Technical University of Denmark

CERAMIC MEMBRANES FOR GAS SEPARATION

– PRODUCTION OF OXYGEN FOR ENVIRONMENTALLY FRIENDLY TECHNOLOGIES

DTU Energy
Department of Energy Conversion and Storage

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Oxygen is a widely used chemical commodity in industry, in research labs, and in a range of medical applications. Today, it is primarily produced by cryogenic distillation and transported in pressurized liquid form or it is produced on site, e.g., by pressure swing adsorption. Its manufacture is both expensive and energy-intensive. Ceramic membranes for the separation of oxygen are potentially both cheaper and more energy efficient than existing processes.

An Oxygen Transfer Membrane (OTM) based on functional ceramic materials allows the separation of oxygen from air by the selective transport of oxide ions when operated at high temperatures. An OTM consists of a Mixed Ionic-Electronic Conductor (MIEC), which allows oxide ion diffusion through vacancies in the crystal lattice without external electrical circuits. This means that oxygen selectivity is infinite, apart from leakages through the membrane or the sealing.

On both sides of the membrane, porous layers support the MIEC. These layers can contain suitable catalysts to increase the membrane's efficiency.

Potential applications for OTMs range from small-scale oxygen pumps for medical applications to large-scale usage in methane conversion, where methane is upgraded to higher value hydrocarbons (methanol, DME, synthetic diesel). Having cheap access to oxygen will also reduce the cost of transport fuels obtained from the gasification of biomass, and in this way make CO_2 neutral transport more economically competitive.

Another attractive use is for oxyfiring in fossil fuel power plants. When combustion takes place with pure oxygen, it is easy to separate the CO_2 from the flue gas. Fossil fuel power plants are by far the biggest single sources of CO_2 and contribute more than 40% of the total worldwide anthropogenic CO_2 emission. Using Carbon Capture and Storage (CCS) from oxyfired fossil fuel power plants will make it possible to reduce CO_2 emissions and allow future electricity supply to be more environmentally safe and sustainable.

Similar types of ceramic membranes using proton-conducting materials can be used for the production of hydrogen and in the chemical and petrochemical industries. At the Department of Energy Conversion and Storage, we are carrying out research on both types of membranes, ranging from fundamental materials research to the shaping of components and testing of prototypes.

ABOUT THE DEPARTEMENT

We focus on functional materials and their applications for sustainable energy technologies

FURTHER INFORMATION

www.energy.dtu.dk

CONTACT

Department of Energy Conversion and Storage
Technical University of Denmark, Risø Campus,
Frederiksborgvej 399, DK-4000 Roskilde,
Denmark

info@energy.dtu.dk, +45 4677 5800