COMPATIBILITY OF DIP-COATED Er_2O_3 BY MOD METHOD WITH LIQUID LI

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An electrical insulating ceramic coating on a self-cooled lithium (Li) blanket is a promising technology for suppression of MHD pressure drop in the blanket system. Among the materials recently investigated, Er_2O_3 ceramic bulk showed good compatibility with liquid Li up to 600°C [1], high electrical resistivity, and thus is regarded as a promising material for the insulating coating. Compared with the other techniques, MOD (metal organic decomposition) method with dip process would be suitable for large area coatings on the components with a complex shapes. However, the information about the compatibility of the coated material by MOD method with liquid Li is limited. The purpose of the present study is to investigate the Li compatibility of Er_2O_3 coating on the ferritic steels by the MOD method.

Substrates of two ferritic steels (SUS430: Fe-18Cr steel, JLF-1: low activation ferritic martensitic Fe-9Cr-2W-0.1C steel) were immersed in MOD liquid precursor and withdrawn at a speed of 200mm/min, and then dried at 150°C for 10min on a hot plate. After repeating the process 20 times, the samples were baked at 600°C for 2h in air. Static exposure experiments in liquid lithium were carried out at 500°C up to 280h with 9Cr crucible, which was placed in the autoclave (SUS316) filled with high purity argon [2]. After corrosion tests, the samples were cleaned with ethanol for removing an adhered Li on their surfaces.

The thickness of Er_2O_3 coating was uniform and about 1.2μm by SEM cross sectional observations. Er_2O_3 coating on SUS430 substrates survived after the Li corrosion test. According to SEM observation of the surface, there were pores on the surfaces. Exfoliation was observed around large pores (Fig.1). The results of XRD analysis indicated some new peaks for the corrosion products which were identified to be $LiErO_2$ [1] after the Li corrosion tests. However, almost no change in the weight of SUS430 substrate took place after Li corrosion test. In contrast, Er_2O_3 coating on the JLF-1 substrate almost disappeared after the corrosion with the same test conditions (Fig.2). It was found by XPS analysis that a thick Fe_2O_3 layer was produced as an intermediate layer below Er_2O_3 coating during the baking procedure. The oxidation layer between the SUS430 and the coating layer was thin and identified to be Cr_2O_3. This difference of the intermediate layer with the different chemical stability is possibly influenced on the compatibility of the coated materials in liquid Li.

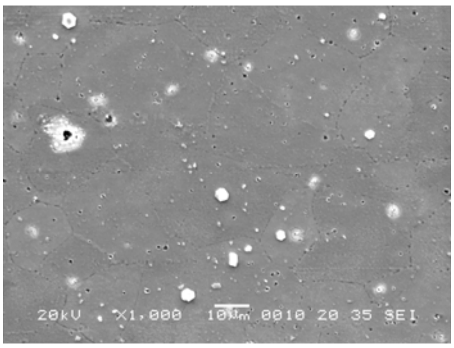

Fig. 1 Surface of Er_2O_3 coating on SUS430 after Li corrosion for 280 hours

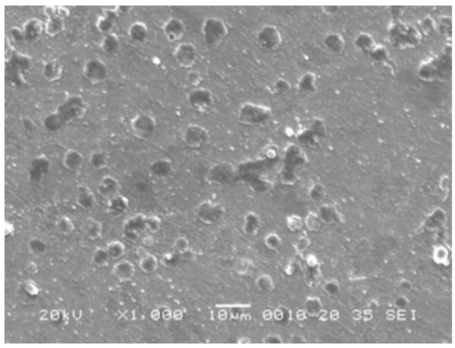

Fig. 2 Surface of Er_2O_3 coating on JLF-1 after Li corrosion for 280 hours

[1] M. Nagura, et al, Fusion Engineering and Design, 84(2009), 1384-1387
[2] Qi Xu, et al, Journal of Nuclear Materials, 394(2009), 20-25