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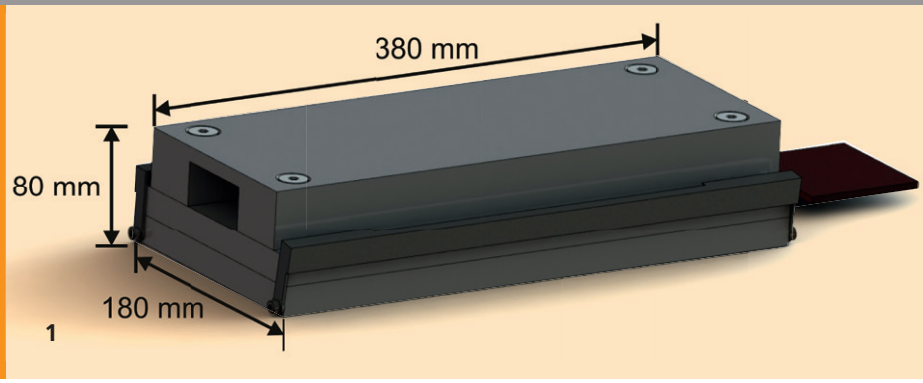

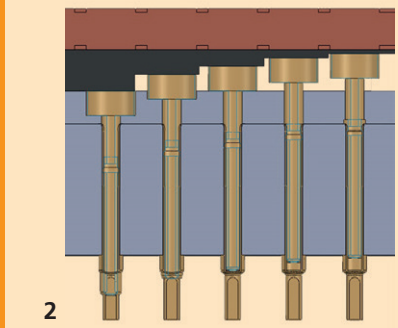

1 *10 x 30 cm² measurement cell.*
2 *Variable spring contact pins for evaluation of materials with different thickness.*

ACTIVE CURRENT FEED FOR MEASUREMENT OF EFFECTS OF INHOMOGENEITIES IN FUEL CELLS

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Introduction

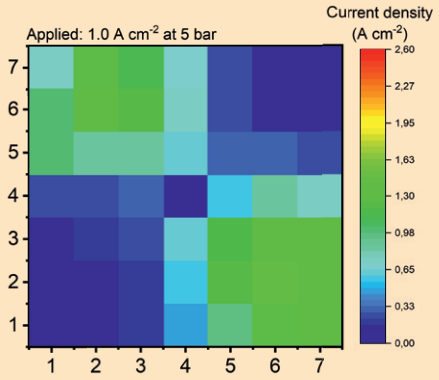
As the power density of energy conversion systems (fuel cells, water electrolysis) increases, a homogeneous current distribution in the cell becomes increasingly important. This depends not only on technical parameters, like flow field structure, stack compression or conductivity of the bipolar plate, but also on media supply and related mass transport, as well as the homogeneity of the reactions.

Challenge: cell measurements

In order to optimize energy conversion systems and evaluate the influence of their components, either ex-situ measurements (e.g. conductivity) have to be conducted, or a large number of samples (e.g. different flow fields or electrodes) have to be prepared. This constitutes a significant effort in terms of time and materials, and preparation parameters might furthermore influence the results.

Approach: twice-segmented cell

Our newly developed twice-segmented cell allows a large variety of different measurements by controlling the local current feed. The measurement cell consists of an array of spring contact pins that contact the sample homogeneously. Every pin can be contacted individually, allowing the control of its current. Thus, different cell geometries can be simulated as well as variations in local current density. A segmented measurement board on the other side of the sample records the in-plane current density distribution with local resolution. This method is a simple way to evaluate in-plane current distribution or the influence of non-active regions in fuel cells or other energy conversion systems.



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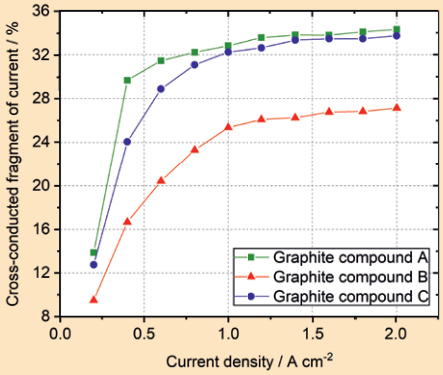

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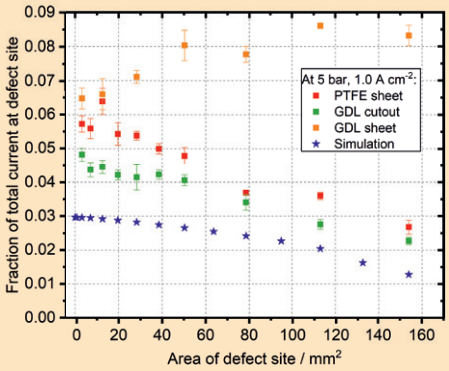

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Graphitic bipolar plates

The ability to tolerate inhomogeneous currents and balance them in-plane is particularly important for graphitic materials. If bipolar plates consist of electron-conducting materials in a polymer matrix, their fabrication process can influence the exact distribution of components within the material. This in turn can have a significant influence on the through-plane and in-plane conductivity of the finished sample. Our setup allows a quick and simple characterization of small samples (5 x 5 cm²), for example by feeding current through half of the sample area and recording the current distribution.

Gas diffusion layer (GDL)

In addition to bipolar plate materials, GDLs can also be evaluated. This includes for instance the influence of thickness, fiber structure or microporous layer (MPL).

Defect sites

A defect site in this context is a local region with significantly higher or lower activity for the respective reaction. Using the cell presented here, the position and the size of these defect sites can be simulated easily by controlling the respective pins.

Gradients

Via a control of the current through individual pins, gradients can also be recreated with this measurement cell. This is relevant for instance where efforts are made to vary catalyst loading along the flow field channels.

Advantages of the twice-segmented cell

- Simple variation of current density across a wide range
- Homogeneous current feed through uniform contact resistance of spring contact pins
- Local resolution freely adjustable by size of contact pins
- Possibility of a wide variety of measurements on one sample without intermittent disassembly/reassembly
- Real measurement values (no pure simulations) are easily obtained

Potential end-users

Manufacturers of:

- Graphitic materials
- Bipolar plates
- Gas diffusion layers
- Energy conversion systems
- Instrumentation technology

End-users and interest groups for:

- Fuel cells, redox-flow and hydrogen technology
- Renewable energy

Figure 5 shows data using different defect site simulations. It shows that the current at the defect site decreases as a function of defect site area, when a reduced current feed is applied (PTFE sheet, GDL cutout). On the other hand the current increases with defect site area, when a higher current feed is present at the defect site (additional GDL).

3 *Current distribution in a graphitic bipolar plate using inhomogeneous current feed.*

4 *Fraction of cross-conducted current as a function of total current for different graphitic compound materials.*

5 *Fraction of cross-conducted current at defect site as a function of defect site area.*