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High-Temperature Membrane-Catalyst Systems for CO-Shift Membrane Reactors

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The sequestration of CO_2 via H_2-selective, ceramic membranes in an IGCC-power plant is particularly for the high-temperature range of 600 °C – 900 °C a highly interesting method due to the low efficiency losses that can be reached. It was shown that even for this high-temperature range the utilization of a CO-shift catalyst leads to a considerable increase of the CO-conversion, at least up to 900 °C compared to an operation mode without catalyst[1]. However, the application of dense H_2-selective membranes and CO-shift-catalysts under the harsh conditions of an IGCC-power plant leads to very challenging operation conditions for the materials.

The present work aimed at the development of thermo-chemically and micro-structurally stable, active and compatible membrane-catalyst systems for a future catalytic CO-shift membrane reactor. Therefore, ceramic membrane materials with mixed protonic electronic conductivity like $BaCe_{0.2}Zr_{0.7}Yb_{0.08}Ni_{0.02}O_{3-\delta}$ and $La_{5.5}WO_{12-\delta}$ were combined with iron based catalysts like Fe/Cr/Cu-spinels. These membranes and catalysts show very good properties for planned applications[2]. For membrane-catalyst systems it is strongly required that the combined components do not influence each other negatively i.e. by diffusion or reaction. The investigation identified systems which seem to be highly applicable combinations for future catalytic CO-shift membrane reactors in the high-temperature range. The combination of a catalyst packed bed of the chromium stabilized catalyst 86Fe14Cr on a $La_{5.5}WO_{12-\delta}$-membrane tested in a membrane-reactor in laboratory-scale at 850 °C exhibits very good compatibility. Additional investigations on membrane-reactor performance, long term stability and scale up are necessary.

[1] D. van Holt, Keramische Membranen für die H_2-Abtrennung in CO-Shift-Reaktoren, Dissertation Ruhr-Universität Bochum 2014

[2] D. van Holt, E. Forster, M.E. Ivanova, W.A. Meulenberg, M. Müller, S. Baumann, R. Vaßen, Ceramic materials for H_2 transport membranes applicable for gas separation under coal-gasification-related conditions, *J. Eur. Ceram. Soc*. 34 (2014) 2381 – 2389

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