# Novel catalyst layer synthesized by *in situ* sol-gel process with tetraethoxysilane in a Nafion ionomer solution with Pt/C for PEFCs: the effect of self-assembled Nafion-$SiO_2$ on Pt ORR activity and an increased water content in the polymer membranes

*Taeyoung Kim,* Junghun Lee, Tae-Hyun Yang, Young-Gi Yoon, Seok-Hee Park, and Sung-Dae Yim***

*Fuel Cell Research Center, New and Renewable Energy Research Division, Korea Institute of Energy Research (KIER), 102 Gajeong-ro, Yuseong-gu, Daejeon, 305-343, Republic of Korea*
*Fax: +82 42 860 3104; Tel: +82 42 860 3548*

**Corresponding author. E-mail: abc@kier.re.kr (T. Kim); Tel: +82-42-860-3007; Fax: +82-42-860-3104*
*** Co-corresponding author. E-mail: jimmyim@kier.re.kr (S. Yim); Tel: +82-42-860-3548; Fax: +82-42-860-3104*
*These authors contributed equally to this work.*

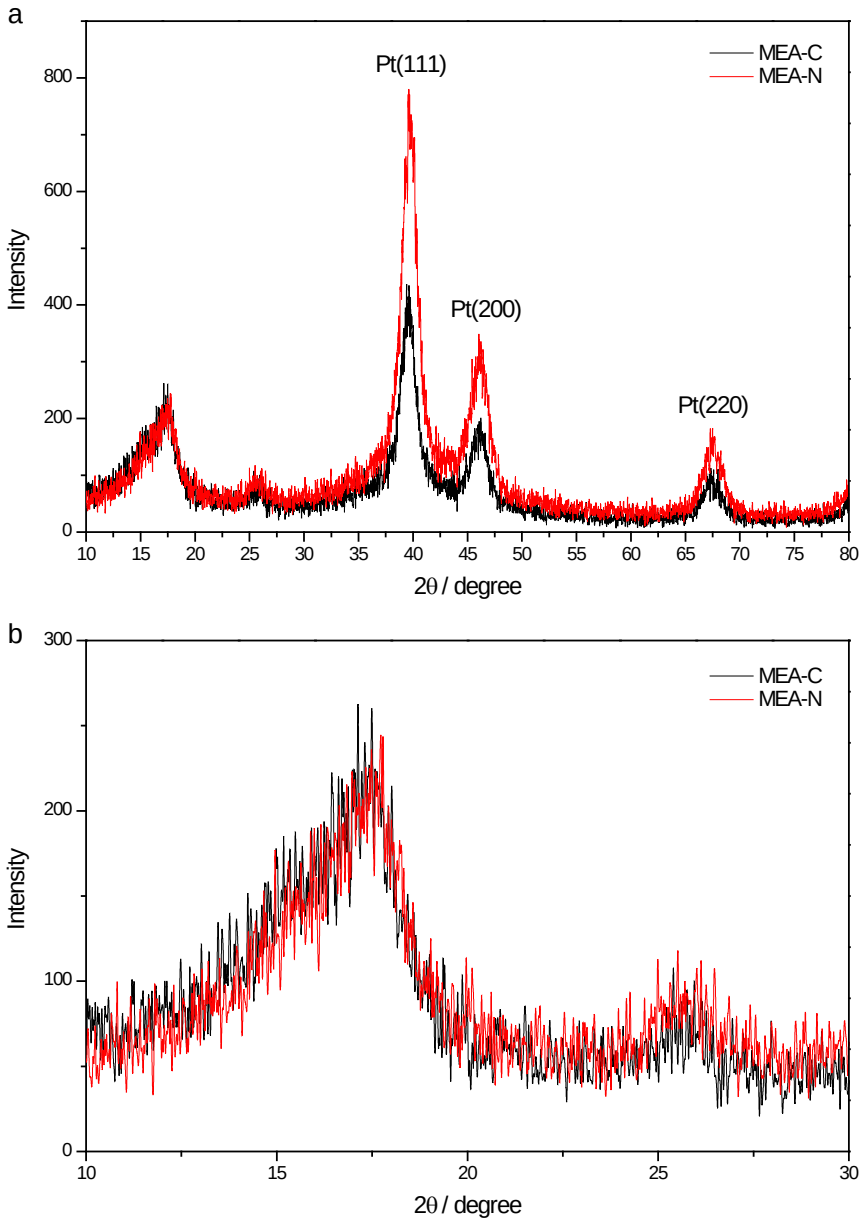


**Figure S1.** XRD patterns of MEA-C and MEA-N.

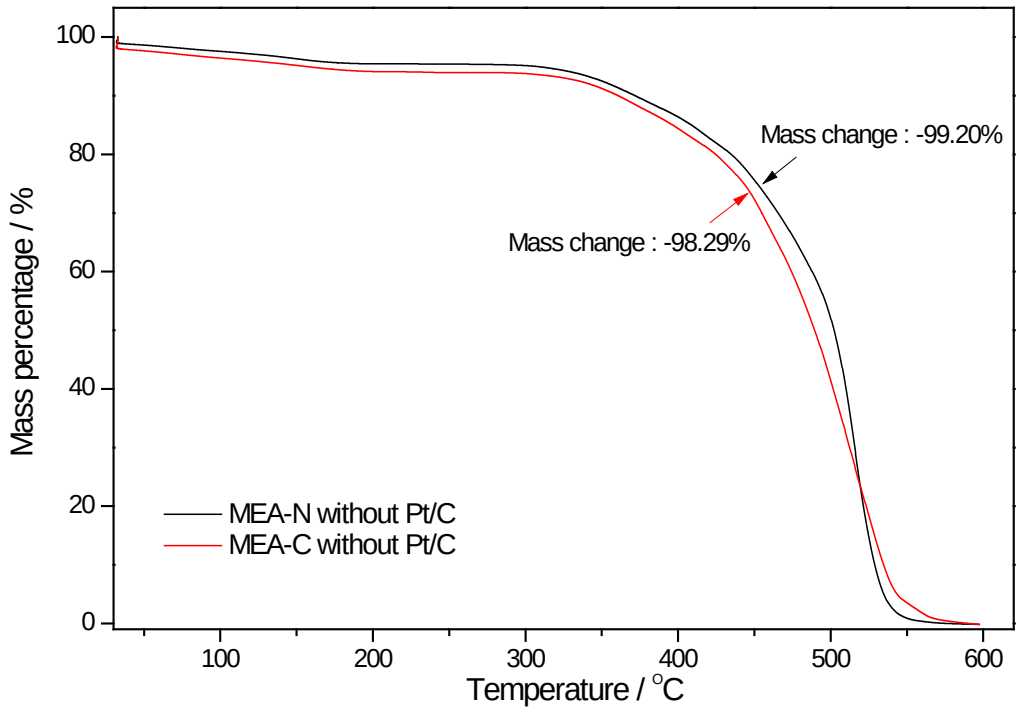


**Figure S2.** TG traces of MEA-N without Pt/C and MEA-C without Pt/C. The heating rate of TG was 10 $^{o}$C min$^{-1}$. In this study, we prepared five samples in order to determine the silica content in the electrode. All experimental samples were conducted five times and the average of twenty five results was taken as silica content in electrode.

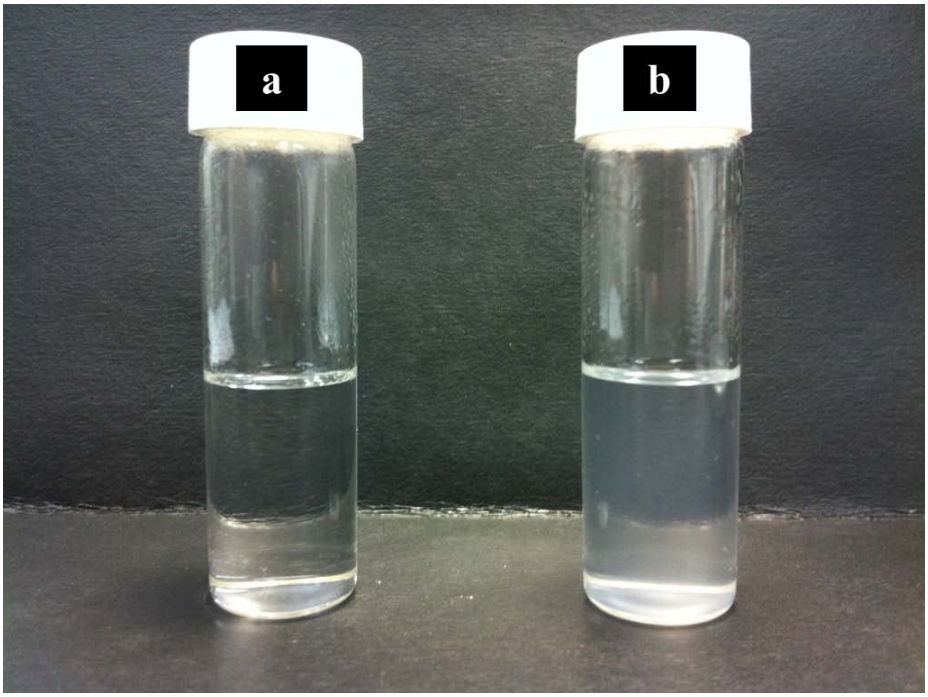


**Figure S3.** Photographs of 1 wt% Nafion solutions dissolved in IPA solvent: (a) without silica nanoparticles and (b) with silica nanoparticles.

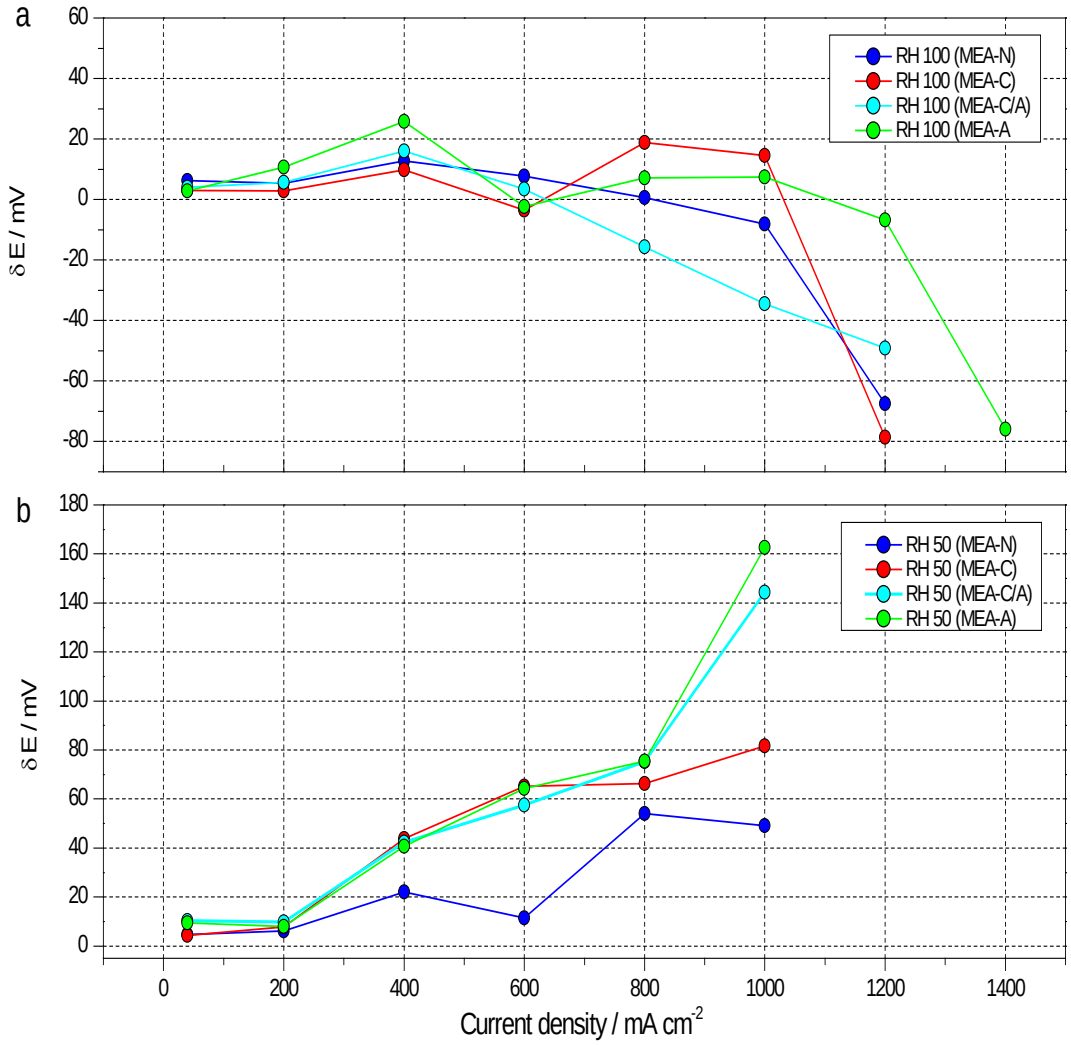


**Figure S4.** (a) Differences in the cell potential ($\delta E$) between initial time and 280 s as function of current density at 100% RH; (b) differences in the cell potential ($\delta E$) between initial time and 280 s as function of current density at 50% RH.

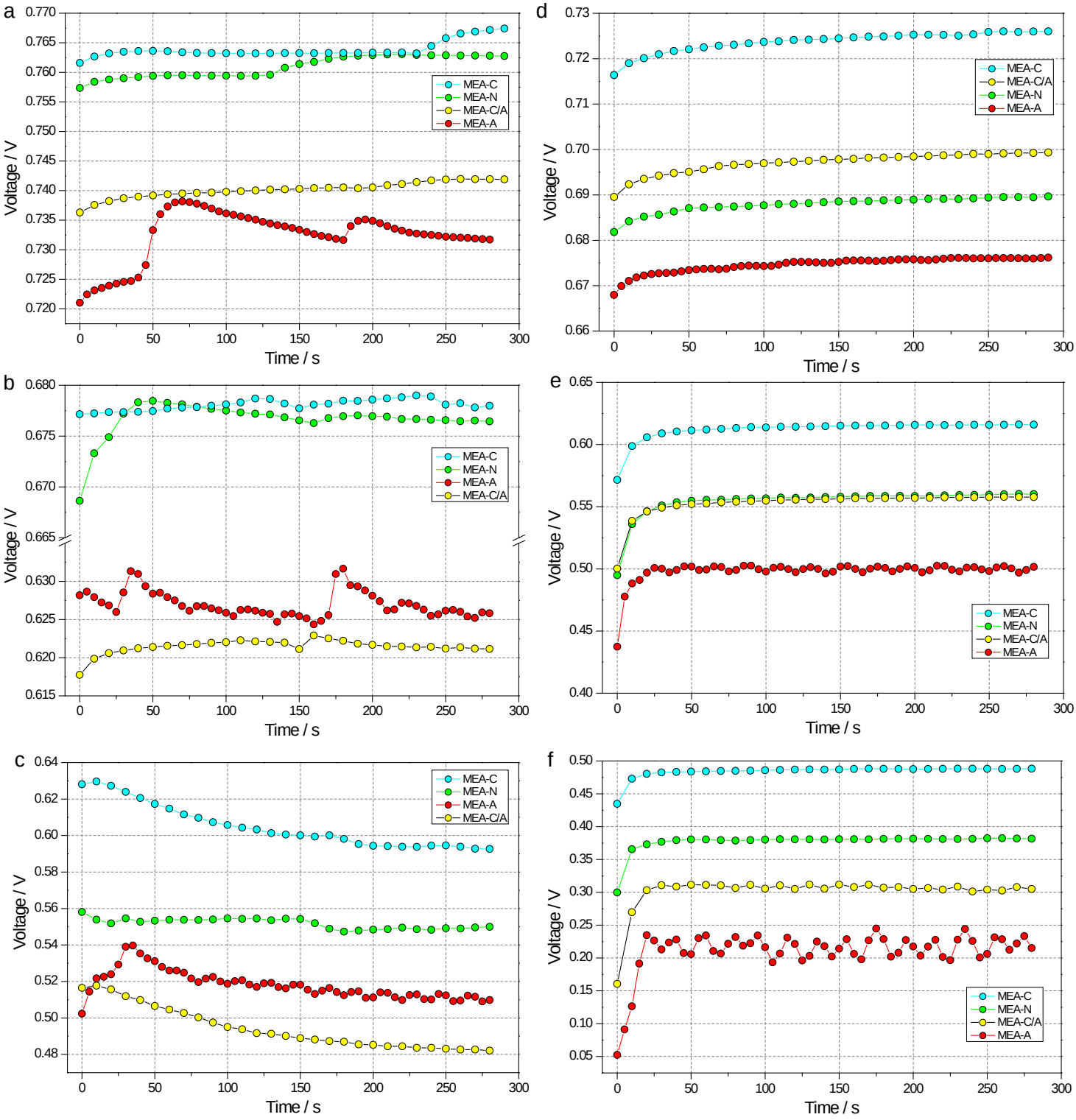


**Figure S5.** Variation of voltage as a function of time under (a) current density of 200 mA $cm^{-2}$ at 100% RH, (b) current density of 600 mA $cm^{-2}$ at 100% RH, (c) current density of 1000 mA $cm^{-2}$ at 100% RH, (d) current density of 200 mA $cm^{-2}$ at 50% RH, (e) current density of 600 mA $cm^{-2}$ at 50% RH, and (f) current density of 1000 mA $cm^{-2}$ at 50% RH.

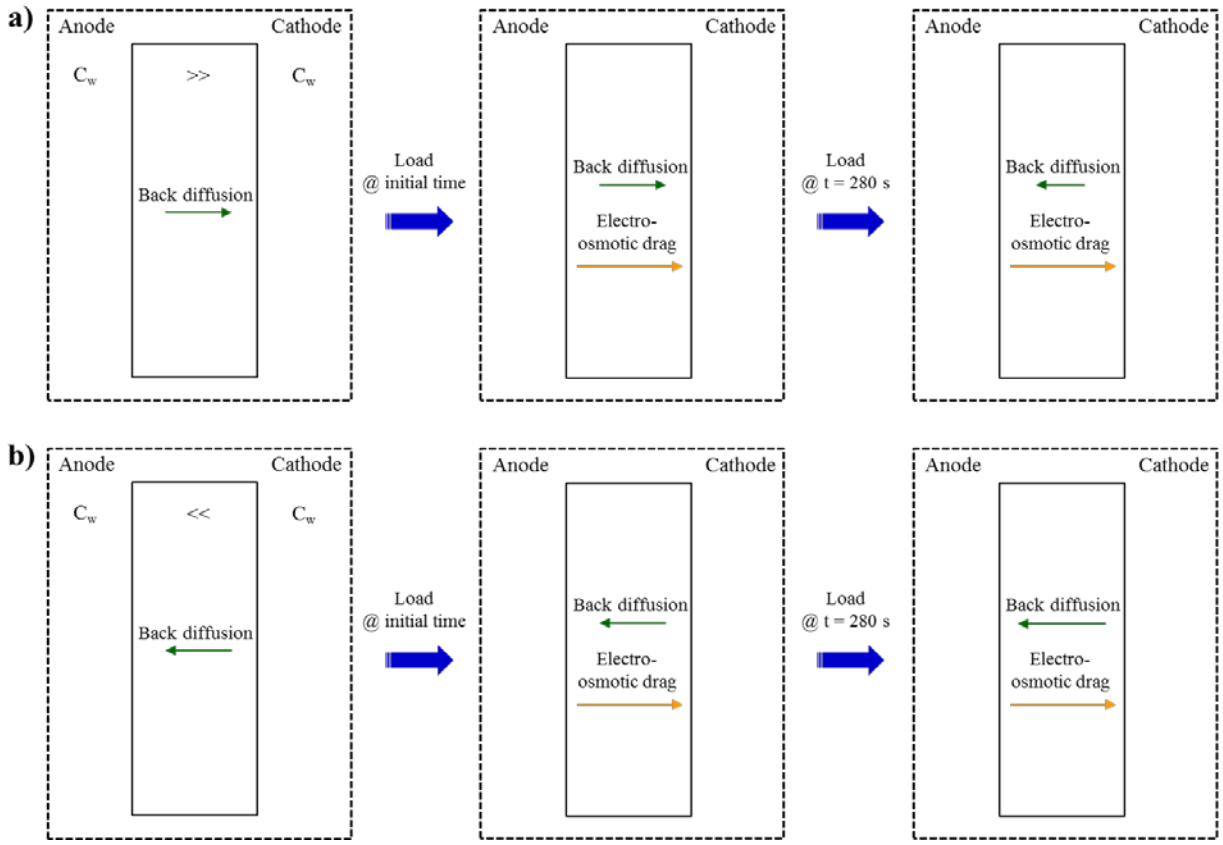


**Figure S6.** Schematic diagrams of water transport via polymer membrane at 50% RH for (a) MEA-A, (b) MEA-C. $C_w$ is the water concentration. $C_w$ is the water concentration.