Zeolites as Inorganic Fillers in Composite Membranes for High Temperature Direct Methanol Fuel Cells

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Composite recast Nafion membranes containing inorganic fillers have been used in direct methanol and H_2-air fuel cells [1-3]. The hygroscopic filler increases the water retention properties of polymer electrolytes allowing fuel cell operation at about 150°C in the presence of low humidification. A further advantage of the composite membrane is the reduction of methanol cross-over [4], due to a physical barrier effect provided by the inorganic filler.

In this work, composite Nafion membranes containing three natural zeolites (Mordenite, Chabazite and Clinoptilolite) were prepared by using a recast procedure. The behaviour of the composite membranes was evaluated in high temperature DMFCs (140°C). The thickness of all membranes was about 70 μm. The catalyst employed for methanol oxidation was a 60 wt% Pt-Ru (1:1)/Vulcan (E-TEK), whereas a 30 wt% Pt/Vulcan (E-TEK) was used for oxygen reduction. The platinum loading in all electrodes was 2 ± 0.2 mg cm^{-2}. Fuel cell tests were carried out in a 5 cm^2 single cell (GlobeTech, Inc.).

Maximum power densities between 350 and 390 mW cm^{-2} were recorded at 140°C under oxygen operation and 2M MeOH feed with 3 and 6 vol.% zeolite-based membranes (Fig. 1). The electrochemical behaviour of the composite membranes was interpreted in the light of the surface properties and acidic characteristics of the fillers.

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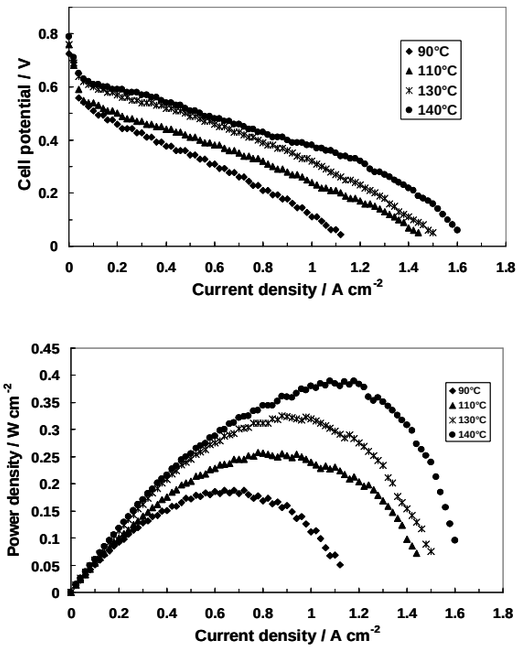

Fig. 1. Influence of operating temperature on the DMFC polarization and power density behaviour for the MEA equipped with a mordenite-based membrane in the presence of oxygen and 2M methanol feed.

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