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Influence of coal power plant exhaust gas on the structure and performance of ceramic nanostructured gas separation membranes

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Carbon capture and storage or utilization is a key technology to decrease CO_2 emissions from conventional power plants, until cost efficient energy supply from renewable sources is possible. Membrane-based systems to capture CO_2 from flue gas streams are considered a promising alternative to conventional absorption technology. In the present work the effect of coal power plant exhaust gas on amino-modified mesoporous ceramic membranes was investigated. Testing membranes in direct contact with exhaust gas represents a new approach, as testing under simulated flue gas conditions has already been undertaken. Flue gas exposure experiments were carried out at a lignite-fueled power plant and a hard-coal-fueled power plant. Most experiments were conducted using a test rig designed to bring planar membrane samples in direct contact with unconditioned flue gas in the exhaust gas channel. Another test rig was designed to test membrane modules with pre-treated flue gas. The tested membranes had an asymmetric structure consisting of a macroporous α-Al_2O_3 support coated with a mesoporous ɣ-Al_2O_3 or 8YSZ interlayer. The microporous functional top layer was made of amino-functionalized silica. The tests revealed different degradation mechanisms such as gypsum/fly ash deposition on the membrane surface, pore blocking by water condensation, chemical reactions and phase transformation. A detailed analysis was carried out by XRD, XPS and SEM to evaluate their impact on the membrane in order to assess membrane stability under real conditions. The suitability of these membranes for this application is critically discussed and an improved mode of membrane operation is proposed.

Biography

K Wilkner holds a Diploma in Physical Engineering from the University of Applied Science Aachen. Since 2011, he has been working at the Institute of Energy and Climate Research: Materials synthesis and processing (IEK-1) in Forschungszentrum Julich. Since 2012, one of his responsibilities is to test membranes in direct contact with flue gas of lignite and hard-coal-fueled power plants.

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