# 23Da07

# セラミック－鉄接合被覆の重水素透過挙動およびリチウム鉛腐食挙動
# Deuterium permeation and Li-Pb corrosion behaviors on ceramic-iron joint coating

法月 亮介[1], 田中 照也[2], 能登 裕之[2], 八木 重郎[3], 菱沼 良光[2], 芦川 直子[2,4], 近田 拓未[1]
Ryosuke Norizuki[1], Teruya Tanaka[2], Hiroyuki Noto[2], Juro Yagi[3],
Yoshimitsu Hishinuma[2], Naoko Ashikawa[2,4], Takumi Chikada[1]

[1]静岡大学, [2]核融合科学研究所, [3]京都大学, [4]総合研究大学院大学
[1]Shizuoka Univ., [2]NIFS, [3]Kyoto Univ., [4]SOKENDAI

## 1. Introduction

For the realization of a sufficient fuel cycle in a fusion reactor, functional coatings have been investigated mainly using ceramics to suppress magneto-hydrodynamic pressure drop, corrosion by liquid tritium breeder such as lithium-lead (Li-Pb), and tritium leakage through structural materials. Our previous studies proved that the Li-Pb corrosion resistance of a ceramic coating in a static condition was drastically improved by covering it with an iron foil, and the sufficient electrical insulation with adhesion to the coating was confirmed by hot pressing [1,2]. However, there is insufficient knowledge about Li-Pb compatibility under flowing conditions and hydrogen isotope permeation of the joint coating with consideration of interfaces. In this study, Li-Pb exposure tests under rotating flow and deuterium permeation tests were conducted for the joint coatings.

## 2. Experiments

Reduced activation ferritic/martensitic steel F82H (Fe-8Cr-2W, F82H-BA07 heat) plates were used as substrates. Zirconium oxide ($ZrO_2$)-iron oxide ($Fe_2O_3$) two-layer coatings were prepared by metal organic decomposition with a dip-coating technique. The coating thicknesses of the $ZrO_2$ and the $Fe_2O_3$ layers were approximately 200 nm and 120 nm, respectively. Subsequently, the coatings were joined with 10-μm-thick iron foils by hot pressing for 0.5 h at 550 ºC and 25 MPa. The coating procedure is described in Ref. [2].

Li-Pb exposure tests under rotating flow were conducted at 550 ºC for 500–1000 h with a rotating speed of 200 rpm. The estimated flow velocity on the samples was 0.52 m/s.

Deuterium permeation tests were carried out for the samples before and after the joining using a gas-driven permeation apparatus in the temperature range of 300–600 ºC.

Surface and cross-sectional observations and structure analysis were conducted by scanning electron microscopy (SEM) with energy dispersive X-ray spectroscopy and X-ray diffraction (XRD).

## 3. Results and discussion

Fig. 1 shows the XRD spectra of the samples after the Li-Pb exposure. The ternary oxides such as $LiFe_5O_8$ were generated on the surface. In the surface SEM observation, a rugged structure was observed after exposure for 500 h, and rounded protrusions were observed after exposure for 1000 h. That indicates corrosion and erosion would proceed during long-term exposure. The Fe layer thickness of the samples after the exposure for 500 h and 1000 h decreased to approximately 9.3 μm, suggesting that the corrosion layer would protect from further thinning of the Fe layer.

In the deuterium permeation tests, the permeation fluxes of the sample before the joining decreased by a factor of approximately 1000 in comparison with that of the substrate after the test at 500 ºC. In the presentation, the permeation behavior after the joining and the effect of interface will be also discussed.

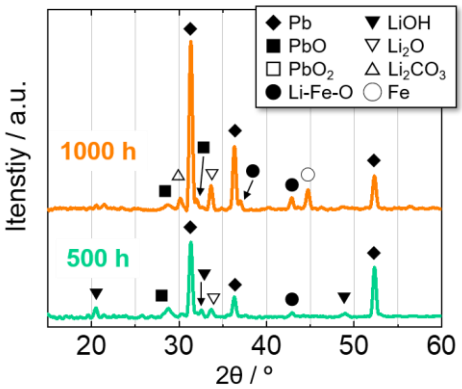


Fig. 1. XRD spectra of joint coatings after Li-Pb exposure tests under rotating flow at 550 ºC for 500–1000 h with flow velocity of 0.52 m/s.

## Reference

[1] S. Horikoshi et al., Nucl. Mater. Energy 16 (2018) 66–70.
[2] R. Norizuki et al., Fusion Eng. Des. 169 (2021) 112438.