



## Is There a Need for International Standardization in Evaluating Coatings for Tritium Permeation Barriers?

Tritium permeation barriers (TPBs) are essential to limit tritium loss and ensure safety in future fusion reactors. This work presents experimental results on hydrogen isotope permeation through  $\text{Al}_2\text{O}_3$  coatings deposited by Atomic Layer Deposition (ALD) and by Pulsed Laser Deposition (PLD) on fusion-relevant structural materials, including AISI 316L, Nitronic alloys, and Incoloy 800H. Hydrogen permeation tests were performed using the ENEA PERI-II experimental facility, under conditions simulating those of breeding blanket environments, including temperatures up to 500°C and well-controlled pressure differentials. The permeation behavior of the samples is discussed supported by morphological and structural characterization of the coatings (SEM, XRD).

The ALD alumina coatings demonstrated a permeation reduction factor exceeding three orders of magnitude under optimal conditions. Substrate influence was also analyzed, with preliminary insights into the impact of ion-induced damage.

In addition to presenting our experimental results, we emphasize the need for international standardization of permeation testing protocols. To this end, we propose the establishment of shared methodologies and long-duration multi-test facilities, enabling direct comparison across different groups and materials worldwide. This collaborative infrastructure would significantly accelerate the validation of TPB performance under reactor-relevant conditions and support future fusion power plant design needs.

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