§5. Hydrogen Transport through Thin Li-Pb Alloy Film

Yagi, J., Watanabe, T., Tanaka, T., Sagara, A., Muroga, T.

Hydrogen transport characteristic of liquid breeding material is still important issues to be clarified because it has great influence on blanket system design, particularly for tritium recovery and permeation reduction. Thus hydrogen permeation monitoring device for many kinds of liquid breeding material was designed and constructed in FY2012. The photo and overview of the device are shown in Fig.1. In this device, hydrogen solubility in breeding material can be estimated in following two methods. (i) Hydrogen gas is supplied to the liquid breeder contained in a capsule, made from pure Fe for liquid metals or from pure Ni for molten salt, settled in an annular core monitoring the pressure change. Desorption of hydrogen can be quantified as well using QMS during the following evacuation with TMP. (ii)Liquid breeding material sandwiched by two metal plates, made from pure Fe or Ni, is monitored its hydrogen permeation breakthrough when hydrogen gas is fed to their one metal plate surface. Fitting the breakthrough curve with diffusion model, both of hydrogen solubility and diffusivity can be estimated. Method (i) is basically suitable for materials with relatively high hydrogen solubility. Method (ii) with thin liquid thickness can reduce the effect of convection which causes a large discrepancy in the estimation of hydrogen diffusion coefficient.

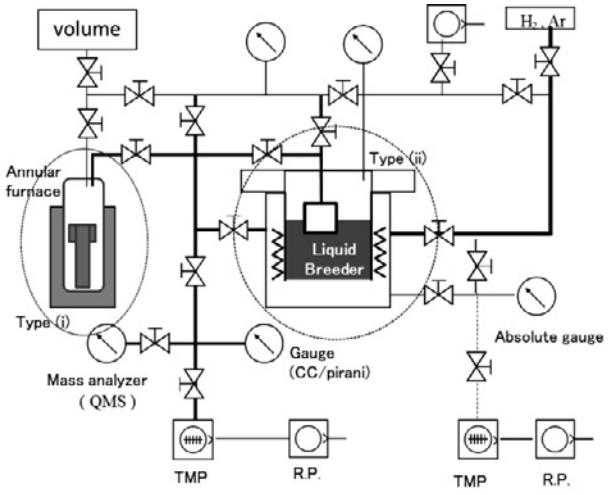

Fig. 1. Overview of the hydrogen permeation device.

Lead lithium alloy (Li0.16Pb0.84, simply written as "LiPb" from now on) has been investigated for its hydrogen isotopes solubility and diffusivity so far with many methods, while the equilibrium pressures for solubility measurement has been usually too high compared to the acceptable reactor condition. Furthermore, hydrogen transport through thin liquid metal film is still unclear which will be very important for the estimation of tritium transport in flowing condition. So that, as a type (ii) experiment, hydrogen transport through 0.5 and 1.0 mm thick LiPb sandwiched by 1.0 and 2.0 mm iron plates (upper/downstream and lower/upstream, respectively) was investigated.

Steady hydrogen permeation fluxes for various upstream hydrogen pressures are plotted in Fig.2 with the reported result by Edao[1](similar experimental setup, 10mm of LiPb and 1.5mm of pure Fe; upstream side only). As shown, hydrogen permeation increases almost linear to the square root of the hydrogen pressure. However, hydrogen permeation is only 2 times larger than that of Edao's result, though the LiPb thickness is ten or more times thinner.

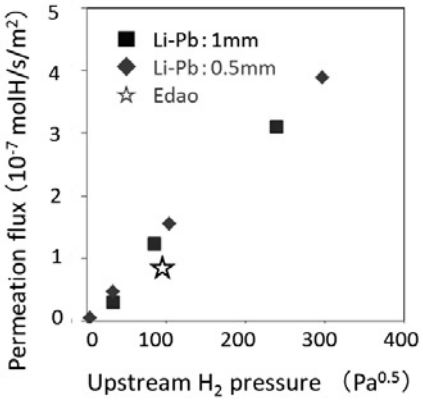

Fig. 2. Steady state hydrogen permeation through Fe/LiPb/Fe system at 773 K.

For further discussion, hydrogen transport model based on diffusion process was constructed. Using the model, fitting of breakthrough curves was performed as Fi.3 to estimate the hydrogen solubility and diffusivity. From the results, hydrogen diffusion coefficient can be much smaller than the reported results. Further experiments are ongoing to discuss precisely.

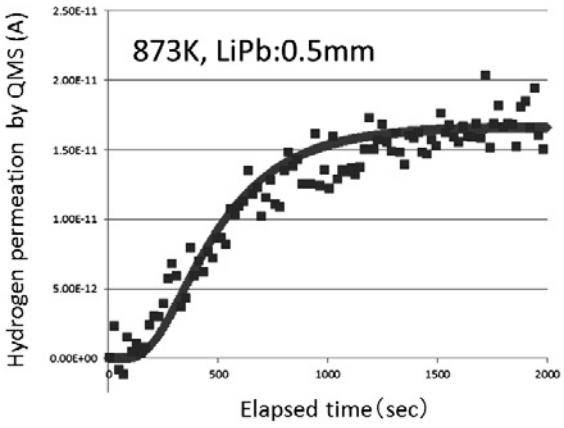

Fig. 3. Breakthrough curve of hydrogen permeation at 873 K with its fitting result by diffusion model

1) Edao et al. : J. Nucl. Mater. **417** (2011) 723