§20. Surface Compositional Changes of Bulk-Boronized Graphite under Helium Ion Bombardment

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The surface compositional changes of bulk-boronized graphite caused by helium ion bombardment have been measured by an Auger-electron-spectrometer (AES). The concentrations of boron at surface have decreased against initial value under 1 keV helium ion bombardment. However, in the case of 3 keV helium ion bombardment, the apparent reduction of boron concentration at surface has not been observed.

In this investigation, the 30 % boulk-boronized graphite (Toyo Tanso GB-130) was used. The ion beam currents on the target are measured with a digital pico-ampere meter and the fed to a personal computer (usually 19 μ A/cm^2 with helium ions). The surface condition is measured by an Auger-electron-spectrometer in the analysis chamber. All present experiments have been performed at room temperature.

In fig.1, the present experimental results for 1 keV and 3 keV helium ions are shown. In the case of 1 keV helium bombardment, it is found that concentrations of boron increase as the incident ion fluence increases in the low fluence region and above a critical ion fluence gradually decrease approaching a constant value which is less than 30 %. In 3 keV helium bombardment, it is noticed that the concentration of boron increases and above a critical ion fluence starts to go down similarly to the case of 1 keV helium ions. However, at high ion fluence region, concentration of boron seems to be almost constant around 32%, indicating that there is no surface compositional changes.

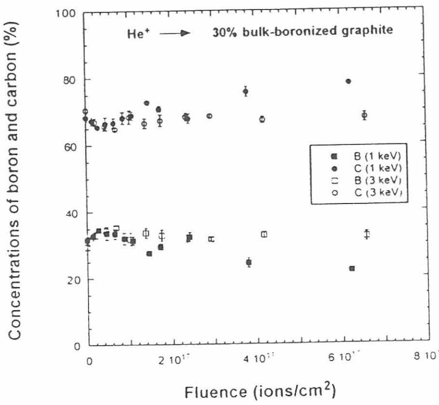

Fig. 1. The fluence dependence of concentrations of boron and carbon induced by 1 keV and 3 keV helium ion bombardment.

In order to understand experimental results, the ACAT-DIFFUSE (ver.2000) has been applied[1]. The simulation had been carried out the same condition for experiment. As concerns the diffusion of carbon, boron and helium atoms in this target, the diffusion coefficients[2,3,4] for pure carbon graphite are adopted for this calculation, as the boron concentration is much less than carbon concentration in the present case. These diffusion coefficients are summarized in Table 1(a). Furthermore, the trap energy[5] of helium atom in the pure carbon graphite are applied to it in this target. This trap energy is shown in Table 1(b). Figure 2 shows simulation results for the surface compositional change of 30 % boulk-boronized graphite under 1,3 and 10 keV helium ion bombardments as a function of fluence. It is shown that the boron concentration is decreased by helium ion bombardment because the surface binding energy of boron atom is lower than that of carbon atom. It noticed that the final constant values of boron concentration increase as kinetic energies of incident helium ion increase. In the case of light ion sputtering, the preferential sputtering is suppresses with increase of the kinetic energy of projectile ions[6]. This is why the final constant value of boron concentration depends on the incident energy of projectile.

From comparison between experimental and simulation results, it is found that the surface compositional change depend on the incident energy of projectile. On the other hands, where the behavior of boron concentration at low fluence is concerned, there are large disagreement between the experimental and simulation results. More systematic studies need to understand this disagreement.

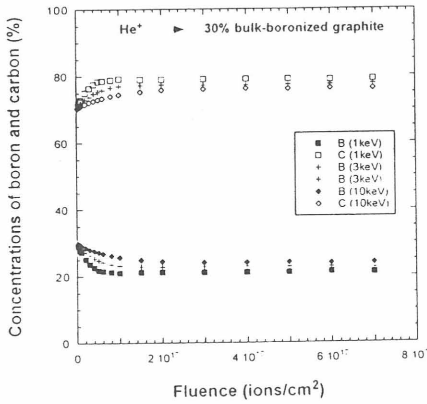

Fig. 2 . The simulation results of concentrations of boron and carbon induced by helium ion bombardmentas a function of the fluence.

Table 1(a) Diffusion coefficients of carbon, boron and helium atom in graphite

	D_0 (cm^2/s)	activation energy (eV)	Reference
carbon	4.9	7.07	[2]
boron	6320	6.8	[3]
helium	0.09	1.1	[4]

Table 1(b) Trap energy of helium atom in graphite

Traped particle	Matrix	Trap energy (eV)	Reference
helium	graphite	1.6	[5]

Reference
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4)P.Jung et al.:J.Nucl.Mater. **185**(1991)149
5)Hino, Tet al.: J. Nucl. Mater. **266-269**(1999)538.
6)T. Ono et al.: J. Nucl. Mater. **232**(1996)52