Effect of substrate surface oxidation on tritium permeation barrier properties of MOD Er_2O_3 coating

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The blanket systems adopting liquid metal Li-Pb, molten salts of Flibe, Flinak etc. have the critical issues of tritium permeation through the structural materials. Fabrication of ceramic coatings on the blanket components would be considered as a promising solution to reduce the permeation. Recently, the research on Er_2O_3 ceramic coating with the arc-source plasma deposition method etc. showed a superior performance as a tritium permeation barrier.

In this study, the Er_2O_3 coating has been fabricated by the metal organic deposition (MOD) method with the dip-coating technique, which can be applied to covering large area as tritium permeation barrier in fusion blankets. However, the MOD method needs a baking process of above 500℃ with oxygen to decompose the erbium metal organic precursor and form Er_2O_3 on substrate surfaces. In this process, oxidized layer would also be formed below the coating and affect the tritium permeation reduction property of the coating.

Dip-coated Er_2O_3 coating baked at 700℃ in air on a Reduced Activation Ferritic/Martensitic Steel (JLF-1) substrate showed a good crystallinity by XRD measurements with the thickness of ~1.2μm. However, Er_2O_3 coating layer on a JLF-1 substrate showed the hydrogen permeation reduction factor of only ~1/15 at 700℃. By examination with XRD, an oxidation layer of mainly Fe_2O_3 was found between the coating and the JLF-1 substrate. The oxidation layer might be the main reason for the low performance as a permeation barrier. The oxidation layer below the Er_2O_3 coating would also affect the stability in the liquid breeders. Thus, to suppress the effect of the oxidation layer, dip-coated Er_2O_3 with MOD liquid was baked in the different atmosphere including air, Ar, and vacuum. The influence of the composition and microstructure of the Er_2O_3 coating and the substrate oxidation layer on hydrogen permeation reduction was investigated.