Reasons for the high power density of direct membrane deposition fuel cells revealed by impedance spectroscopy

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Klingele et al. showed never reached high power fuel cells by applying direct membrane deposition (DMD), excelling the peak power of a catalyst coated membrane (CCM) by a factor of 2.3. [1] To understand the underlying reasons for their high power, we identify the reasons and quantify their impact by employing electrochemical impedance spectroscopy.
As a result we show, that the main reasons for the high power of DMD fuel cells are (i) a 50% reduced high frequency resistance (26 mΩcm²) due to a thinner membrane (12µm) compared to state-of-the-art and (ii) a factor 2.2 reduced mass transport losses (0.12 Ωcm²) due to increased water back diffusion through the thin membrane (Figure 1a). A comparison of DMD vs. CCM fuel cells at the maximum power point of the CCM shows that 91% of the DMD's improvement can be attributed to reduced mass transport losses and only 9% are caused by the reduction of the ohmic resistances (Figure 1b).

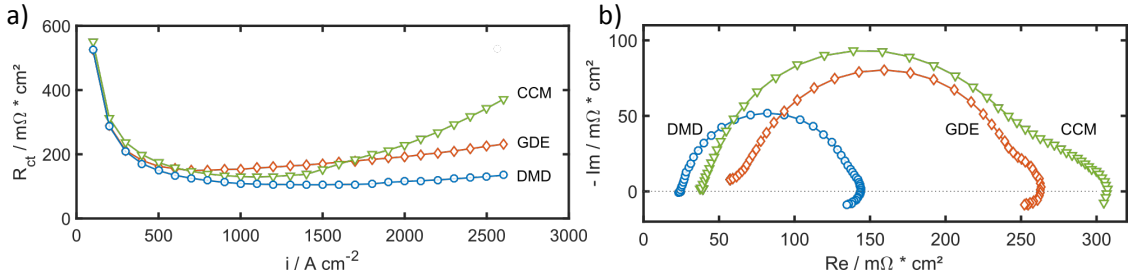

Figure 1 *Comparison of a DMD with a CCM and a gas diffusion electrode (GDE) with membrane foil: a) Charge transfer resistance (R_{ct}) over current density. b) Impedance spectra at the maximum power point of the CCM, 2.2 A/cm², showing improved mass transport of DMD.*

***Keywords**:* direct deposited membranes, electrochemical impedance spectroscopy, charge transfer resistance, mass transport loss

[1] M. Klingele, M. Breitwieser, R. Zengerle, S. Thiele, *J. Mater. Chem. A* **2015**, *3*, 11239.