

TITLE: The performance and degradation of Pt electrocatalysts on novel carbon carriers for PEMFC applications

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ABSTRACT:

The aim of this work was to elucidate the factors that reduce the performance of the electrocatalyst for polymer electrolyte membrane (PEM) applications, focusing on the sintering of Pt and formation of platinum sulphide (PtS<sub>2</sub> and PtS) on the anode electrode. Platinum nanoparticles (average diameter of 6.9 nm) were supported on graphitic nanofibres (GNFs) which were prepared by chemical vapour deposition over an unsupported NiO catalyst precursor. The membrane electrode assembly (MEA) consisted of Nafion-115 membrane, Sigracet carbon paper as current collector, Pt (1.75 mg/cm<sup>2</sup> onto GNFs) anode and Pt (2.0 mg/cm<sup>2</sup> onto Vulcan XC-72) cathode. The performance of Pt/GNFs based electrodes were studied by cyclic voltammetry and a single-cell fuel cell test and were compared with a commercial carbon Vulcan XC-72 in a 7 cm<sup>2</sup> PEM fuel cell.

Characterisation of the pre- and post-operation of the Pt/GNFs by XRD and TEM showed that structural changes of the Pt had occurred during testing. It was found that the average diameter of each grain remained unchanged but the degree of agglomeration among particles was increased, creating elongated clusters of Pt along the carbon fibre. The analysis of post-operation also identified that the sulphate in the Nafion membrane was reacting with the Pt surface creating new phases of PtS<sub>2</sub> and PtS. These phases were confirmed by the present of low intensity sharp XRD peaks, attributed to a few large diameter particles, 18 nm and 49 nm respectively. These two factors resulted in the cell performance dropping from 0.70 V to 0.50 V (at 0.2 A/cm<sup>2</sup> current density) over 25 hours of test.