



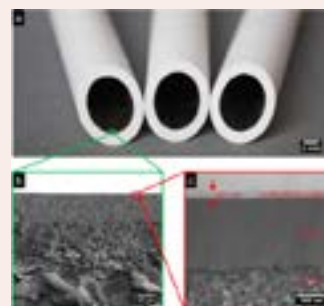
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High selective carbon membranes for water and gas separation

With a lattice plane distance in the range of the kinetic diameter of small gas molecules, carbon is an interesting material for membranes. To overcome problems of low mechanical stability, thin carbon layers (<1  $\mu\text{m}$  thickness) were prepared inside mechanical stable ceramic support tubes by coating with organic precursor solutions, drying, cross linking and pyrolysing in inert atmosphere. Lattice plane distances of 0.4 nm were measured by electron diffraction. A high  $\text{H}_2$ -permeance of around  $5 \text{ m}^3/(\text{m}^2 \cdot \text{h} \cdot \text{bar})$  and nearly no permeation for bigger molecules of >4 nm diameter giving evidence for a mole sieving behavior. Nearly pure  $\text{H}_2$  of >99% was separated through the membranes by mixed gas measurements in  $\text{H}_2/\text{C}_3\text{H}_8$  mixtures at temperatures up to  $300^\circ\text{C}$  and pressure up to 10 bar. By intercalation of hetero atoms, the properties were transformed to an adsorption selective mechanism giving  $\text{CO}_2$ -selective carbon membranes. The membranes were scaled up to 0.5 m long membrane elements and successfully tested in a side stream of a commercially used biogas fermenter. A pore condensing mechanism can be used for the separation of  $\text{H}_2\text{O}$  from hot gas streams. Infinite high selectivities for mixtures of water with gases like  $\text{N}_2$ ,  $\text{CO}_2$ ,  $\text{CH}_4$  and  $\text{H}_2$  were measured at  $280^\circ\text{C}$  and 11 bar. A robust membrane performance was found in first

tests of in-situ water separation from methanization of  $\text{CO}_2$  and  $\text{H}_2$ .



### Biography

Hannes Richter is Head of the Department of "Nanoporous Membranes". For his thesis on ceramic nanofiltration membranes (1998), he received the Bernhard-von-Cotta Award of the Freiberg University. He is experienced in amorphous membranes for 20 years and in zeolite and carbon membranes for more than 10 years. For the development of NaA-membranes and its scaling-up in to an industrial level, he received the Exceptional price of "Junior Scientist Award" competition at Materialsweek 2004, the "Innovation Award Middle Germany 2008 - Cluster Energy and Environment" and "Innovation Award Energy 2009" of the Society for the Promotion of Renewable Energy. For the development of ceramic nanofiltration membranes with a cut-off of 200 Da, he won the "Fraunhofer Award 2017". He is the author of about 38 papers, gave more than 70 lectures in national and international congresses, thereof 26 invited presentations and is inventor of 8 patents.

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