

### §3. Compatibility of Dip-coated $\text{Er}_2\text{O}_3$ Coating with Liquid Li at Static Condition

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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,  $\text{Er}_2\text{O}_3$  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. The purpose of the present study is to investigate the Li compatibility of an  $\text{Er}_2\text{O}_3$  coating fabricated by the MOD (metal organic decomposition) method with the dip-coating process, which would be suitable for large area coatings on complex shaped blanket components.

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steel; JLF-1: low activation ferritic martensitic Fe-9Cr-2W-0.1C steel) was immersed in MOD liquid precursor and withdrawn at a speed of 200 mm/min, and then dried at 150 °C for 10 min on a hot plate.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

According to SEM observation of the surface, there were some small pores on the surfaces and exfoliation was found around large pores (in Fig.1). Small white portions observed on the coating surface were nickel particles which were dissolved from the crucible.

After the Li corrosion test for 280 hours, small pits were found along the grain boundaries at the substrate surface and small pores appeared at the same positions in the coating layer as shown in Fig. 2. Therefore, defects might be induced in the coating layers along the grain boundaries of the substrate and corroded at first.

The results of XRD spectroscopy indicate some new peaks of corrosion products which were identified to be  $\text{LiErO}_2$  [1] (Fig. 3). The mass loss of the samples after the test was negligible. The  $\text{Er}_2\text{O}_3$  coatings on SUS430 substrates mostly survived after the Li corrosion test.

In contrast, the  $\text{Er}_2\text{O}_3$  coating on the JLF-1 substrate almost disappeared after the corrosion with the same test conditions (Fig.4). It was found by XPS analysis that a thick  $\text{Fe}_2\text{O}_3$  layer was produced as an intermediate layer below  $\text{Er}_2\text{O}_3$  coating during the baking procedure. The oxidation layer between the SUS430 and the coating layer was thin and identified to be  $\text{Cr}_2\text{O}_3$ . This difference of the intermediate layer with the different chemical stability or the different mechanical strength possibly affects the compatibility of the coated materials in liquid Li. In order to improve the stability of the coatings on JLF-1 in Li,

suppression of the substrate oxidation by controlling the baking atmosphere is under study.

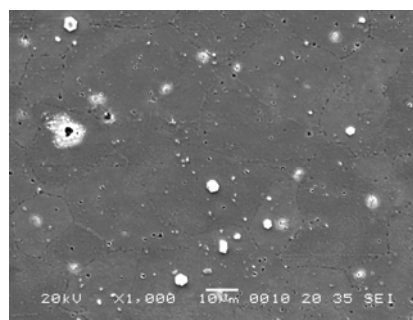


Fig. 1 Surface observation of  $\text{Er}_2\text{O}_3$  coating on SUS430 after Li corrosion for 280 hours

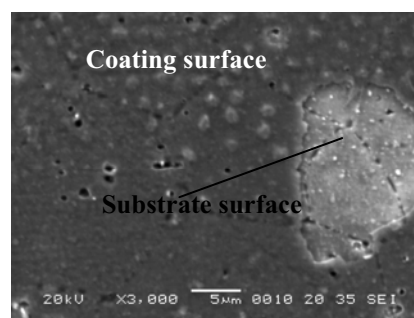


Fig. 2 Pores observation of  $\text{Er}_2\text{O}_3$  coating on SUS430 after Li corrosion for 280 hours

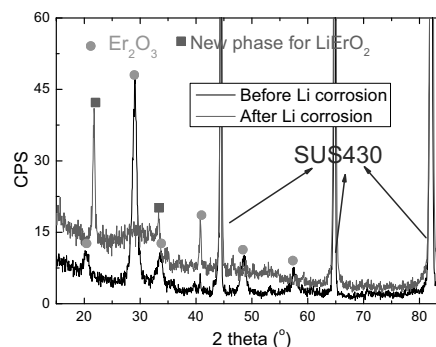


Fig.3 XRD patterns changes of  $\text{Er}_2\text{O}_3$  coating on SUS430 before and after corrosion

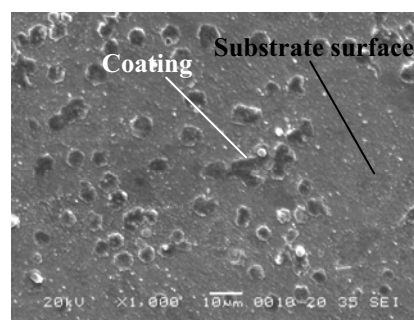


Fig. 4 Surface of  $\text{Er}_2\text{O}_3$  coating on JLF-1 after Li corrosion for 280 hours

- 1) M. Nagura, A. Suzuki, et al.: Fusion Engineering and Design **84** (2009) 1384
- 2) Qi Xu, Masatoshi Kondo, et al.: Journal of Nuclear Materials **394** (2009) 20