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Improved elastomer gasket materials for PEM fuel cells

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Polymer electrolyte membrane fuel cell (PEMFC) stacks require sealing around the perimeter of the cells to prevent the gases inside the cell from leaking. Elastomeric materials are commonly used for this purpose. These gaskets are exposed to an acidic environment, humid air and hydrogen and are subjected to mechanical stress. The overall performance and durability of the fuel cell is heavily dependent on the long-term stability of the gasket. In this study, the degradation of three elastomeric gasket materials in an accelerated ageing environment was investigated. The accelerated aging conditions were chosen related to the PEM fuel cell environment, but with more extreme conditions of elevated temperature (140°C) and greater acidity. Three accelerated ageing media were used. The first one was dilute sulphuric acid solution with a pH value of 3. Secondly, Nafion[®] membrane suspended in water was used for accelerated ageing at a pH 3 to 4, to more closely correspond to a PEM fuel cell environment. Finally, diluted trifluoroacetic acid (TFA) solution of pH 3.3 was chosen because TFA has been identified as a degradation product of Nafion[®]. The three elastomeric materials tested were silicone rubber (SR), commercial ethylene propylene diene monomer rubber (EPDM), and an optimised EPDM compound that we developed in the course of the project (EPDM2). The test results showed that the effect of TFA solution on silicone rubber was more aggressive than sulphuric acid and Nafion[®] solutions with the same acidity (pH value). Acid ageing in all three acidic solutions caused visible surface damage and a significant decrease in tensile strength of the silicone rubber material, but did not significantly affect the EPDM materials. The EPDM2 compound had a desirable (low) compression set value which was similar to silicone rubber and much better than the commercial EPDM. It was concluded that an EPDM compound has great potential as a durable sealing material for PEMFCs.

Keywords: fuel cells; ageing; sealing; elastomers, rubber