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Influence of Artificial Aging of Gas Diffusion Layers on the Water Management of PEM Fuel Cells

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Up to now ageing mechanisms of gas diffusion layers (GDLs) of PEM are still not completely understood. Successful long-term tests have been completed by different research groups and interested parties [1]. Beside high manufacturing costs, the long term stability of the cells still remains a problem. Several thousand hours of reliable operation are required for stationary or mobile applications. Several artificial ageing experiments are still being performed to overcome the problem of insufficient cell durability [2,3].

One approach of artificial ageing is to insert GDLs into hot hydrogen peroxide solution. The chemical reaction corrodes the GDL material. As a result, the contact angle between water and GDL surface is reduced indicating decreased hydrophobicity of the GDL. This has a severe impact on the water management (see Figure 1) due to the fact that the capability of water discharge is significantly changed.

Synchrotron X-ray imaging is a non-destructive method that can provide insights into operating fuel cells at high spatial and temporal resolution [4,5]. In this work, we applied an artificial ageing procedure on two types of GDL: a Freudenberg H2315 series and a SGL 25 BC. After accelerated aging for 24 h in a 90°C hot hydrogen peroxide solution both GDLs showed an increase of the water fraction during cell operation at increased gas humidities (50 % r.h. and 100 % r.h.) and current density (1.5 A/cm^2).

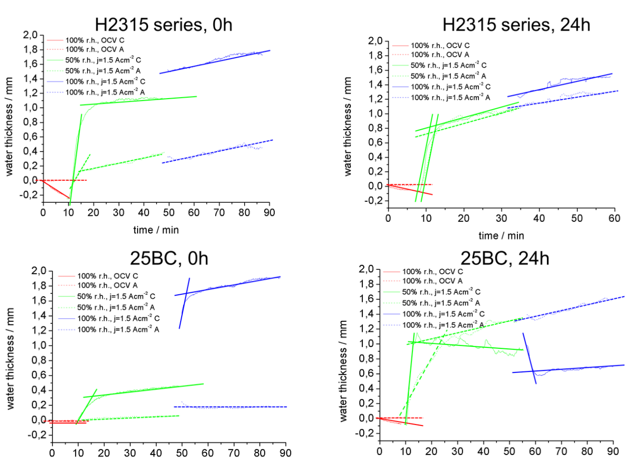

Figure 1: Water management in Freudenberg H2315 series and SGL 25 BC gas diffusion layers in dependence of artificial ageing.

By observing the dynamic water evolution, significant differences in the water distribution between both GDL types are visible. Further some blocked paths for water discharge from under the rib into the flow field channel were detected. Blocked paths through the GDL hamper the transport of reactant gases between channels and GDL and have, therefore, a great impact on the water management of the cell. Through-plane measurements have shown such blocked or filled water paths under the ribs. These effects are exemplified in Figure 2 and Figure 3.

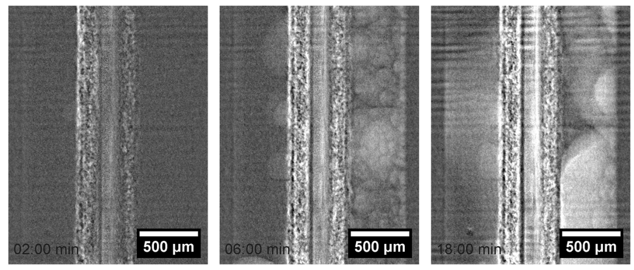

Figure 2: Water evolution in a test cell equipped with GDL (type Freudenberg H2315 series) and operated at 1.5 A/cm^2 and 50% relative humidity.

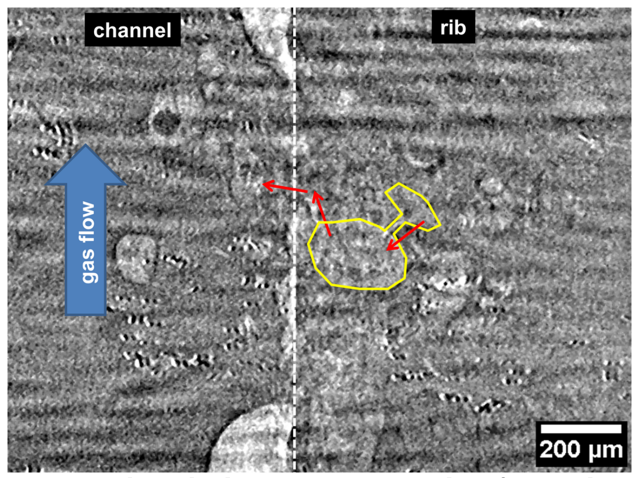

Figure 3: Through-plane view: water evolves from under the ribs and migrates through fixed paths into the channel.

As one result, we calculated evolving water volumes per time, depending on the operating state of the fuel cells. Interesting saturation effects of water volumes are given. A detailed analysis of the water management and an overview about the impact on the two types of GDL will be given.

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References

[1] W. Schmittinger, A. Vahidi, Journal of Power Sources 180 (2008) 1–14
[2] C. Perrot, G. Meyer, L. Gonon, G. Gebel, Fuel Cells 06, (2006) 1, 10-15
[3] N. Zamel, X. Li, Progress in Energy and Combustion Science 37 (2011) 292-329
[4] Ph. Krüger, H. Markötter, J. Haußmann, M. Klages, T. Arlt, J. Banhart, C. Hartnig, I. Manke, J. Scholta, Journal of Power Sources 196, 12 (2011) 5250–5255
[5] T. Arlt, I. Manke, K. Wippermann, C. Tötzke, H. Markötter, H. Riesemeier, J. Mergel, J. Banhart, Electrochemistry Communications 13, 8 (2011) 826–829