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Changes in the angular dependence of SiO2 etch rates with bias voltage in a C4F8 plasma

Chang Jin Park, Chang-Koo Kim

Ajou university, Suwon, South Korea

plack99@ajou.ac.kr

Plasma etching is widely used to etch SiO_2 in the fabrication of integrated circuits (IC). Because the etch rate is strongly dependent on the angle between the incident ion and the substrate surface, it is essential to understand the angular dependence of the SiO_2 etch rates. To obtain the angular dependence of etch rates, the angle between the incident ion and the substrate surface needs to be precisely controlled. In a conventional plasma etching process, a sheath is formed along the surface of the substrate. The direction of ions incident on the substrate is vertical to the surface of the substrate irrespective of the angle of the substrate. Accordingly, the ion-incident angle is not controlled in a conventional plasma etching system.
In this work, the angular dependence of SiO_2 etch rates in a C_4F_8 plasma was investigated using a Faraday cage system. A Faraday cage is simply a closed box of a conductor, having a grid on the top plane. Because the Faraday cage formed a closed box, the electric potential in the cage was uniform and unaffected by outside electric fields. Therefore, the ions traveling inside the cage maintained their initial direction. The etching was carried out in an inductively coupled plasma system. The substrate was a SiO_2 film deposited on a p-type Si substrate. The discharge gas was C_4F_8. The bias voltage applied to the substrate was varied to investigate the effect of the bias voltage on the angular dependence of SiO_2 etch rates. The angular dependence of SiO_2 etch rates was correlated with changes in thickness and F/C ratios of the steady-state fluorocarbon films formed on the surface of SiO_2.

Keywords
Oxide etching
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