High CO tolerance of new SiO2 doped phosphoric acid/polybenzimidazole polymer electrolyte membrane fuel cells at high temperatures of 200–250 °C

The high CO tolerance or resistance is critical for the practical application of proton exchange membrane fuel cells (PEMFCs) coupled with on board reformers for transportation applications due to the presence of high level of CO in the reformats. Increasing the operating temperature is most effective to enhance the CO tolerance of PEMFCs and therefore is of high technological significance. Here, we report a new PEMFC based on SiO2 nanoparticles doped phosphoric acid/polybenzimidazole (PA/PBI/SiO2) composite membranes for operation at temperatures higher than 200 °C. The phosphoric acid within the polymer matrix is stabilized by PA/phosphosilicate nanoclusters formed via prior polarization treatment of the membrane cells at 250 °C at a cell voltage of 0.6 V for 24 h, achieving a high proton conductivity and excellent stability at temperatures beyond that of conventional PA/PBI membranes. The proton conductivity of PA/PBI/SiO2 composite membranes is in the range of 0.029-0.041 S cm⁻¹ and is stable at 250 °C. The PA/PBI/SiO2 composite membrane cell displays an exceptional CO tolerance with a negligible loss in performance at CO contents as high as 11.7% at 240 °C. The cell delivers a peak power density of 283 mW cm⁻² and is stable at 240 °C for 100 h under a cell voltage of 0.6 V in 6.3% CO-contained H2 fuel under anhydrous conditions.