Multifunctional nanoceramic barriers for breeding blanket applications

Boris Paladino,[1,2] Daniele Iadicicco,[1] Matteo Vanazzi,[1] Patricia Munoz,[3] Serena Bassini,[4] Marco Utili,[4] and Fabio Di Fonzo[1,*]

[1] *Center for Nano Science and Technology (CNST), Istituto Italiano di Tecnologia (IIT), via G. Pascoli 70/3, 20133, Milano, Italy*

[2] *Politecnico di Milano, Energy department, via Lambruschini 4, 20156, Milano, Italy*

[3] *Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas (CIEMAT), av. Complutense 40, 28040, Madrid, Spain*

[4] *Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile (ENEA), Brasimone, 40032, Camugnano, Bologna, Italy*

*corresponding author: fabio.difonzo@iit.it

Materials are one of the major bottlenecks for future fusion reactors, especially concerning the breeding blanket modulus. The main technological issues include structural material's corrosion by Pb-16Li, radiation damage and Tritium confinement. We report on multifunctional nanoceramic oxide coatings grown by Pulsed Laser Deposition (PLD) and Atomic Layer Deposition (ALD) techniques. Oxides were chosen as the main candidates given their chemical inertia and thermodynamic stability. Among these, Aluminium Oxide and Yttrium Oxide were identified as promising candidates. PLD-grown coatings of these materials have been tested as Tritium permeation barriers with Hydrogen at different temperatures (from 350°C to 650°C). They showed a permeation reduction factor (PRF) up to 10^5 at 650°C. These results have been confirmed also in the case of Deuterium permeation, both under 1.8 MeV electron irradiation and for samples that were previously irradiated with ions. In addition, to evaluate the chemical compatibility of the films in Pb-16Li, samples have been exposed to static corrosion tests up to 10000 hours. No corrosive attacks on the steel substrate were detected. As for the magnetohydrodynamic drag for breeding blanket applications, the electrical resistivity of the coatings has been measured, showing good insulating behaviour. Finally, the ALD process has been recently employed and optimized, and the coatings thus produced preliminary characterized. To conclude, oxide coatings grown by PLD and ALD present interesting properties as multifunctional protective barriers, proving to be one of the possible solutions for the technological issues of future fusion applications.