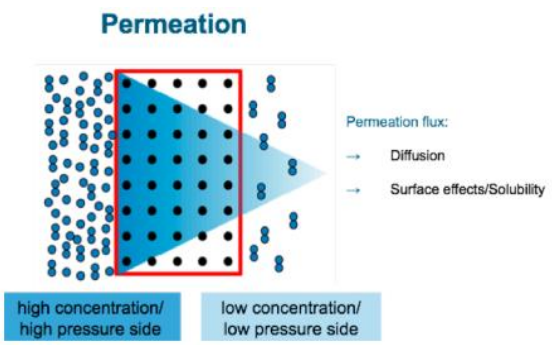
# Hydrogen Permeation Barriers

*The object of the invention is to provide manufacturing parameters for a holographic diffraction grating on a concave or toroidal surface, which is used as the single optical element in a VUV spectrometer with a flat detector. The spectrometer geometry is also defined alongside the diffraction grating parameters. The invention from the research center Juelich (Germany) consists of a proprietary software code which uses various numerical methods to determine the optimal grating parameters, with the aim of producing such gratings for VUV spectrometers with a minimal line width for a pre-defined wavelength and at the same time achieving high spectrometer efficiencies.*

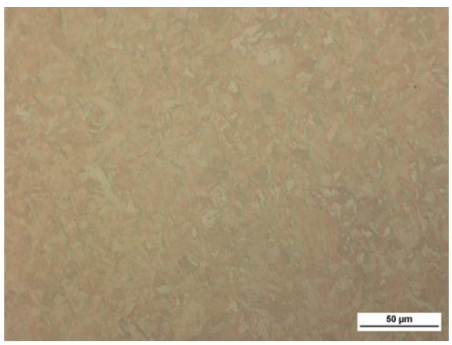
## Description of the technology

The Research Centre Juelich has gained substantial expertise in the development, preparation and characterization of hydrogen permeation barriers. In the fusion domain, such coatings are needed to limit losses of Tritium to the environment. Promising laboratory experiments have been conducted. A partner is sought that is interested in developing coating equipment and processes for industrial application based on the know-how available at Research Centre Juelich.

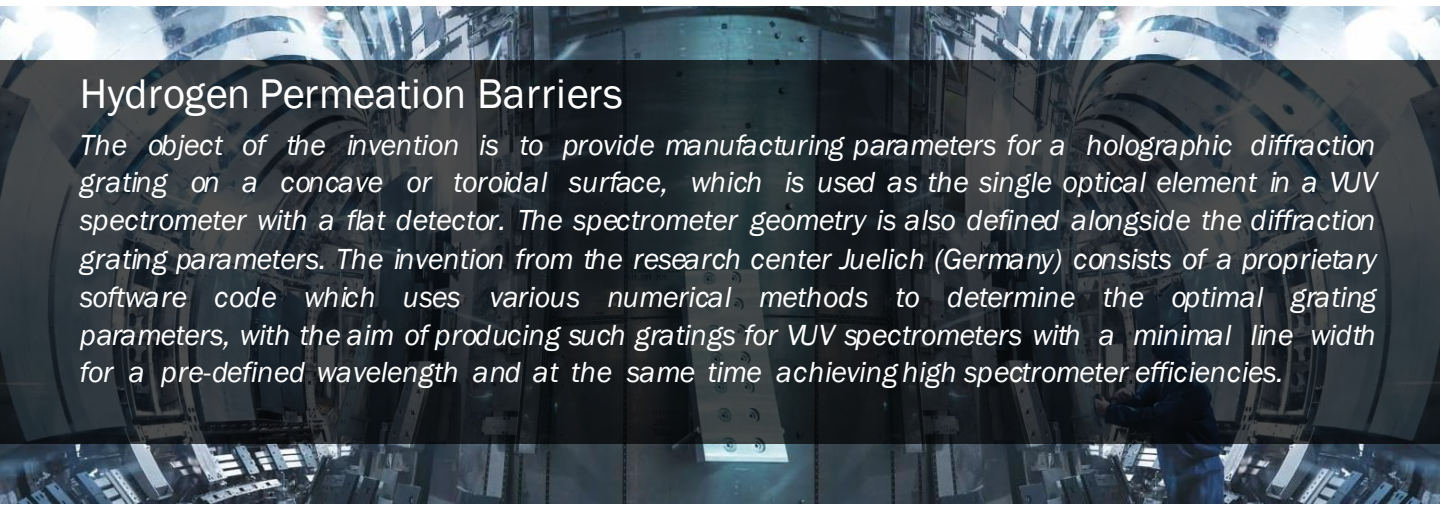
The invention is a combination of new kinds of layers and a method of deposition of layers through a magnetron sputter deposition device. Barrier Layers require high thermal stability and corrosion resistance. They need to have a similar thermal expansion coefficient to the substrate, they have to be crack-free, dense, and smooth and need to show a good activation behavior. Promising candidates here are oxides. The Magnetron Sputter Deposition Device used at Juelich for the production of hydrogen permeation barriers consists of four magnetrons that allow the co-deposition of four different components simultaneously with three DC sources and one RF source, which makes the production of insulating layers possible. The top-down sputtering makes the sample mounting easy and flexible and through rotation of the sample stage a homogeneous layer deposition is ensured. The sample stage can be heated up to 800 K. The process of deposition includes etching and biasing of substrate and reactive sputtering. Substrates for deposition may be Eurofer97 plates, a Reduced Activation Ferritic Martensitic (RAFM) steel, with low content of undesired elements like Nb, Mo, Ni, Cu, with a thickness of 0.5-1mm.




*The Process of Permeation*




*A Yttrium-Oxide Layer on a Eurofer97*



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## Innovation and advantages of the offer

The method described above allows crack--free, dense and smooth layers of ~ 1µm thickness. The layers provide high thermal stability and show good activation behaviour as well as a high permeation reduction factor. In the fusion domain, such coatings are needed to limit losses of Tritium to the environment as well as to limit the amount of Tritium stored in the walls of the fusion reactor.

## Non-fusion Applications

Since permeation is a general issue in transportation and storage of hydrogen, this new method of reducing permeation is applicable to all systems of transportation and storage of hydrogen such as hydrogen tanks and hydrogen vehicles. It significantly contributes to reducing permeation. Potential Application Domains are thus the power-engineering domain, where hydrogen gas is widely used. Examples of use are tubes and containers for hydrogen storage and transportation, especially in case of hot gases.

## EUROfusion Heritage

In the fusion domain, such coatings are needed to limit losses of Tritium to the environment as well as to limit the amount of Tritium stored in the walls of fusion reactor. Promising laboratory experiments have been conducted at Research Centre Juelich.