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Development of a microcontactor for gas/liquid separation for µDMFC

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The gas/liquid phase separation plays a key role for the many chemical processes, either to separate products or to intervene in the balance of a reaction. An example for application of orientation independent separation is in "Lab-on-a-Chip" (LOC) design-based µDirect-Methanol-Fuel-Cell (µDMFC). The overall performance is strongly dependent on the gas/liquid phase separation at the anode and cathode side, especially if the µDMFC is operated transiently with a recovery system for unused fuel (water-methanol) at the anode side.
By integrating a membrane or microsieve based micro contactor downstream into the µDMFC, the efficient removal of CO_2 from a water-methanol solution is possible. The use of membrane technology enables the separation of the two-phase flow into liquid and gas in a compact and flat device. With a membrane based micro contactor installed downstream the µDMFC, the CO_2 gas can be very efficiently be removed from the water-methanol solution.
In general, this can be achieved by using a polymeric membrane based micro contactor installed downstream of the µDMFC. However, polymeric membranes are not methanol resistant in long-term use and have a high transport resistance. In contrast, metallic or ceramic microsieves have a high thermal and chemical stability in methanol as well as a low transport resistance due to their small uniform pore diameters and length.
The gas/liquid phase separation is achieved by combination In general; the gas/liquid phase separation is achieved by using a combination of the pressure gradient as a driving force and capillary forces in the pores of the membrane acting as a transport barrier depending on the nature of it (hydrophilic/hydrophobic)
Besides process parameters as pressure gradients, temperature, and flows, the surface properties of the channels and membrane/microsieve materials play an essential role for separation performance, tailored selectivity and low system energy consumption. By a systematic study of the separation process with both polymeric membranes and metallic micro sieves the influence of several parameters have been studied. Additionally the separation efficiency (separation factor, pressure gradient, orientation and liquid loss) for different feed inlet temperatures and methanol concentration were investigated to get a better understanding of the separation process at transient working behaviour of the µDMFC.