Development of a process for the industrial production of electrodes for polymer electrolyte fuel cells

The automobile companies as well as the manufacturers of stationary fuel cell systems see the necessity to be able to operate polymer electrolyte fuel cells at temperatures above 100 ℃. Especially for automotive applications the advantages of so called high-temperature systems (operating temperature 100-200℃) compared to so called low temperature systems (operating temperature 70-90℃) are significant. Us ing polymer membranes whose proton conductivity is almost independent from water, the expenditure of water management for the fuel cell system is zero. There is no need for a complicated moisture-system, which is not easy to handle and which needs quite a lot of space when it is integrated in the car. Operating a fuel cell at higher temperatures also reduces the heat exchange area needed to dissipate the excess heat. This is also a significant advantage for the overall fuel cell system design. Additionally, a higher operating temperature leads to a higher catalytic activity of the fuel cell electrodes and a decreasing proneness of the catalytic material to impurities in the feed.

The recent work deals with the development of a manufacturing process for membrane electrode assemblies based on polybenzimidazol membranes for fuel cells operating at higher temperatures. One of the main interests of this work is the optimization of a screen-printing process with the aim of producing electrodes in a reproducible quality; the main requirement for optimizing the electrode structure and the electrode composition. With varying the electrode structure and composition it should be possible to determine the possible performance of the polybenzimidazol/phosphoric acid system.

Different characterization methods were used to investigate and to compare different membrane electrode assemblies. These were made of a polybenzimidazol membrane and self-made or commercially available electrodes. The characterization methods helped to show significant advantages in the behaviour in different operating modes of the membrane electrode assemblies based on a polybenzimidazol membrane and self-made, optimized electrodes in comparison to assemblies with commercial electrodes.

For automotive application it is necessary to provide electrodes with large active areas so the scale up of the electrode size was part of this work as well.

The conclusion of the present work is that the optimization of the electrode structure and composition led to a powerful polybenzmidazol/phosphoric acid system. There is still a need for further detailed investigations as the results of the work show problems with the existing system which need to be solved to make the system competitive to the low temperature systems.