Summary

For special applications Direct Methanol Fuel Cells (DMFC) are close to commercial application or already commercialized today. However, for the step from laboratory to a broader market of fuel cells, a significant cost reduction, as well as an improvement in life time and power density of the systems is needed. These items were the focus of the project BZ-StatBild, to be reached by new knowledge in alternative materials, operation strategies as well as the realization of enhanced sub systems.

In the project a 100 W DMFC compact system as battery extender is successfully developed and operated. The reduction of the number of components and the simplification of the system make possible a high reduction of price, weight and volume. The feasibility of a micro-DMFC system was evaluated, which enables a minimized system periphery due to an improved system architecture for this alternative materials and functional components were used. The cell stack design was developed, enabling a long-term operation at low air stoichiometry and favourable system efficiency. Gas diffusion layers of various composites were tested and optimised material was selected. New sealing materials with good methanol stability and optimized processability in commercial production process were developed. MEAs preparation was adapted to the new materials. The use of a simple, cost-effective way of stack production was demonstrated for DMFC use. The investigation and construction of enhanced sub systems and operation strategies, which enable and optimise the use of new components and materials, as also the realisation of the micro-DMFC system is a focus of the project. The technical feasibility of the results is investigated in the application, which means it is tested as battery extender of a solar boat. The DMFC fast cell system serves as a basis for an efficient, compact and cost-effective 100 W demonstrator system developed.

Boat Integration

- Hybridisation fuel cell electricity
- Stability calculation of boat-hull, verification from accredited laboratory
- Increase of cruising range and time of operation by approx. 30 %

System Development

- 100 W demonstrator system developed
  - compact system, 8 kg without methanol, size 49x26x51 cm
  - high power density: 430 W/kg with 5% (rank)
  - consumption: 0.8 l/h (km)
  - subsystems developed, number of components minimised

Stack/Sealing Development

option A

- successful stack development of 120W and 300W stacks demonstrated
- stack with project flow field design
- alternative sealing concept
- "rapid prototyping"
- cost efficient
- commercially available technique
- 40 cell stack with > 100 W demonstrated
- commercial MEAs used
- extension to 50-70 cells is feasible

option B

- New sealing for the project Freudenberg FCCT has developed a new stack sealing material on a polyethylene basis with improved stability in the DMFC environment (see picture right top). It has been demonstrated that the production of this material is reproducible and that it is processable using an injection moulding process. A stack sealing design for a conventional type stack was developed. An integrated sealing on the gas diffusion layers has been realised using cold-rubber technology (see picture right bottom). This "Fast GDL" concept allows a simplified cell assembling.

Membrane Development

new materials for block-co-polymer blend membranes

Phase separation of block-co-polymers into hydrophilic and hydrophobic domains increases proton conductivity and reduces methanol permeability. Ionical-crosslinking of acidic block-co-polymers with basic polybenzimidazole (PBIOO®) stabilizes the phase-separated morphology and ensures a stable membrane performance.

- performance of "CVC" and "between" membranes in U(I)-curves comparable to Nafton
- methanol permeation reduced
- water permeation reduced
- cells can be run at lower air stoichiometry or higher methanol concentration
- cost-efficient alternative to Nafton

MEA Development

- MEA development for 50-70°C, low air stoichiometry, ambient pressure
- DLR dry spraying technology avoiding use of solvents
- selection of optimised GDL
- optimisation of reaction layer composition
- reduction of catalyst loading to 2.4 mg/cm² total MEA

MEA 2.4 mg/cm² cat., 60% Nafion, cathode stoich. 3