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Degradation of polymer electrolyte membrane fuel cell by siloxane in biogas

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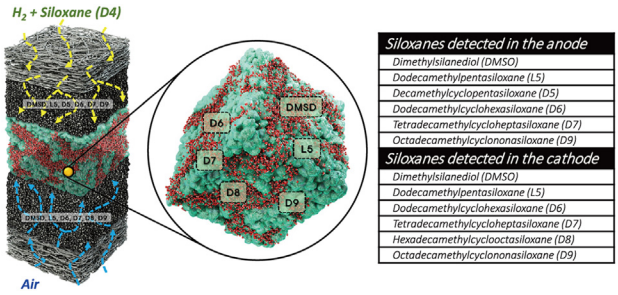
HIGHLIGHTS

- The degradation and durability of PEMFC by siloxane were investigated.
- Ring-opening polymerization produced various linear and cyclic siloxanes.
- Siloxane did not hinder the electrocatalytic activity of Pt and proton transport.
- Siloxanes were accumulated in pores of catalyst layer.

GRAPHICAL ABSTRACT



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ABSTRACT

We studied the degradation and durability of polymer electrolyte membrane fuel cell (PEMFC) at membrane-electrode-assembly (MEA) level by injection of octamethylcyclotetrasiloxane (D4) as a representative siloxane, which has been found in many industrial and personal products. Specifically, *i*) GC/MS analysis demonstrated that the ring-opening polymerization of D4 could result in the formation of various linear and cyclic siloxanes in both electrodes of MEA; *ii*) post-test analysis revealed that the transformed siloxanes were transported from the anode to the cathode *via* free-volumes in the polymer membrane; *iii*) RDE measurement and DFT calculation revealed that D4 was not directly responsible for the electrocatalytic activity of Pt; *iv*) electrochemical analysis demonstrated that the residual methyl groups of siloxane and various siloxanes did not hinder the proton transport in the polymer membrane; and *v*) siloxanes accumulated in the primary and secondary pores with the exception of an external surface of carbon, causing an increase in the oxygen reactant's resistance and resulting in a decrease of the cell performance. In addition, we confirmed that injection of D4 did not affect the carbon corrosion adversely because the siloxane had little influence on water sorption in the catalyst layer.

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