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$Li_{17}Pb_{83}$中に生成したトリチウムのホットアトム反応によるLiTの形成
Formation of lithium-tritiate by hot atom reactions of tritium produced in $Li_{17}Pb_{83}$

[1]奥野健二、[1]小林真、[2]山西敏行、[1]大矢恭久
[1]Kenji Okuno, [1]Makoto Kobayashi, [2]Toshiyuki Yamanishi and [1]Yasuhisa Oya

[1]静大理放射研、[2]原子力機構
[1]Shizuoka Univ. [2]JAEA

A blanket concept using lithium–lead ($Li_{17}Pb_{83}$) eutectic alloy is considered as one of the promising liquid state blanket systems for fusion reactors. The tritium inventory in $Li_{17}Pb_{83}$ eutectic alloy has been estimated to be negligibly small due to its low tritium solubility, which was determined by thermal doping methods. However, there could be a possibility of LiT formation in the neutron-irradiated $Li_{17}Pb_{83}$ alloy by a hot atom reaction of tritium, resulting in enhancement of its tritium inventory. There have been few reports about the formation of LiT in neutron-irradiated $Li_{17}Pb_{83}$ alloys. In the present study, thermal neutron irradiation for the $Li_{17}Pb_{83}$ eutectic alloy was carried out in the KUR reactor at Kyoto University with the thermal neutron fluence of 3.1×10^{15} n cm^{-2}, and JRR-3 at JAEA with the thermal neutron fluence of 3.3×10^{16} n cm^{-2} at ambient temperature to produce hot tritium into the alloy. The deuterium gas exposure was also performed to introduce deuterium under thermal-equilibrium. The release behaviors of both hydrogen isotopes were evaluated by Thermal Desorption Spectroscopy (TDS) under the heating rate of 5 K/min. Comparing both the TDS results, the possibility of hot atom reactions of tritium produced in the $Li_{17}Pb_{83}$ eutectic alloy was investigated.

Figure shows the TDS spectra of hydrogen isotopes for $Li_{17}Pb_{83}$ exposed to D_2 gas or irradiated with thermal neutron. It was observed that a major release stage of hydrogen isotopes was appeared in the temperature region just a little higher than the melting point (508 K) of the $Li_{17}Pb_{83}$ alloy. Major hydrogen isotope release was found to be governed by diffusion process in the liquid phase of $Li_{17}Pb_{83}$. The tritium and deuterium diffusion coefficients agreed with each other and the literature values. The deuterium solubility was also determined as $S = 6.56 \times 10^{-7} \exp(-0.11\ [eV] / kT)$ [at. fr, $Pa^{0.5}$], from the results for deuterium gas exposure experiments. An additional tritium release stage was observed around 600 K, for the thermal neutron-irradiated alloy while no deuterium release was found in the same temperature region for the thermally doped alloy. The amount of additional tritium release was about 5% of total tritium. From the kinetic analyses for the additional release peak, the activation energy of tritium release at 600 K was determined to be about 1.4 eV, which is almost consistent with the decomposition energy of LiH, showing that LiT could be formed in the $Li_{17}Pb_{83}$ eutectic alloy by hot atom reactions of tritium produced by the nuclear reactions. It is, therefore, important to consider the possibility of the formation of LiT to estimate tritium inventories in $Li_{17}Pb_{83}$ blanket systems. Especially, in the liquid state of $Li_{17}b_{83}$ under the operation temperature, LiT would be the major source of tritium retention in Li-Pb system and the tritium inventory would be underestimated with regardless of the formation of LiT.

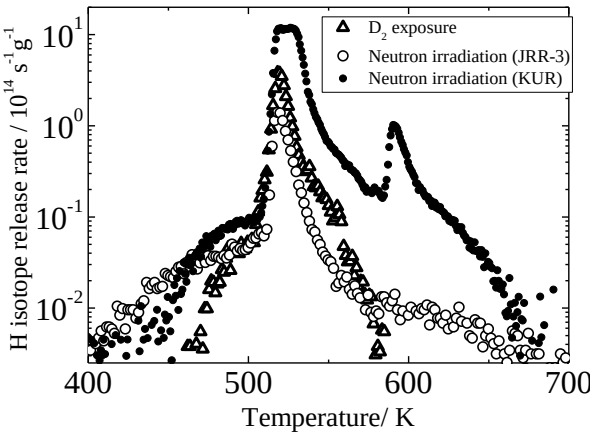

Fig. TDS spectra of hydrogen isotopes released from $Li_{17}Pb_{83}$ exposed to D_2 gas or irradiated with thermal neutron