Abstract for poster presentation

Toward predictive PEFC simulation: The importance of thermal and electrical contact resistance

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In computational models of polymer exchange fuel cells (PEFCs), thermal and electrical resistances between the different contacting material layers are commonly disregarded [1,2]. Various experimental conductivity measurements have shown, though, that the effect of interfacial resistance can have a significant share in the overall through-plane resistance and may even dominate over bulk resistance [3], such that they cannot be just neglected in numerical simulations that aim to be quantitatively predictive. Here, based on published experimental evidence, we argue that both thermal and electrical contact resistivities R at the interfaces between catalyst layers, gas diffusion layers (GDLs) and bipolar plates (BPs) are governed by power law relationships with the applied clamping pressure P: $R \sim P^{-\alpha}$ with an exponent α lying in the interval [1/2,1] for typical materials such as SGL and Toray carbon papers and stainless steel or graphite. A selection of measurements in support of this is shown in Fig. 1.

We demonstrate the effect of taking thermal and electrical contact resistance into account in modelling by implementing them into a sophisticated, steady-state, non-isothermal, macro-homogeneous two-phase finite element COMSOL model of a single PEFC. Our simulations show that contact resistance is responsible for a significant voltage loss of the fuel cell even at high clamping pressures, and that this performance drop increases with current density, as shown in Fig. 2. These results challenge researchers in PEFC modelling not to neglect interfacial resistance in their computational studies.

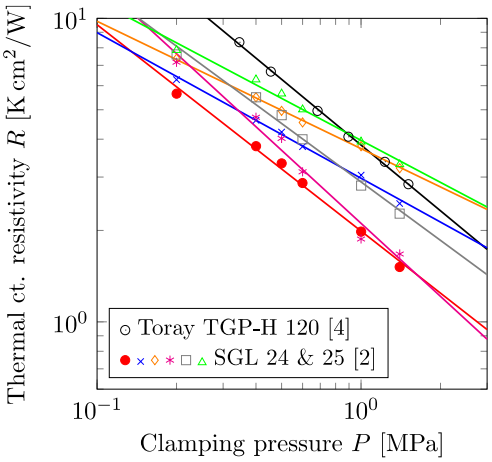

Figure 1: Thermal contact resistivity between GDL and BP as a function of applied clamping pressure. Data points from experiments, lines represent power law fits.

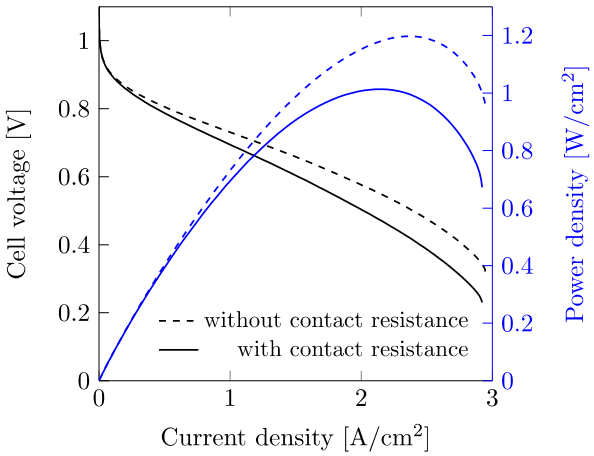

Figure 2: Effect of thermal and electrical contact resistance (at 2 MPa clamping pressure) on fuel cell performance as computed with the finite element model.

References

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