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Preparation of Nafion/Pt-containing TiO_2/Graphene oxide composite membranes for self-humidifying proton exchange membrane fuel cell

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Abstract

Pt nanoparticles with about 2 nm are successfully deposited onto ~50 nm commercial TiO_2 and various Nafion/xPt-TiO_2/(1-x)Graphene oxide composite membranes are prepared. Water uptake of composite membrane is enhanced with GO content by maximum 15.3 % due to hydrophilic GO compared to casting Nafion. Ion exchange capacity and proton conductivity are also enhanced with GO content but too much GO incorporation seems to reduce them probably due to the blocking effect by 2-dimensional GO sheets. Hydrophilic TiO_2 alone does not seem to exhibit sufficient water retention ability to exert excellent cell performance. The results clearly show that the cell performance under low humidifying condition including zero humidity is significantly affected by retention ability of water formed from Pt sites. Thermogravimetric analysis shows that free water retained by membrane could be increased by 32 % with the addition of TiO_2 and 45 % further with additional GO compared with that of casting Nafion, respectively. The cell performance is significantly enhanced by sinergistic effect upon addition of appropriate amount of Pt-TiO_2 and GO to Nafion: that is, at 0.6 V, 1.0 A/cm^2 and 0.54 A/cm^2 for Nafion/0.8Pt-TiO_2/0.2GO, and 0.42 A/cm^2 and 0.02 A/cm^2 for casting Nafion under 100 %RH and 0 %RH.

Key words: self-humidifying, composite membrane, IEC, proton conductivity, cell performance

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