§17. Dynamical Simulation for Sputtering of B_4C Material under Ion Beam Irradiation

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Using the ACAT-DIFFUSE code[1] , we tried to calculate compositional change near the surface of B_4C material during D^+ ion irradiation at normal or grazing incidence. The ACAT-DIFFUSE code is a simulation code which is based on a Monte Carlo method with the binally collision approximation and on solving diffusion equation. This simulation was performed with incident beams of D^+ ions of several energies (50,80,200eV) of an ion flux of 1.0×10^{18} ions/cm²/sec. In this paper, we present a simple explanation of the ACAT-DIFFUSE code and some examples of the result.

The ACAT-DIFFUSE code includes both kinetic processes and thermal processes which take place during ion bombardment . In the ACAT-DIFFUSE code the total dose Φ is divided into enough small dose $\Delta\Phi$ during which the bombarded ions do not change the target composition appreciably. Here, the ions corresponding to $\Delta\Phi$ are assumed to hit the target altogether and be slowed down instantaneously. Their slowing down , the associated vacancy and range distributions are calculated by the ACAT routine of ACAT-DIFFUSE code. These thermalized particles diffuse during the time interval of $\Delta\Phi/J$ (J being the ion flux). The diffusion process is estimated by solving the diffusion equations numerically in the DIFFUSE routine of ACAT-DIFFUSE code. These procedures are repeated n times , where $n = \Phi / \Delta\Phi$. The logical representation of the ACAT-DIFFUSE code is as follows :

$$\text{ACAT-DIFFUSE} = [(\text{ACAT}) + (\text{DIFFUSE})]^n , \qquad (1)$$

When ion beams bombard a B_4C material, Boron tend to preferentially be sputtered from the surface . In the room temperature, this tendency was obtained remarkably at normal incidence of incident energy below 100eV , but this tendency becomes not so match remarkable at a incidence energy of above 200eV. When B_4C material is bombarded with D^+ ion, the surface composition of the steady state of bombarding differ from one of the surface composition of no bombarding at lower incident energy as a result of this tendency. Figure 1 shows the dependence of incident energy on the steady state surface ratio. Moreover, we calculated total sputtering yields at normal and grazing incidence with several energies (50,80,200eV). In these cases, total sputtering yield of grazing incidence is larger than those of normal incidence. This tendency results from different mechanisms of right ion sputtering at normal and grazing incidence. Figure 2 shows total sputtering yield with 50eV D^+ ions.

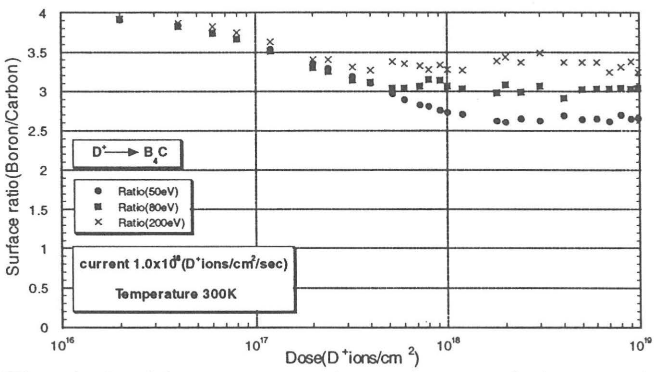

Fig. 1. Incident energy dependence of the steady steady state surface ratio.

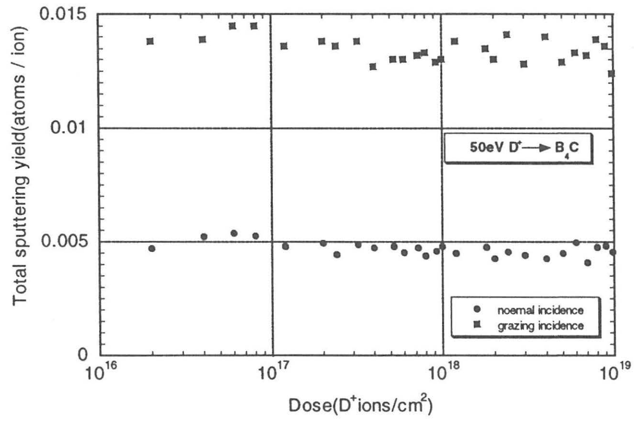

Fig. 2 Total sputtering yield with 50eV D^+ ions at normal and grazing incidence.

1) Takiguchi, T., Ishida, M., Yamamura, Y., Radiat.eff.130-131 (1994) 387
2) Ono, T., Kawamura, T., Ishi, K., Yamamura, Y., J.Nucl.Mater. 232 (1996) 52.