



Degradation of polymer electrolyte membrane fuel cell by siloxane in biogas



Ji-Sung Seo ^{a, b, 1}, Da-Yeong Kim ^{a, 1}, Sun-Mi Hwang ^c, Min Ho Seo ^a, Dong-Jun Seo ^{a, d}, Seung Yong Yang ^{a, d}, Chan Hui Han ^{a, b}, Yong-Min Jung ^a, Hwanuk Guim ^e, Kee Suk Nahm ^b, Young-Gi Yoon ^a, Tae-Young Kim ^{a, *}

^a Hydrogen and Fuel Cell Center, Korea Institute of Energy Research (KIER), Republic of Korea

^b Department of Energy Storage and Conversion Engineering, Chonbuk National University, Republic of Korea

^c Fuel Cell Research Center, Korea Institute of Energy Research (KIER), Republic of Korea

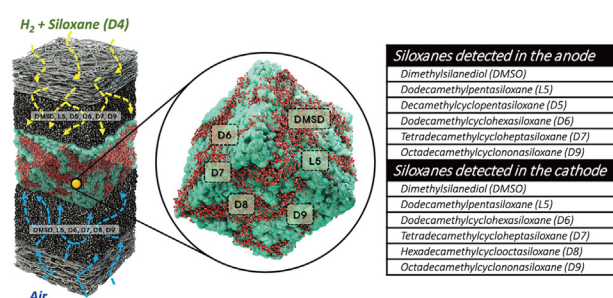
^d Department of Chemical and Biomolecular Engineering, Yonsei University, Republic of Korea

^e Division of Electron Microscopic Research, Korea Basic Science Institute (KBSI), Daejeon, Republic of Korea

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



ARTICLE INFO

Article history:

Received 6 November 2015

Received in revised form

6 January 2016

Accepted 17 March 2016

Available online 4 April 2016

Keywords:

Polymer electrolyte membrane fuel cell (PEMFC)

Biogas

Siloxane

Octamethylcyclotetrasiloxane (D4)

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.

© 2016 Elsevier B.V. All rights reserved.

* Corresponding author. Tel.: +82 63 581 1672; fax: +82 63 581 1630.

E-mail address: kt@kier.re.kr (T.-Y. Kim).

¹ These authors contributed equally to this work.