講演番号をこちらに

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表面活性化接合用新形高速原子ビーム源の照射特性

Irradiation characteristics of a new fast atom beam source for surface activated bonding

森崎 諒[1)]，山崎 貴大[1)]，岡 智絵美[1)]，櫻井 淳平[1)]，
赤尾 隆嘉[2)]，高橋 知典[2)]，辻 裕之[2)]，大野 哲靖[1)]，秦 誠一[1)]
R. Morisaki[1)], T. Yamazaki[1)], C. Oka[1)], J. Sakurai[1)], T. Akao[2)], T. Tomonori[2)], H. Tsuji[2)], N. Ohno[1)], S. Hata[1)]

[1)]名古屋大学大学院工学研究科，[2)]日本ガイシ株式会社
[1)]Nagoya University, [2)]NGK INSULATORS, LTD.

1. Introduction

Surface activated bonding (SAB), which is a room temperature bonding method, is used as a packaging technology in the manufacture of semiconductor devices because it achieves a bonding strength equivalent to that of the bulk materials and enables the bonding of heterogeneous materials[1]. In the SAB method, contaminants such as the natural oxide layer on the surface of the material to be bonded are removed by fast atom beam (FAB) irradiation, and the bonding is achieved by contacting the obtained active surfaces. In our previous study, we developed a new FAB source for use in SAB and found that it achieves a higher etching rate than that of a conventional FAB source by generating high-energy Ar^+ and Ar[2].

SAB uses neutral beam irradiation to remove contaminants, preventing charge-up in the bonding materials and electrical damage to the devices. In a previous study, it was reported that Ar^+ ions in the Ar plasma generated inside a conventional FAB source were neutralized by charge exchange and surface recombination inside and outside the source, and that the neutralization ratio of the irradiated Ar-FAB was over 90%[3]. However, the irradiation characteristics of FAB from the proposed FAB source in our previous study have not been studied yet. In this study, we investigated the beam irradiation characteristics of the proposed FAB source.

2. Experiments

The beam irradiation characteristics of the proposed FAB source were analyzed by irradiating Ar-FAB onto a planar probe and measuring the ion current flowing into the probe. The probe can be driven in the irradiation direction. The Ar^+ neutralization process outside the source was estimated from the dependence of the irradiation distance x, and the diffusivity of Ar-FAB was evaluated from the spatial distribution of the ion current in the vertical direction y of the FAB irradiation direction. Particle-in-cell-Monte Carlo simulation of Ar plasma generation and transportation inside and outside the FAB sources were used to compare the neutralization rate and beam size of Ar-FAB irradiated from the conventional and new FAB sources, and the applicability of the proposed source to the bonding equipment was discussed.

3. Summary

Figure 1 shows the ion current measurement results. The ion current increased with increasing irradiation distance, became constant, and then decreased monotonically. Near the irradiation aperture, electrons are contained in the Ar-FAB, and the ion current increases with decreasing electron inflow as the irradiation distance increases. In the region of constant ion current, the decreasing effect of Ar ion diffusion is equivalent to the increasing effect of ion current due to the easy capturing of low energy Ar ions generated by inelastic collision by the electric field on the probe surface. This indicates that the charge exchange reaction, which is a neutralization reaction of Ar ions, occurs frequently in this region. The monotonic decrease of the ion current is caused by the diffusion of low energy Ar ions by Coulomb repulsive force.

The diffusivity of Ar-FAB irradiated from the proposed FAB source and the simulation results will be described in the presentation.

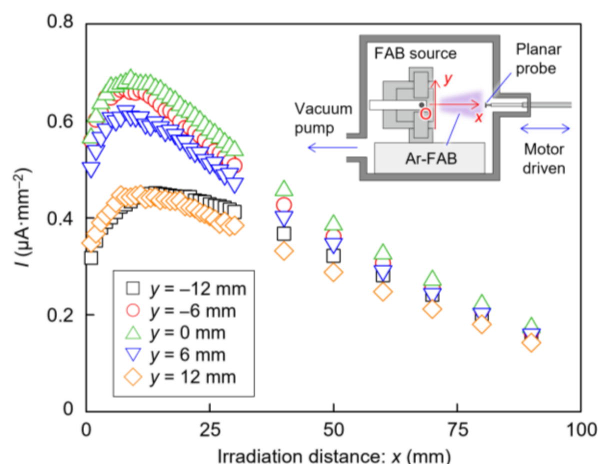

Fig.1 Dependence of ion current in Ar-FAB irradiated from a proposed FAB source on irradiation distance and spatial distribution in the vertical direction.

References

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