Controlling pores on demand

A membrane developed by scientists at the University of Twente, in The Netherlands, can be made more or less porous "on demand". In this way, smart switching between "open" and "closed" is possible, which paves the way to innovative applications involving biosensors, chemical analysis and catalysis.

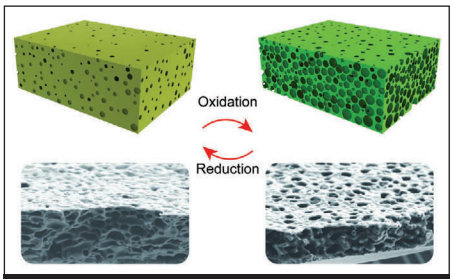

Figure 1. Redox-induced changes demonstrate reversible switching between more open (*right*) and more closed (*left*) porous structures.

The "Swiss cheese" structure is characteristic of many polymer membranes and has been modified by introducing iron to the polymer. Using an electric signal or a chemical reaction, the pore size can be adjusted. The key to this is the controlled addition or removal of electrons to and from the iron.

The pore size of the smart membrane can be adjusted from the outside, which is very attractive in applications such as biosensors or chemical analysis, say the researchers.

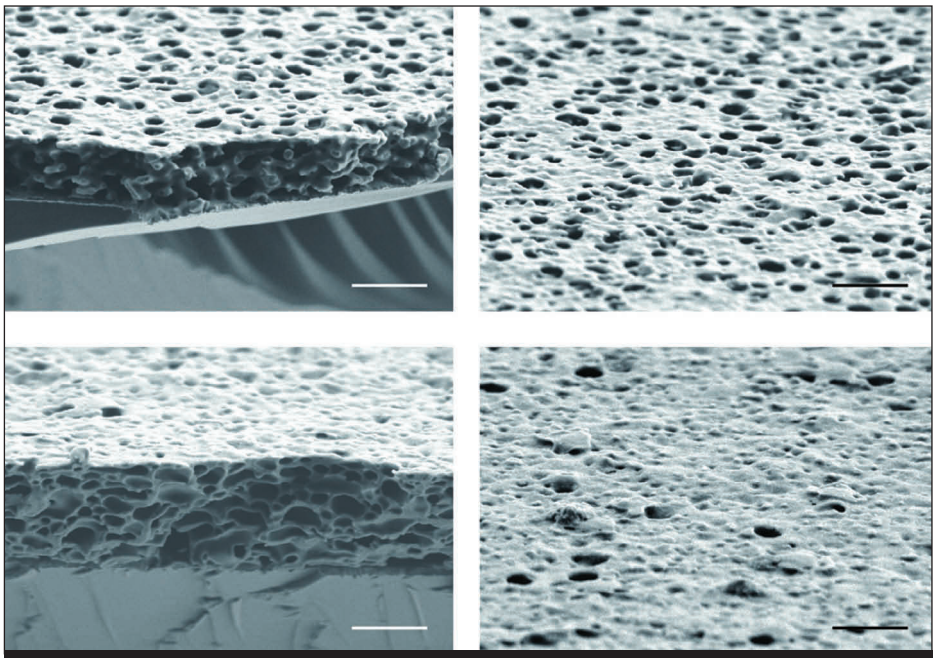

Figure 2. Cross-sectional and surface SEM images of porous membranes after oxidation (*top*) and reduction (*bottom*) (scale bar: 1 µm).

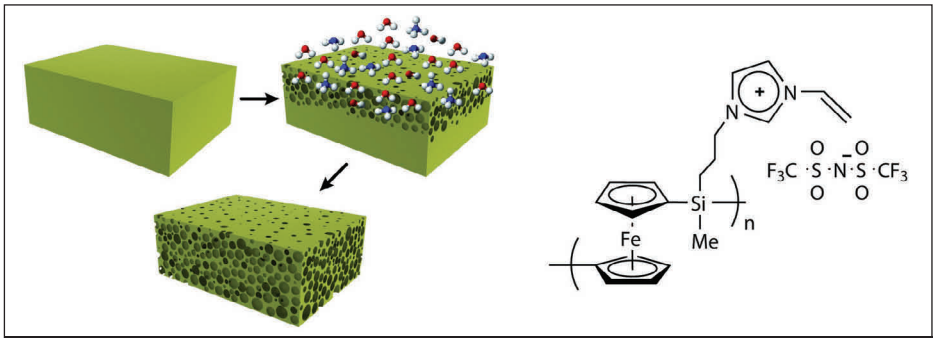

Figure 3. Representation of the pore-formation process induced by ammonia diffusion (*left*); chemical structures of poly(ferrocenylsilane)-based poly(ionic liquid) used in this study.

Tuned

The ability to adjust the pore size means that the permeability and selectivity of the membrane can be tuned for separation purposes or controlled release. The researchers see possibilities in analysis and separation of proteins, for example.

An additional advantage of the new membranes is the change in colour that takes place. The process of protein detection and analysis becomes visible in an easy way, which may lead to a cheap type of biosensor.

'The ability to adjust the pore size means that the permeability and selectivity of the membrane can be tuned.'

Another application of the smart membrane is in catalysis. Here, it is possible to achieve two things in a single action. Whilst pore size and permeability can be altered using a chemical reaction with silver salt, nano-size particles of silver also can be deposited on the membrane at the same time say the researchers. Silver is an important catalyst in many applications.

(This membrane research is being conducted by the Materials Science and Technology of Polymers group – part of the MESA+ Institute for Nanotechnology of the University of Twente – led by Professor Julius Vancso. A paper detailing this research, entitled 'Breathing cells on command: redox-responsive porous membranes from poly(ferrocenylsilane)s' by Kaihuan Zhang, Xueling Feng, Mark Hempenius and Julius Vancso, appears in *Angewandte Chemie International Edition*, Volume 53, Issue 50, 8 December 2014, pages 13 789–13 793.)

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