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PROTECTIVE Sol-Gel Oxide COATINGS LIMITING HYDROGEN PERMEATION through polymer materials

The subject of the invention is a method (know-how, partly confidential) of the production and application of sol-gel coatings on polymeric materials. These can then be used as a part of pressure storage system.
Know-how is the answer to the problem of hydrogen permeation through the vessel/container (polymeric liner), especially at higher pressures (compressed) eg.70MPa (700 bar).

TECHNICAL DETAILS

The problem: Hydrogen can be stored as compressed gas in the high-pressure (of ~ 70 MPa) tanks. Storing hydrogen in tanks causes a problem of hydrogen permeation through the tank walls, especially in the case of long-term storage.

The max. range of permeation is determined by industry standards, e.g. in the case of power supply systems for passenger cars it is less than 6 Ncm^3 per hour of hydrogen per liter internal volume of the container (Commission Regulation EU No 406/2010). Hydrogen permeation is an important issue both in the individual (passenger cars) and the industrial applications (hydrogen transport, storage, energy conversion), especially from the safety point of view, because of the high explosiveness of the air-hydrogen mixture.

The solution to the problem: The know-how concerns the method of protecting polymeric materials against hydrogen (H2) permeation by using a sol-gel oxide coating. The sol-gel oxide coating is applied to polymeric surfaces, and it's a kind of barrier limiting the permeation of hydrogen molecules.

The sol-gel oxide coating is obtained by synthesis so-called wet chemistry, in particular as a result of hydrolysis and condensation reactions using appropriate precursors. The layers are applied to a given polymeric substrate and stabilized. More than one layer can be applied and each layers can have different composition. The thickness of the coating is less than 1 µm.

The table below shows the change in hydrogen permeation at 700 bar (70 MPa) pressure through the polymer (HDPE) with a protective layer obtained according to the offered know-how compared to a polymer without it. Each time the proposed coating is matched to the established substrate, as a result of which the expected interaction of the coating with the substrate is obtained, which determines the stability and efficiency of the solution. Below we present the results obtained for an example of a match that were obtained in experimental studies.

The sample	Permeability coefficient [mol s^{-1} Pa^{-1} m^{-1}]	Permeability (basically= 100% for uncoated HDPE)
HDPE without a protective layer	$9.14 \cdot 10^{-16}$	100%
HDPE with a protective layer acc. the offered know-how	$5.92 \cdot 10^{-16}$	64% (improve the properties 36%)

APPLICATIONS/MARKETS

Production of hydrogen (compressed hydrogen CH2) storage tanks.

Protection of existing hydrogen (or other gasses) transmission lines.

INNOVATION/ADVANTAGES

• Considerable reduction of hydrogen permeation through the polymer surface by thin oxide film. For HDPE under 700 bar hydrogen pressure, at least 30%;

• Reduction of the energy losses due to hydrogen leakage;

IP STATUS

- ☐ Patent application
- ☐ Patent
- ☒ Know-how
- ☐ Other

COMMERCIALISATION FORM

- ☒ Sale
- ☒ Implementation contract
- ☒ Granting a license
- ☐ Spin off
- ☒ Other contract

LEVEL OF IMPLEMENTATION READINESS

- ☒ A concept and a theoretical model
- ☒ An experimental validation of the concept
- ☐ Initial technology / demonstrator
- ☐ Tests in the laboratory conditions
- ☐ Tests in real conditions
- ☐ Final technology / prototype
- ☐ A technology verified in the operational conditions

RESEARCH SCOPE OF THE RESEARCH TEAM

• Material Engineering
• Functional Materials
• Smart materials
• Sol-gel materials
• Nanotechnology

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