**INTRODUCTION**

- Catalyst layer (CL) is a key component affecting the cost and durability of polymer electrolyte fuel cells (PEFCs).
- Cracks and other mechanical defects occur during manufacturing and over the life cycles of fuel cells.
- Experimental observations suggest that large cracks are preferential water transport pathways and can promote water removal under flooding conditions.
- The interface between CL/MPL can significantly impact or mitigate water accumulation and the blocking of oxygen access to the CL.

**OBJECTIVES**

- Characterize types of crack structures and study their impact on liquid water transport.
- Investigate impact of delaminated interface on water transport.

**MATERIALS & METHODS**

**CL preparation and image acquisition:** The CL was ink-printed on a standard Al stub for the SEM. A small edge portion of the CL, to be milled in using FIB, was removed using a sharp knife. The specimen was cut and imaged at 52° to the surface normal, using a field emission SEM and FIB. A contiguous series of 75 slices, 20 nm apart were imaged.

**Image processing:** SEM images were processed in ImageJ (Fig. 1 (a) & (b)) and Matlab R2011b.

**Numerical reconstruction:** The 3D numerical model shown in Fig. 2 was constructed in two stages. First, a regular 3D grid consisting of randomly placed C spheres with an ionomer layer was created. The number of C spheres and ionomer sites were chosen to give the same porosity as observed experimentally. Second, a simulated annealing procedure was employed to further move the microstructure towards the experimentally derived measures (e.g. two-point correlation function). See [1] for more details.

**Liquid water simulation:** A lattice Boltzmann method (LBM) suitable for high-density ratio multiphase flows is used to calculate the velocity field and dynamic phase distributions. To study the effect of various types of cracks, the reconstructed catalyst layer was modified to obtain various geometries. In this numerical technique, a fixed volume of liquid water is placed at the boundary associated with the high pressure. The simulation then proceeds with water percolating through the pores towards the boundary with the lowest pressure.

**REFERENCES**


**RESULTS**

**Effect of delaminated interface on water transport**

- Fig. 1 Image processing procedure illustrated using a single slice at various processing stages: (a) original 8-bit image, (b) thresholded image, (c) computationally reconstructed CL

- Fig. 2 3D computationally reconstructed CL

- Fig. 3 Water transport through the catalyst layer, for different perforation structures: (a) no perforations, (b) planar (c) thin and long at the center (d) interfacial (e) interfacial and planar.

**CONCLUSIONS**

The effect of various types of cracks on liquid water transport in the catalyst layer is investigated.

The impact of a delaminated interface on water distribution was simulated and shows that any types of gaps at the MPL/CL interface result in lateral spreading of water on the CL surface and consequently blockage of O2 pathways.

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