Development of MEAs based on Electrophoretic Deposition (EPD) for HT-PEMFC Applications

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Introduction & Objectives

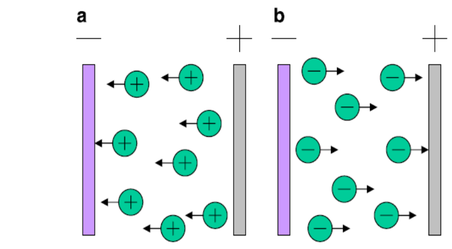
❖ Fuels cells are considered the most technically viable solution for clean energy scenarios.

❖ In PEMFCs, PGM represents one of the most important expenditures for PEMFC production.

❖Active research is being carried out to improve efficiency of noble metal catalyst utilization.

❖ Electrophoretic deposition (EPD) is a process where charged particles in a dilute suspension are moved under the influence of an applied electric field and deposited onto a target substrate.

❖ Figure shows schematic of the EPD process [1].



Schematic illustration of electrophoretic deposition process. (a) Cathodic EPD and (b) anodic EPD.

❖ Objectives of this study were to adapt the EPD process for MEA preparation and to test these MEAs under HT-PEMFC conditions.

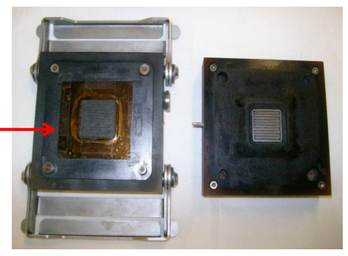
EPD advantages

- High uniformity of deposit
- Low cost and up scaling possible
- Fast and reproducible

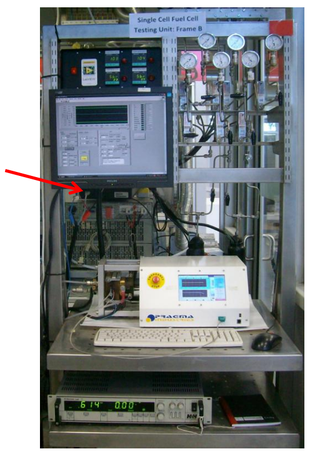
Experimental Methods

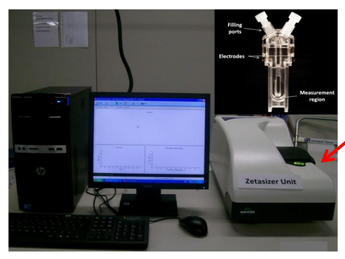
High voltage power supply and cell for EPD

HT-MEA inside test cell



HT-MEA test stand





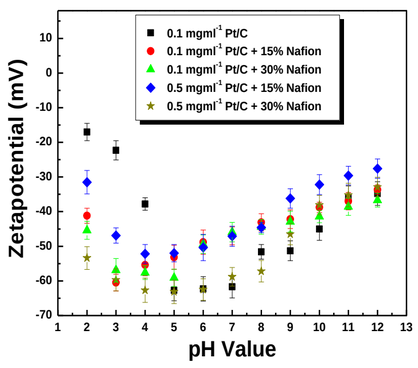
Malvern zetasizer Nano ZS for zetapotential and particle size

FuelCon impedance analyzer

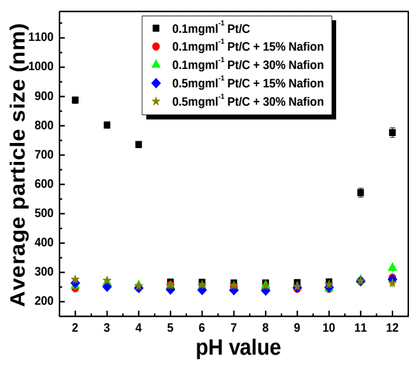
Results

Zetapotential and Particle Size

❖ Zetapotential is important for suspension stability, direction of particle movement and particle migration velocity.
❖ Particle size control is important for uniform deposit formation.
❖ Stabilization effect of Nafion ionomer clearly evident over the whole pH range.

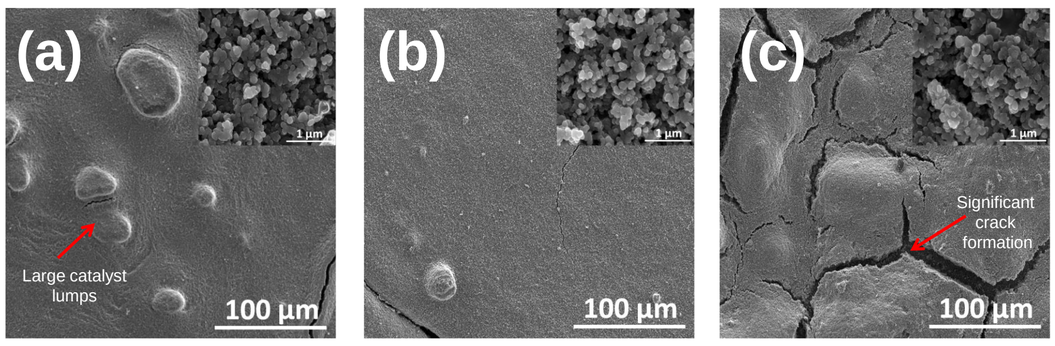


Zetapotential of Pt/C in isopropanol



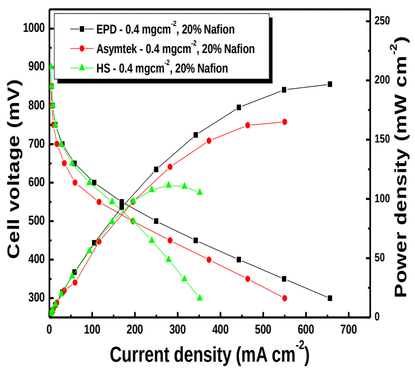
Average particle size of Pt/C in isopropanol

SEM Characterization

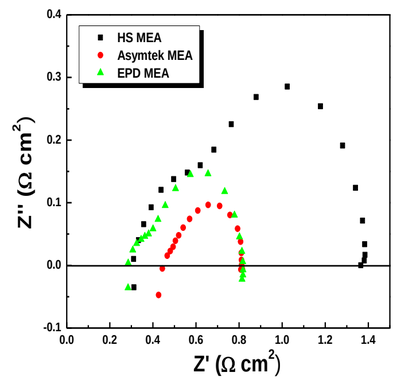


SEM images of (a) hand sprayed GDE (b) Asymtek sprayed GDE (c) EPD GDE. Magnification X1000 and X100 000 (insert).

Polarization Curves and EIS

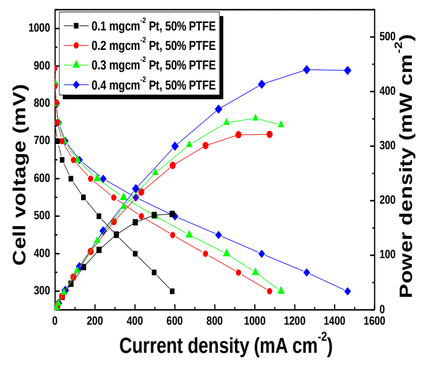


Polarization curves for EPD, hand sprayed (HS) and Asymtek sprayed MEAs. Pt loading 0.4 mgcm^{-2} with 20% Nafion. Cell temperature 160°C. Gas flow: 0.5 slpm H_2 and 1 slpm air at 0% RH.

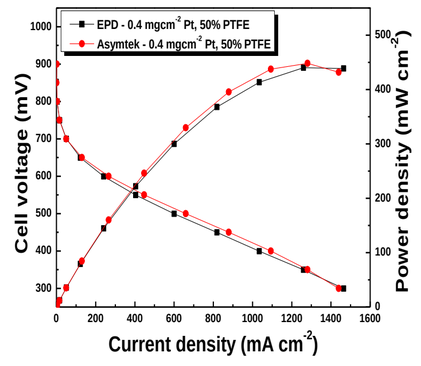


Nyquist plots for EPD, hand sprayed and Asymtek MEAs at 300 mAcm^{-2}

Polarization Curves

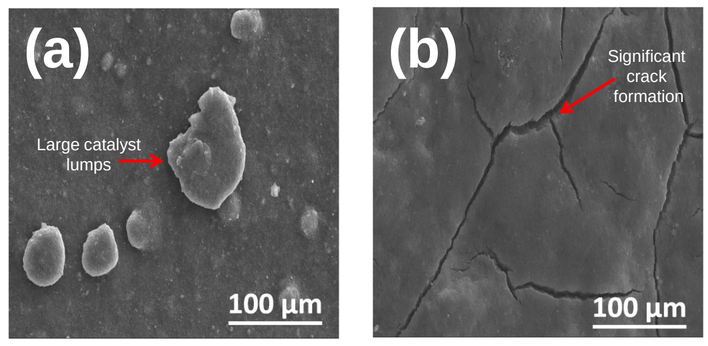


Polarization curves for EPD MEAs. Pt loading: 0.1 - 0.4 mgcm^{-2} with 50% PTFE. Cell temperature 160°C. Gas flow: 0.5 slpm H_2 and 1 slpm air at 0% RH.



Polarization curves for EPD and Asymtek sprayed MEAs. Pt loading: 0.4 mgcm^{-2} with 50% PTFE. Cell temperature 160°C. Gas flow: 0.5 slpm H_2 and 1 slpm air at 0% RH.

SEM Characterization



SEM images of (a) Asymtek sprayed GDE (b) EPD GDE. Pt loading 0.4 mgcm^{-2} with 50% PTFE. Magnification X1000

Conclusions

❖ EPD based MEAs with Nafion ionomer in catalyst layer showed better performance than the hand sprayed and Asymtek sprayed MEAs.

❖ Nafion ionomer significantly affected MEA performance at high temperature (160°C).

❖ MEAs containing PTFE in catalyst layer showed much better performance compared to Nafion ionomer.

❖ Performance of EPD and Asymtek sprayed MEAs with PTFE binder are comparable.

❖ Catalyst inks containing PTFE for EPD needs further optimization to improve catalyst layer morphology and MEA performance.

References

1. L. Besra,M. Lui, Progress in Materials Science 52 (2007) 1 – 61.

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