Hydrogen solubility and electrical resistivity measurements of hydrogenated Pb-Li

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Introduction

The eutectic Pb-Li alloy (Li 17at.%) is proposed as liquid breeder material for both ITER test blankets modules (TBMs) and future DEMO reactors. In this view, hydrogen isotopes transport properties in Pb-Li are of great interest for tritium control and confinements. Furthermore, the electrical resistivity of hydrogenated Pb-Li is of concern for the assessment of MHD regimes. So far, the literature reports large discrepancies for the measurements in Pb-Li of both the hydrogen isotopes solubility and the electrical resistivity [1-3].
This work reports the results of hydrogen solubility in Pb-Li in the temperature and pressure ranges 250-450 °C and 20-150 kPa, respectively. Preliminary electrical resistivity measurements have been carried out at 360 °C in Ar and in hydrogen (250 kPa).

Experimental

❖ Technical information

Metal sample → **1955.0 g of eutectic Pb-Li with Li nominal content 0.615 ± 0,016 wt% (15.6 at.%)**

Vol A → **stainless steel of 208.73 cm³**

Vol B → **stainless steel of 72.86 cm³**

Holding sample → **alumina crucible**

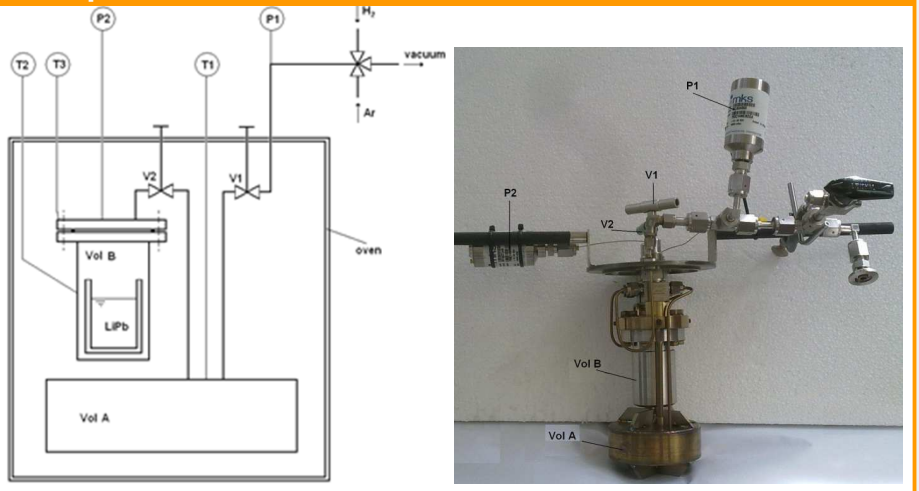

Figure 1 – Experimental set-up: scheme (left) and picture (right).

❖ Solubility measurements

The hydrogen uploading tests have been carried out in the temperature range 250-450 °C by varying the pressure from 20 to 150 kPa. Firstly, the container with the Pb-Li has been vacuum pumped and then filled with a known amount of hydrogen coming from the second container (Vol A). Following tests have been performed by sending further known volumes of hydrogen which increased the pressure (**absorption method**). The amount of hydrogen uploaded into the liquid metal has been calculated by applying the perfect gas law and assessing the lack of hydrogen in the gas phase.

❖ Electrical resistivity measurements

Preliminary measurements of Pb-Li electrical resistivity have been performed at 360 °C under inert gas (Ar) at atmospheric pressure and hydrogen at 250 kPa, respectively.

Results & Conclusions

$$K_S = K_{S0}\, exp\left(\frac{-E_a}{RT}\right)$$

$$K_{S0} = 2.81 \times 10^{-6}\,\frac{H}{M}\,at.frac.Pa^{-0.5}$$
$$E_a = 3792{,}7\,J\,mol^{-1}$$

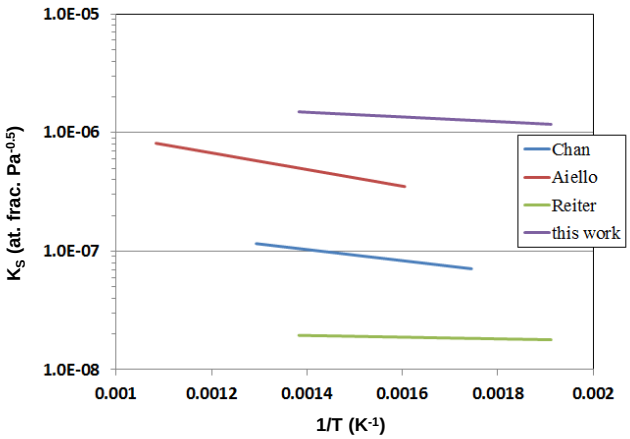

Figure 2 – Sieverts' constant of hydrogen in eutectic PbLi.

Table I – Electrical resistivity of hydrogenated Pb-Li at 360 ℃

Gas	Ω m
Argon	1.28
Hydrogen (at 250 kPa)	1.12

- **the solubility measurements exhibit values of hydrogen solubility in the upper part of the literature review**
- **Preliminary electrical measurements demonstrate a reduction in the resistivity of about 10 % for the hydrogenated alloy**

Future work will investigate the solubility of deuterium in PbLi in order to verify the isotopic effect and will measure the electrical resistivity vs. the hydrogen uploading into the liquid metal.

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[2] F. Reiter, Fusion Engineering and Design 14 (1991) 207-211.
[3] A. Aiello, A. Ciampichetti, G. Benamati, Fusion Engineering and Design 81 (2006) 639.