Technology Offer

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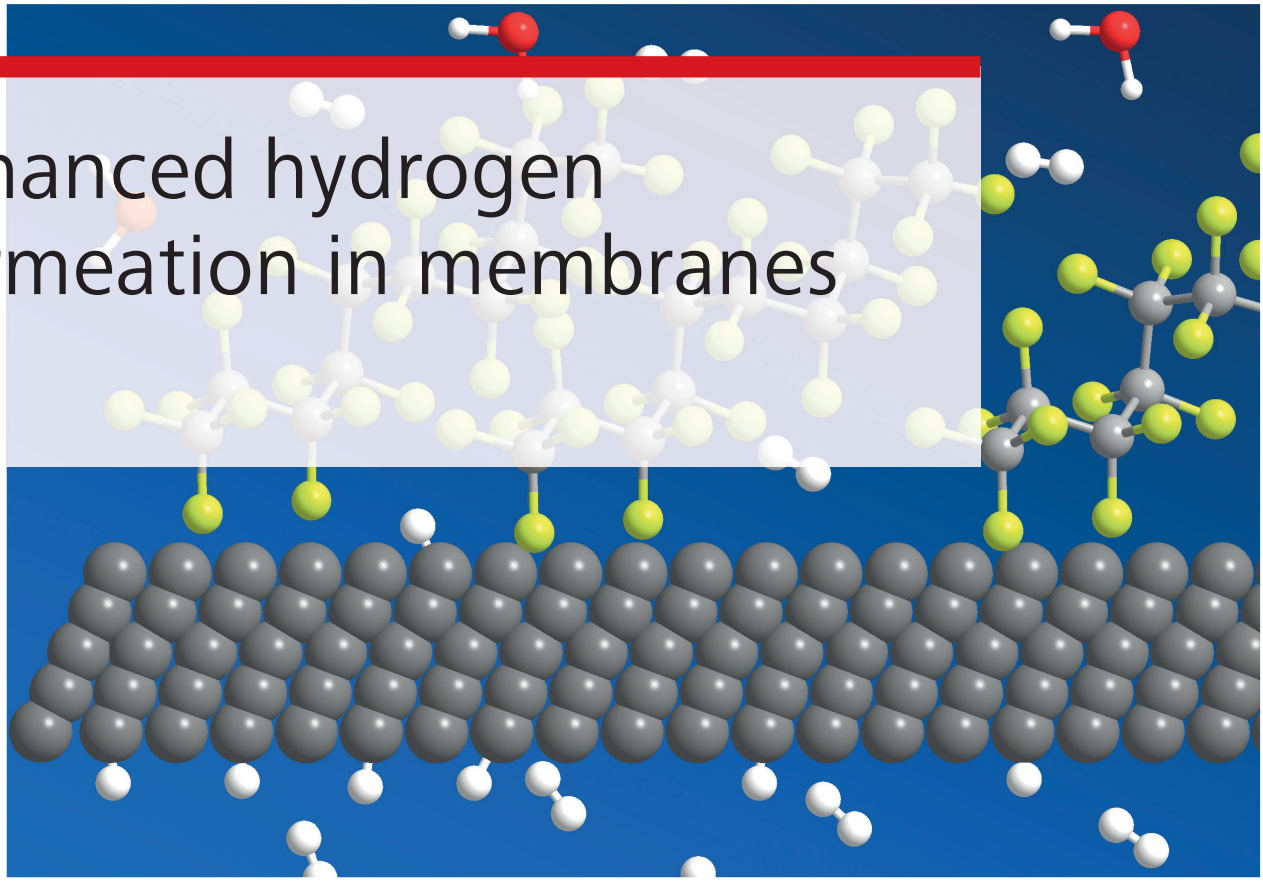
Empa
Materials Science and Technology

Enhanced hydrogen permeation in membranes



Invention

Separation of hydrogen from gas mixtures is an important technical process, that increases the economic and energetic value of the complete process chain, in which it is implemented. Hydrogen permeable membranes such as Pd are already used on a large scale. A simple coating on top of such metallic membranes can improve the permeability by an order of magnitude. In addition to the enhanced functionality, the lifetime of membranes is extended. The coating is also applicable to other hydrogen related devices, which depend on gas-solid interactions (e.g. sensors and catalysts).

Background

Hydrogen is used on a large scale as a process gas in chemical industry. Virtually no reaction has a 100% conversion rate of reactants into products; i.e., in practice, the compounds leaving a reactor contain the desired products plus non-converted reactants. To enhance the overall efficiency of the process, hydrogen is separated from the mixture after the reaction [1], and maybe re-used. In future scenarios with hydrogen as an energy carrier, the separation and/or purification of the energetically costly hydrogen is most relevant. A promising way is the use of hydrogen selective membranes made of hydrogen absorbing metals, such as Pd and Pd-alloys [2]. The permeability of such membranes is determined by the surface properties of both sides (dissociation/recombination) and by the bulk permeability (diffusion and solubility) [2]. There has been substantial research effort in finding cheaper materials with a higher permeability than Pd (e.g., V, Nb, Ta and their alloys [3,4]), however, expensive Pd and Pd-based alloys remain the superior membrane materials owing to their favorable surface properties, which may be prone to poisoning by contaminants such as water, CO or H_2S.

Advantages

The metallic foil itself is self-supporting. By coating the low pressure side of metallic hydrogen membranes with a hydrophobic polymer with electronegative functional groups, preferably a polytetrafluorethylene coating, the surface remains free of contaminating elements. The surface properties of a Pd membrane can be improved by one order of magnitude using a fluoropolymer cap layer on top of it (Ref. 5). Currently, other coatings are under investigation, aiming at protecting the active surface against poisoning by contaminants such as CO and H_2S. The promotion effect may be also effective in other applications, that depend on gas-solid interactions.

Applications

Primary application is the improvement of hydrogen selective membranesfor the the chemical industry, petrochemistry, and industries, where hydrogen is an important process gas. There is also great potential to improve the overall efficiency in power-to-gas applications. Other potential applications of the promotion effect of polymer coatings may be:

- PTFE on Metal hydride H-sensors [6] for hydrogen related industry, hydrogen infrastructure, hydrogen cars etc.
- Fluorination method for improving surface properties and (sorption) characteristics of AB -types of hydrides [7] for producers of materials for hydrogen storage.
- Fluorinated hydride alloys, applicable as methanation catalysts without being influenced by carbon oxides and by products such as methane, CO and water [8] for catalyst producers, chemical industry, energy companies.

Ownership

Empa, Swiss Federal Laboratories for Materials Testing and Research, Überlandstrasse 129, CH-8600 Dübendorf and Technische Universiteit Delft, Stevinweg 1, NL-2628 CN Delft; Patent pending

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Keywords

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