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Contribution ID: **570** Type: **Poster (+) Presentation**

Experimental study of drying in the presence of fluorescent colloidal particles in model porous media

Wednesday, 2 June 2021 16:00 (1 hour)

The motivation for the present study stems from visualizations of the PTFE distribution in the gas diffusion layer (GDL) of Proton Exchange Membrane Fuel Cell (PEMFC). The GDL is a fibrous carbon layer treated with polytetrafluoroethylene (PTFE), by drying a layer saturated with a solution of PTFE particles, to improve hydrophobicity [1, 2, 3]. During the fabrication, internal surfaces appears to be hardly covered homogenously causing a mixed wettability in the medium, indeed it is showed in [4] that PTFE distribution strongly depends on evaporation conditions, such as the surrounding pressure. In this context, the objective of the work is to study the pattern formed by fluorescent colloids (250nm) in the porous media after the evaporation of the water, in different geometries, starting from a single pore before moving to a pore network on micro-models and/or with different initial conditions. The first step was to use a transparent material to make the porous medium (polymer), filling it with a solution of fluorescent red colloids and let it dry at constant temperature and humidity. Using fluorescent colloids allows us to visualize the final particle deposit. With this type of particles, it will be also possible to follow their position during evaporation, compute the velocity field and connect it to the final deposit. The flow of water during evaporation and the pattern of deposited particles were observed under a microscope using a confocal green source. In the pictures below the particles are bright.
The largest channel is the first one to dry out, forcing the particles to move on the other side. This results in an overall heterogeneous pattern of deposited particles, with higher concentration in the narrower channel, see Figure (d). The experiment also indicates that the evaporation of the residual liquid films at the very end of the drying process do have an impact on the final particle deposit.
The next step is to be able to analyse and predict the materials properties such as wettability, contact angle, hydrophobicity of particles, etc⋯on polymer micromodels. These procedures would allow us to explain how the fluid moves while drying, thanks to the tracking of particles, how it influences the colloidal particle deposition and finally, find procedures to improve GDL's hydrophobicity properties for better fuel cell operation.

Figure: (a), (b) and (c) different stages of evaporation in a plexiglass pore 3mm x 3mm filled with a solution with concentration 2×10^(-5) % (timesteps: 20 minutes, 1 hour and 40 minutes and 3 hours), (d) deposit of the bright particles after drying.

Time Block Preference

Time Block A (09:00-12:00 CET)

References

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[2] Hasan K. Atiyeh, Kunal Karan, Brant Peppley, Aaron Phoenix, Ela Halliop, and Jon Pharoah. Experimental investigation of the role of a microporous layer on the water transport and performance of a PEM fuel cell. Journal of Power Sources, 170(1):111–121, June 2007.
[3] Chung-Jen Tseng and Shih-Kun Lo. Effects of microstructure characteristics of gas diffusion layer and

microporous layer on the performance of PEMFC. Energy Conversion and Management, 51(4):677–684, April 2010.
[4] Hiroshi Ito, Katsuya Abe, Masayoshi Ishida, Akihiro Nakano, Tetsuhiko Maeda, Tetsuo Munakata, Hironori Nakajima, and Tatsumi Kitahara. Effect of through plane distribution of polytetrafluoroethylene in carbon paper on in-plane gas permeability. Journal of Power Sources, 248:822–830, February 2014.

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