Irradiation characteristics of unidirectional magnetic field-applied fast atom beam source for surface-activated bonding

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Abstract

In surface-activated bonding (SAB), the surfaces of the materials to be bonded are activated by fast atom beam (FAB) irradiation in a vacuum, and then they are brought into contact with each other to achieve room-temperature and low-pressure bonding. The conventional FAB source, which is used for SAB, can be used for only short time due to bonding failures caused by carbon particle adhesion to the bonding surface. By applying magnetic fields in a bidirectional manner, we have successfully controlled the motion of charged particles in the plasma. This has resulted in highly efficient Ar-FAB irradiation and reduction in the wear of the inner carbon walls caused by Ar^+ ion sputtering.

We developed a unidirectional magnetic field-applied FAB source to meet a growing need in recent years for a beam source that can irradiate a larger area. A unidirectional magnetic field was formed near the irradiation port to realize large-area irradiation by increasing length and size of the FAB source. The evaluation of the irradiation characteristics of the proposed FAB source confirmed the improvement of etching rate and the distortion of irradiation distribution. Non-uniform etching increases the surface roughness of the bonded material surface, leading to decrease in bonding strength. In this study, we worked on relieving the distortion of the etching distribution and further improving the performance of the unidirectional magnetic field-applied FAB source by modifying the applied magnetic field.

The distortion was improved by forming a uniform unidirectional magnetic field inside the FAB source, suggesting the possibility of irradiating a large area by enlarging the irradiation port. It was also found through plasma simulations and experiments that there is an optimal magnetic field strength that maximizes the carbon particle reduction performance while maintaining stable operation of the proposed FAB source.

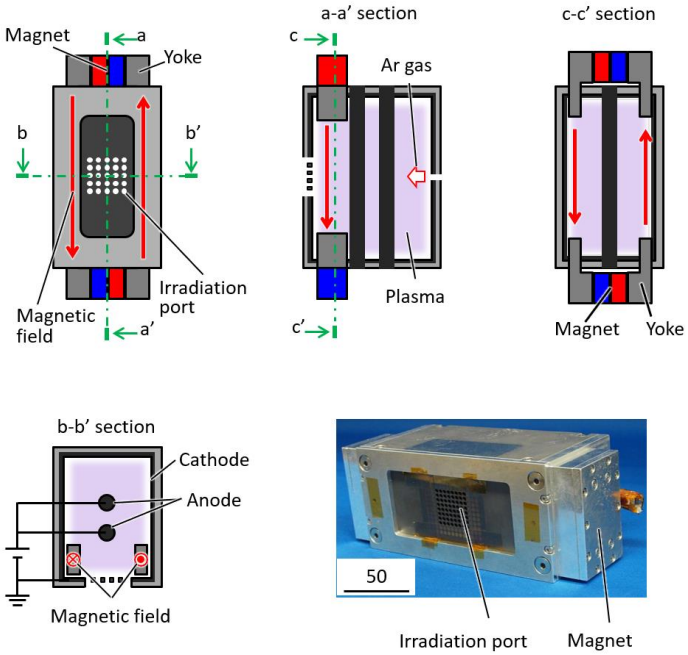

Figure 1: Structure and appearance of bidirectional magnetic field-applied FAB source

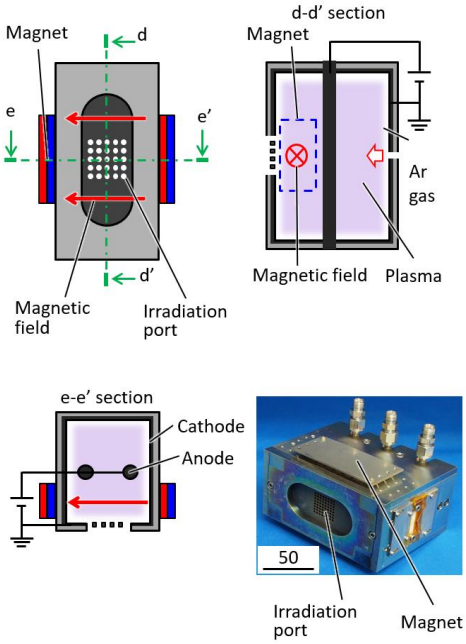

Figure 2: Structure and appearance unidirectional magnetic field-applied FAB source