

# RESEARCH NEWS

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Module for a CO<sub>2</sub>-free energy supply

## Green hydrogen: Transportation in the natural gas grid

**Researchers at the Fraunhofer-Gesellschaft have developed a technology for the energy-efficient and economic separation of hydrogen from natural gas. This membrane technology makes it possible for the two substances to be routed through the national natural gas grid together and then isolated from one another at their final destination. A major step forward in the transportation and distribution of hydrogen as an energy source.**

Alongside ceramic-based materials, the Fraunhofer Institute for Ceramic Technologies and Systems IKTS is researching the potential of other materials such as carbon, for example. This material could play a key role in the movement towards hydrogen as an energy source. Hydrogen is seen as a beacon of hope for establishing a CO<sub>2</sub>-free energy supply. If hydrogen is collected from renewable sources such as wind and solar power, there are no climate-damaging emissions. But how do we move this "green" hydrogen from the producer to the consumer? Germany still does not have an extensive distribution network for hydrogen.

The HYPOS (Hydrogen Power Storage & Solutions East Germany) project initiative is working to solve this dilemma. The aim is to create an intelligent infrastructure of distributor networks and storage stations that will make the clean energy source available to all regions.

### Distribution of hydrogen through the natural gas grid

The HYPOS project partners are pursuing the idea, among other approaches, of transporting the hydrogen (H<sub>2</sub>) along with the natural gas (the principal component being methane, CH<sub>4</sub>). After all, Germany does have a 511,000 kilometer long gas grid and 33 gas storage locations. "The advantage of this infrastructure is that it allows hydrogen to be fed into the natural gas grid as well. The two substances can be transported together in one line. Once they arrive at the destination, we can separate them from one another again as needed," explains Dr. Adrian Simon, Group Manager at Fraunhofer IKTS.

This is where carbon comes in. It forms an ultrathin layer on porous, ceramic substrates where it acts as a membrane, separating natural gas and hydrogen from one another. There are various processes involved in membrane production, starting with custom polymer synthesis. Polymers are substances consisting of branched macromolecules. These are then applied to the porous substrate. When the polymer is heated up and

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starved of oxygen at the same time, it forms a layer of carbon on its surface. The pores in the carbon are less than a nanometer in diameter, and this makes them effective for gas separation. Physical and chemical processes can be employed to adapt the membrane's separation behavior even further. Fraunhofer IKTS has been collaborating with Leipzig-based DBI Gas- und Umwelttechnik GmbH to develop tubular carbon membranes.

During the separation process, hydrogen and natural gas are pushed through the tubular modules. The smaller hydrogen molecules are forced through the pores in the membrane and reach the outside in the form of gas, the larger methane molecules on the other hand are held back. "This gives us hydrogen with an 80 percent degree of purity. We then filter the residual natural gas in a second separation step. The end result is a purity of over 90 percent," explains Simon.

### **Emission-free power and heat supply in buildings**

We can use hydrogen with this degree of purity for various applications: In steel production for example. In high-temperature furnaces, it replaces carbon in the process of reducing iron ore to iron, making an important contribution to cutting CO<sub>2</sub> emissions. Hydrogen is also an attractive option for the climate-friendly energy supply to buildings. When combusted, hydrogen generates power and heat, the only by-product is water. Combined heat and power systems (CHP), for example, could supply clean power and heat energy to individual building complexes. We could also conceivably use them in gas-fired boilers.

The researchers at Fraunhofer IKTS are currently working on scaling the technology to an extent that will allow the separation of larger volumes of natural gas and hydrogen. The construction of prototypes is already in the pipeline.

#### **HYPOS project**

The "Hydrogen Power Storage & Solutions East Germany" research project has set itself the goal of providing "green" hydrogen, meaning hydrogen produced from renewable energies and without climate-damaging emissions, on a nationwide basis. The idea is to network power and gas grids, storage stations and hydrogen pipelines in an intelligent infrastructure. This will create an energy network that can serve as the basis of an extensive and cost-efficient hydrogen economy.

The plan is to then roll out the model-based structure in East Germany nationwide. The project partners, numbering more than 130, include eight research units or institutes of the Fraunhofer-Gesellschaft, including Fraunhofer IKTS.

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**Fig. 1** The 19 channels in the carbon membrane enlarge its surface area, and this in turns encourages a higher substance throughput.

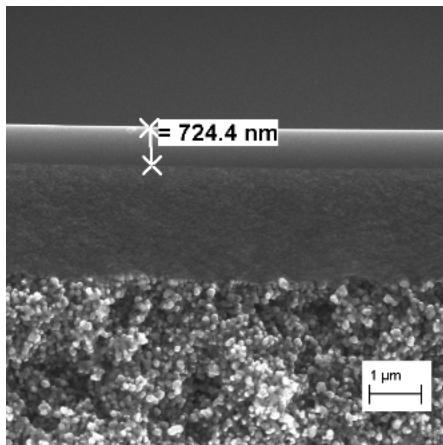
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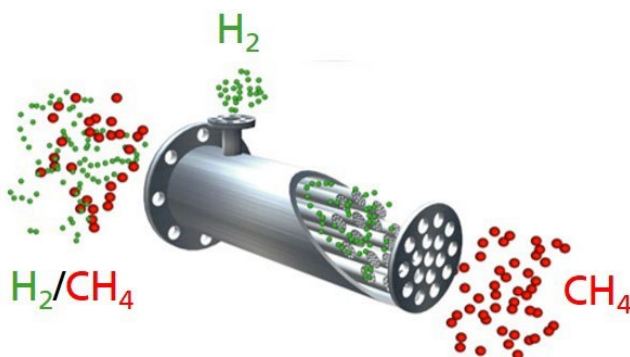
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**Fig. 2** Exposure in the scanning electron microscope: Carbon membrane with a layer thickness of less than 1 micrometer.

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**Fig. 3** How does a membrane work in principle? The gas mixture is surrendered to the input side of the membrane. The small hydrogen molecules pass through the membranes and the larger methane molecules are held back.

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