## 機能性セラミックス被覆の流動リチウム鉛合金中 腐食挙動

# Corrosion behavior of functional ceramic coatings in flowing lithium-lead alloy

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### 1. Introduction

Ceramic coatings have been investigated as a tritium permeation barrier and shown high permeation reduction performance for the realization of an efficient fuel cycle and the lowest emission of radioactive tritium into the environment from a fusion reactor. In liquid blanket concepts, not only tritium permeation but corrosion of the coatings by liquid tritium breeders such as lithium-lead (Li-Pb) is an unavoidable concern. Recently, the Li-Pb corrosion resistance of the singlelayer and multi-layer coatings was investigated in static conditions [1,2]; however, a limited number of reports investigating in flowing conditions are available. Therefore, in this study, the Li-Pb exposure tests under rotating flow were conducted using the coatings with various layer structures to investigate the effect of layer structure on the compatibility with flowing Li-Pb.

#### 2. Experimental

Reduced activation ferritic/martensitic steel F82H (Fe-8Cr-2W, F82H-BA07 heat) plates were used as substrates. The coating procedure including formation of chromium oxide ( $Cr_2O_3$ ) on the substrate, dipcoating of zirconium oxide ( $ZrO_2$ ) and erbium oxide ( $Er_2O_3$ ) coating precursors, drying, pre-heat treatment, and heat treatment is described in detail in Ref. [2]. The layer structures of the coatings are presented in Fig. 1. The heat treatment was performed every time after dipping, drying, and pre-heating of each layer.

Li-Pb exposure tests under rotating flow were performed using a rotating apparatus at 550 °C for 100– 500 h with a rotating speed of 200 rpm. The samples were fixed to the rotating blades by stainless steel wires. The relative flow velocity on the samples is calculated to be up to 0.06 m/s using a simplified computational simulation. Surface and cross-sectional observations of the exposed samples were conducted by scanning electron microscopy (SEM) with elemental analysis.



Fig. 1 Layer structure of coating samples.

#### 3. Results and discussion

The change in the coating thickness after the Li-Pb exposure is summarized in Table 1. The thicknesses increased by 40-100 % after exposure for 100 h and then decrease by approximately 10 % after 500 h. Cross-sectional observation indicated that a corrosion layer formed on the coating surfaces, leading to the increase in the total thickness of the coatings. Cracks were observed on the surfaces of Samples A and C after exposure for 500 h. In Sample B, swelling of the coating with a growth of iron oxide underneath the coating was observed. Since a similar change in thickness was not confirmed in the static exposure tests for up to 2000 h at 600 °C [2], it was found that corrosion was accelerated by flowing Li-Pb. The results of Li-Pb exposure tests for up to 2000 h will be included in the presentation.

Table 1 Li-Pb exposure time dependence of coating thickness at 550 °C under rotation flow

	Sample A	Sample B	Sample C
Before	300 nm	90 nm	190 nm
100 h	470 nm	170 nm	340 nm
500 h	420 nm	N/A	300 nm

Reference

- [1] M. Matusnaga et al., J. Nucl. Mater. 511 (2018) 534-543.
- [2] E. Akahoshi et al., Fusion Eng. Des. 160 (2020) 111874.