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液相法で作製したトリチウム透過低減被覆のリチウム鉛中重水素透過実験

Deuterium permeation experiment through liquid lithium-lead for tritium permeation barrier coatings fabricated by a liquid phase method

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1. Introduction

For the realization of fusion reactor liquid blanket systems, tritium permeation barrier (TPB) coatings on structural materials in a fuel system and blanket components has been studied for several decades. Detailed hydrogen isotope permeation behaviors as well as efficient permeation reduction have been investigated in several materials such as erbium oxide, zirconium oxide (ZrO_2) etc. [1,2]. As a tritium breeding material, liquid lithium-lead (Li-Pb) is a promising candidate due to its higher thermal efficiency by high temperature operation and potential use also as a coolant, while corrosion of the structural materials and TPB coatings should be considered. However, the effect of corrosion of coating materials on hydrogen permeation behavior is not clear. In this study, deuterium permeation measurements for a ZrO_2-coated steel in liquid Li-Pb were carried out to investigate the in-situ Li-Pb corrosion behavior of the TPB coating via deuterium permeation.

2. Experimental

ZrO_2 coating with a thickness of approximately 300 nm on a reduced activation ferritic/martensitic steel F82H plate (25 × 25 × 0.5 mm^3) was prepared by metal organic decomposition, the fabrication parameter of which followed the previous study [3]. Deuterium permeation flux through the sample was detected by a quadrupole mass spectrometer installed in a gas-driven permeation apparatus with the deuterium driving pressure of 10.0–80.0 kPa in the temperature range of 250–550 ºC [3]. The thickness of Li-Pb set in the deuterium-introduced side was about 1 cm (3.8 ml). In this study, the permeation fluxes of the coatings were compared at the driving pressure of 80 kPa, which is the highest driving pressure and then has the smallest effect on surface reactions.

3. Results and discussion

Fig. 1 shows Arrhenius plots of deuterium permeability of the ZrO_2 coating sample through and without Li-Pb. The results of the ZrO_2 coating sample without Li-Pb accorded with the literature values of the permeability. The permeability of the ZrO_2 coating through Li-Pb was lower than that without Li-Pb in the test temperature range. In addition, the permeability of ZrO_2 coating through Li-Pb at 400−550 ºC was lower than that of the literature values. These results suggest that deuterium partial pressure in Li-Pb became lower than the gas phase, and no degradation of the ZrO_2 coating would occur during the permeation tests. Further results and more detail discussion will be included in the presentation.

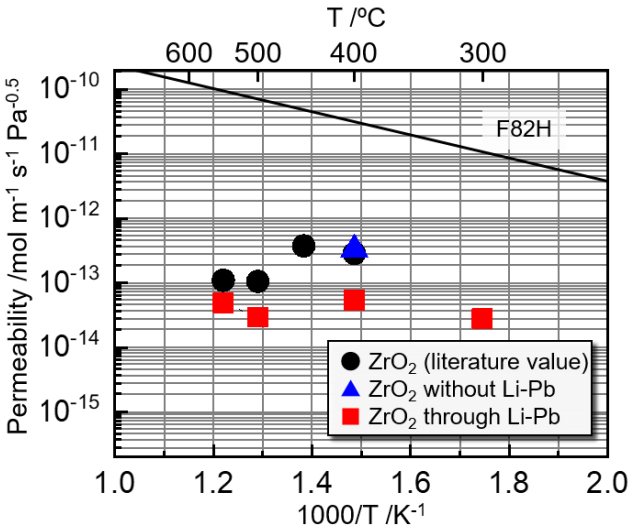

Fig. 1 Arrhenius plots of deuterium permeability of ZrO_2 coating sample through and without Li-Pb.

References

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