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Plasma treatment of membranes for direct methanol fuel cells

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Membranes for polymer membrane fuel cells have to fulfill several ambitious requirements. First of all they should have good proton conductivity. Direct methanol fuel cells (DMFC) in particular should have small methanol permeability and should be chemically stable so that they can be operated at temperatures higher than 100°C. Additionally, the contact to the catalyst carrying electrodes should be very good. Another important component of a fuel cell is the gas diffusion layer (GDL). A GDL provides a homogeneous gas flow to the catalyst and should control the water content of the cell. However, most GDLs consist of a highly hydrophobic material which is critical for a proper water management.
In this study, a plasma induced modification of the membranes like Nafion and acid-base blend membranes developed at ICVT[2] as well as of the GDLs is investigated. A low-pressure microwave plasma source based on the Duo-Plasmaline principle is used. In this device, a linearly extended and axially homogeneous plasma is formed outside of a glass tube.
The treatments of the membranes and the GDLs are performed by O_2, N_2 and CF_4 plasmas. The contact angles of different liquids to the membranes are measured with the sessile drop method.
A special permeation experiment was developed that allows measurement of the time dependent absolute methanol particle flux through the membranes. It is possible to investigate the methanol permeation at different temperatures and different methanol-water molarities that are relevant for applications.
It will be shown that some of the critical properties of a DMFC can be improved by plasma treatment which leads to an increase in fuel cell efficiency.

Keywords
fuel cells
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polymer membrane
gas diffusion layer