§40. Hydrogen Isotope Retention Behavior on the Surface of Metal-carbon Mixture Layer under Carbon, Hydrogen Isotopes and Helium Simultaneous Irradiation Circumstance

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1. Introduction

On the surface of plasma facing components, it is important to elucidate the dynamics of hydrogen isotope behavior under simultaneous ions implantation conditions, especially carbon, hydrogen isotopes and helium ions. This study motivates us to reveal the fundamental interaction mechanism of carbon and hydrogen isotopes on the metal surface for the establishment of hydrogen recycling processes. In this fiscal year, a simultaneous ion implantation system was developed at Shizuoka University and preliminary experiments using carbon (C^+) and deuterium ions (D^+) implantation in tungsten were performed as a function of ion implantation sequences. In addition, these results were compared to that for only D_2^+ implanted tungsten carbide (WC).

2. Experimental procedures

Simultaneous C^+ and D_2^+ implantation and sequential C^+ and D_2^+ implantation experiments were carried out onto the preheated tungsten (W) sample at the simultaneous ion implantation system. The chemical states of W and C on the sample surface before and after each ion implantation were evaluated by XPS measurements and the retention behavior of D and desorption were studied by TDS from room temperature up to 1200 K with the heating rate of 0.5 K s^{-1}.

3. Results and discussion

Figures (a) and (b) show D_2 TDS spectra for tungsten after simultaneous C^+ and D_2^+ implantation and sequential C^+ and D_2^+ implantation, respectively. The desorption temperature region of D was found to be from 350 K to 1300 K for both samples. It was found from the peak analysis using Gaussian distribution function that the D_2 TDS spectra consisted of four stages. From comparison to D_2 TDS spectra for the tungsten carbide and highly oriented pyloritic graphite, D was found to be trapped by interstitial site and carbon, forming C-D bond (sp^2 hybrid orbital and sp^3 hybrid orbital type). The D retention for the simultaneous implanted tungsten was less than that for the sequential implanted one. From the C-1s XPS spectra, it was revealed that C-C (284.6 eV) and C-W (282.7 eV) bonds were formed in C^+ implanted tungsten. On the other hand, the peak position of C-1s for tungsten with simultaneous C^+ and D_2^+ implantation was slightly shifted toward lower energy side, that is, the amount of C-C bond was less than that of C^+ implanted tungsten. These results indicated that C-C bond could be interacted with implanted D_2^+ during ion implantation.

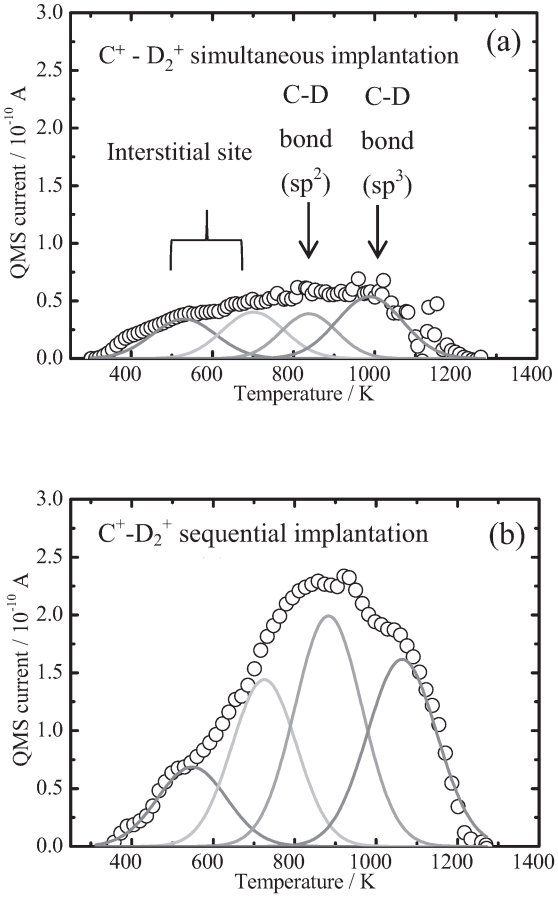

Fig. D_2 TDS spectra of C^+ and D_2^+ (a) simultaneous implanted tungsten and (b) sequential implanted tungsten.