2]. While these materials have their advantages, they dehydrate at high temperatures, leading to a significant reduction in proton conductivity [3]. Recently, we found that heteropolyacids (HPA) such as tungstophosphiric acid (abbreviated as HPW) can be used to functionalize ordered mesoporous silica (MSN) to make nanocomposites PEMs. While these nanocomposites have shown promising preliminary results as HT-PEMs, the ways in which changes to the structure of these materials affect the proton exchange properties are largely unknown. Analysis techniques such as ex- and in-situ HR-FTIR, SAXS, SANS, and QENS will be used to build an understanding of the membrane structure and proton diffusion mechanisms of these HT-PEMs, thereby determining the best performance HPA-MSNs for use in direct alcohol fuel cells.

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