

ガス曝露水素同位体交換反応によるタングステン中に滞留したトリチウムの除去

Removal of tritium retained in tungsten through hydrogen isotope exchange reaction by gas exposure

戸荻陽大¹、植村有希²、桜田翔大²、藤田啓恵²、東奎介²、周啓来¹、
波多野雄治³、矢嶋美幸⁴、時谷政行⁴、増崎貴⁴、近田拓未⁵、大矢恭久⁵
TOGARI Akihiro¹, UEMURA Yuki², SAKURADA Shodai², FUJITA Hiroe², AZUMA Keisuke²,
ZHOU Qilai¹, HATANO Yuji³, YAJIMA Miyuki⁴, TOKITANI Masayuki⁴, MASUZAKI Suguru⁴,
CHIKADA Takumi⁵, OYA Yasuhisa⁵

¹静大理、²静大院理、³富山大水素研、⁴核融合研、⁵静大学術院理

¹Faculty of science, Shizuoka University,

²Graduate School of Science and Technology, Shizuoka University,

³Hydrogen Isotope Research Center, University of Toyama

⁴National Institute for Fusion Science

⁵College of Science, Academic Institute, Shizuoka University,

1. Introduction

The tritium inventory in fusion devices is one of the important concerns for their safe operation. Due to the good thermal/mechanical properties, tungsten (W) is regarded as the leading candidate for a plasma facing material (PFM). W will be irradiated by high flux, low energy deuterium (D) and tritium (T) particles during plasma operations. Also, the layer of impurities like carbon and sputtered metal particles will be deposited to PFMs. As a result, considerable amount of T will be retained in W material. To remove retained T, hydrogen isotope exchange is proposed. In this experiment, W samples with carbon and W mixture layer were prepared by plasma-enhanced chemical vapor deposition (PECVD) to reproduce the impurity of PFMs after plasma operations, and exposed to T/D gas sequentially. After the exposure, thermal desorption spectroscopy (TDS) was applied to evaluate the remaining D / T retention characteristics.

2. Experimental

Polycrystalline W (10 mm^φ × 0.5 mm^t) purchased from A.L.M.T. Co. Ltd was used as samples. The samples were heat-treated at 1173 K for 30 min under ultrahigh vacuum (< 10⁻⁶ Pa). After the heat treatment, a C-W mixture layer was deposited by PECVD at the pressure of 25 Pa, with the power of 100 W by using methane and tungsten hexacarbonyl as reagent gases. X-ray photoelectron spectroscopy (XPS) was applied to characterize the surface chemical state. After the deposition, the sample was heated to 573 K to remove unreacted reagent.

T₂ gas exposure was performed at 573 K at around 100 Pa. After that, D₂ gas exposure was performed at various temperatures at around 100 kPa. TDS was performed from room temperature (R.T.) to 1173 K

at the ramp rate of 30 K/min. H₂, HD, D₂ gases were analyzed by a quadrupole mass spectrometer (QMS). T₂ gas was analyzed by proportional counters. Released T was oxidized by using CuO catalyst, collected by bubblers, and analyzed by liquid scintillation counter (LSC).

3. Results & discussion

Fig.1 shows the XPS spectra for a C-W layer deposited tungsten. The peak around 34 eV corresponds to W oxide, and 32 eV to W metal. It can be said that the film deposits produced by PECVD mainly consists of tungsten oxide as a W impurity.

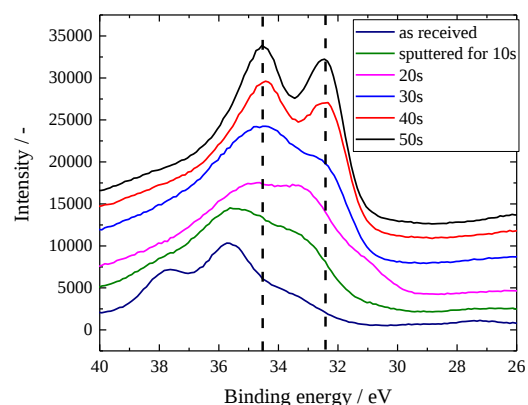


Fig. 1 XPS spectra for PECVD processed tungsten.

At the deeper region of the layer, C and W intensity was increased although O intensity was decreased. This indicates that the carbon or carbide are major chemical states at the interface between W substrate and the film.

In this presentation, T removal effect by D exposure at various temperatures will be discussed.