

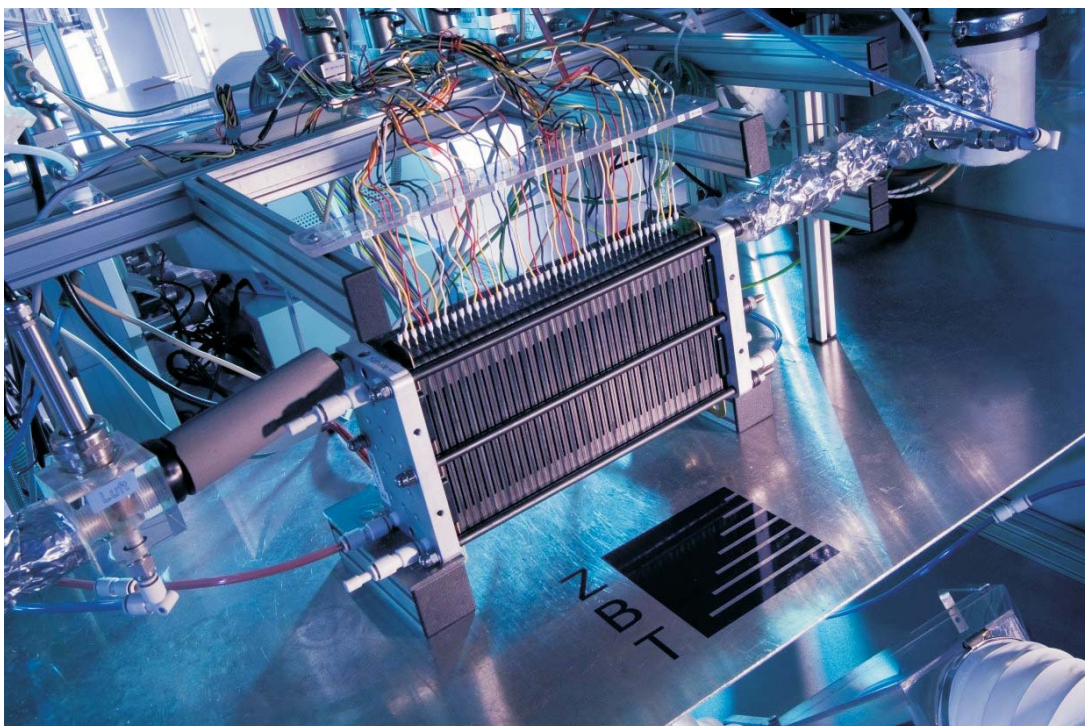
PEM fuel cell stacks and efficient system topologies for hydrogen based low power applications

P. Beckhaus, J. Burfeind, C. Kreuz, C. Matten, S. Souzani, A. Heinzl
 Zentrum für Brennstoffzellen Technik ZBT gGmbH
 Carl-Benz-Straße 201, 47057 Duisburg, Germany
 p.beckhaus@zbt-duisburg.de www.zbt-duisburg.de



Introduction

Applications for which fuel cells give the highest surplus are situated in the field of **auxiliary power units (APU)** and other low power applications. In the range of 100 W_{el} up to 500 W_{el} (net power) the fuel cell research centre ZBT ("Zentrum für Brennstoffzellen Technik gGmbH") has developed and demonstrated different hydrogen fuel cell based power supply layouts. These systems which include ZBT's **air cooled APU-stack** technology have been used for demonstration and application purposes for both energy supply and lightweight transportation.



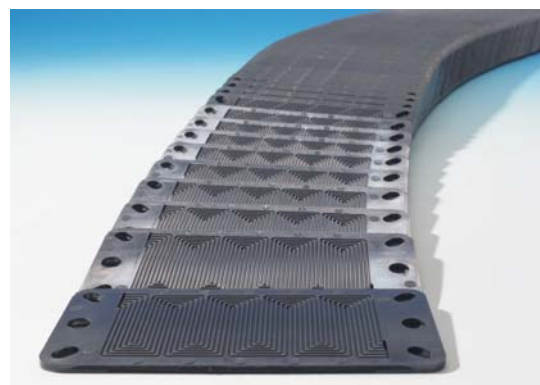
40 cell ZBT fuel cell stack based on injection moulded bipolar plates including air cooling channels during automated activation procedure in a test rig. This stack is delivering 750 Watt under test rig conditions, 500 Watt in a hydrogen system

Fuel Cell Stack Technology

The standard low temperature fuel cell stack framework allows manufacturing of fuel cell stacks in the range of about 100 W_{el} up to 750 W_{el} (depending on numbers of cells and operation mode). The basis of the stacks are graphite-polymer compound bipolar plates which proved to be stable in fuel cell stacks operated below 100 °C. The plates are produced in a common laboratory of ZBT and the university of Duisburg-Essen by **injection moulding** as **halfplates** including a serpentine flow field for the active side and an air cooling structure on the passive side. The core benefit of this production method is the significant reduction in the total production time for the plates and a **constant high quality** of the parts. Even at relatively small quantities of 500 plates the production process from raw material to pre-finished plate including flow fields and structures has been demonstrated to be less than 2 minutes per half-plate (moulding time: ~ 20 sec). Manufacturing of the stack is done by manual assembly using commercially available 5 layer membranes (MEA+GDL). This enables building up **uniform stacks** in sufficient volumes for R&D and demonstration purposes.



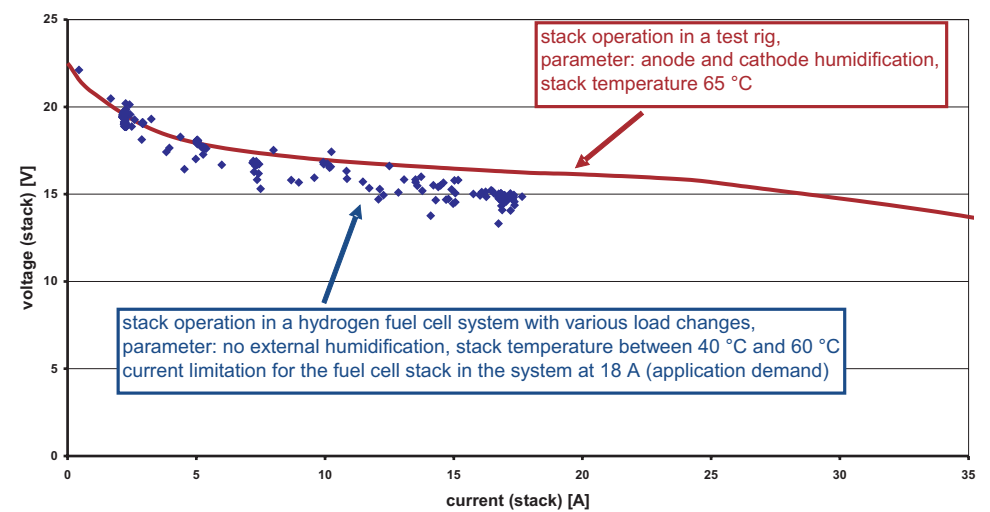
Different stack sizes (100 W_{el} - 400 W_{el})



Injection moulded bipolar half plates

Hydrogen fuel cell systems (APU)

A significant number of stacks has recently been manufactured and integrated into hydrogen fuel cell systems: Various topologies have been developed for attractive applications as portable or stationary power generators. A **simplified system topology** was focus of the developments made for these projects. Systems which have been delivered to project partners have been designed to be self starting and self supervising. No other media than hydrogen is necessary and no maintenance topics for the end user remain, stable operation of these systems is realized without humidification components. Fuel circulation on the anode side and optimization of general controls are core topics of the development.

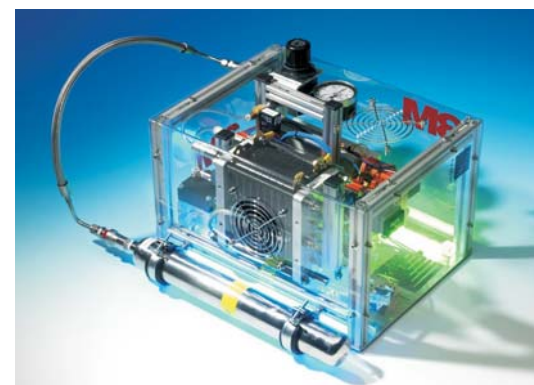


24 cell stack operation in a test rig environment and in a simplified hydrogen system: even without humidification a very stable operation is possible

Transport applications

The basic system layout was also utilised for lightweight transportation purposes: accumulator powered e-scooter have been retrofitted to fuel cell vehicles. Two general system topologies have been chosen: direct fuel cell driven and accumulator hybrid systems have successfully been operated. As hydrogen storage small metal hydride cylinders are integrated.

The **direct powered scooter** shows a good performance, the space for the accumulators in the chassis was used for a 32 cell stack which is able to power the DC motor. A good driving performance was established. Nevertheless the **hybrid system** using fuel cell technology as on board battery charging unit keeps a higher fun factor as the possible acceleration is higher. The accumulator serves the power and the fuel cell ensures the energy for long distances.



150 W technology demonstration system as on site portable power supply



E-scooter with direct and hybrid fuel cell drives

Summary

Fuel cell stacks

- 100 - 750 W_{el}, air cooled stacks for low power applications
- injection moulded bipolar plates and design allow smooth assembly

Hydrogen fuel cell systems:

- different layouts for portable and stationary APU systems tested
- system stability good without active humidification
- lightweight transportation as interesting option for future markets
- hybrid accumulator - fuel-cell systems favourable

Acknowledgements

This work was supported by the European Funds of Regional Development and the Region of North Rhine-Westphalia, Germany.

