Contribution ID: **368** Type: **Poster**

Deuterium transport and retention in a liquid metal Gallium under steady state plasma bombardment

Wednesday 7 June 2017 13:40 (2 hours)

Power and particle handling in the plasma edge region is one of the critical issues, affecting the successful operation of a steady state magnetic fusion power reactor. Tungsten has widely been employed for plasma-facing components in existing fusion experiments and is envisaged to be used for the ITER divertor [1]. Unfortunately, conventionally available tungsten is known to suffer from cracking due to its high DBTT. The use of liquid metals has been proposed and implemented in a number of medium-sized confinement devices. Liquid lithium covered divertor was tested on NSTX, and continuously flowing liquid lithium limiter with a loop was performed in EAST, both of which yielded improved plasma performance. Free-falling liquid gallium drops were tested on the T-3M and ISTTOK tokamaks, where no severe effects on the main plasma parameters have been found.

Hydrogen isotopes transport in plasma facing metals is essential to study hydrogen recycling, tritium retention, and tritium recovery. While hydrogen isotopes transport and retention in solid plasma facing materials have been studied in detail, very few information is available for liquid metals. To evaluate these properties for liquid metals, a new technique for the plasma-driven permeation (PDP) experiment has been developed, by holding a liquid metal on a sheet mesh with surface tension. This technique has been verified with a low melting point liquid metal alloy Ga67In20.5Sn12.5, and hydrogen and deuterium diffusivity, surface recombination coefficients have been obtained [2].

In the present work, deuterium PDP experiments for gallium have been conducted in a laboratory-scale linear plasma device, VEHICLE-1. In these PDP experiments, the ion bombardment flux is set of the order of 10ˆ16 cm-2s-1. A liquid metal sample is fixed in such a way that the upstream surface is exposed to deuterium plasma, while the downstream side is pumped to ultrahigh vacuum (10ˆ-6-10ˆ-5 Pa). The depth of the liquid metal is about 4mm. Deuterium diffusivity and surface recombination coefficients have been obtained by fitting the permeation breakthrough curves. After PDP, deuterium retention in the gallium sample is measured by TDS (Thermal Desorption Spectroscopy). Detailed results will be presented and discussed in the conference.

[1] Y. Hirooka.et al, Fusion science and technology, Vol.68, 477-483(2015)
[2] H. Bi .et al, A study on hydrogen isotopes transport in a liquid metal GaInSn by plasma-driven permeation method, paper presented at 22nd PSI conference, Rome, 2016

Eligible for student paper award?

Yes

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Session Classification: W.POS: Poster Session W

Track Classification: Plasma facing components