

Defect-free Carbon based EUV Pellicle by using Bi-layer Capping with Atomic Layer Deposition

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For several decades, semiconductor device scaling down has been steadily progressing. Therefore, lithography technology has also been developed to engrave smaller patterns into circuits. Extreme ultraviolet lithography (EUVL) technology which uses a wavelength of 13.5 nm, which is significantly shorter than conventional lithography, has emerged as a solution. However, the increased light source power of EUV causes the chamber to become harsher and high temperature. These conditions accelerate mask damage and require frequent mask replacement. So, as EUV equipment advances, demand for pellicle increases.

Carbon-based pellicles are considered as EUV pellicle materials because they have high transmittance, good thermal stability, high emissivity, and good mechanical properties. However, they have low durability against hydrogen plasma in EUV equipment, so a capping layer is essential. Therefore, in this study, we attempted to deposit a very thin and uniform film of MoN with low EUV absorption coefficient and H₂ plasma durability through ALD. However, plasma pre-treatment or PEALD was required to perform ALD on graphite with an inert surface, which caused graphite damage.

In this study, we greatly improved the adsorption using physisorption on the graphite surface at high precursor vapor pressure. An oxide thin film less than 2 nm was deposited as the first layer, and the coverage was confirmed by comparing the I_d/I_g peak ratio of Raman spectrum before and after H₂ plasma treatment. After full coverage of the oxide thin film, a defect-free graphite capping layer was successfully deposited by depositing a MoN film less than 5 nm. Next, we conducted a characteristic evaluation as an EUV pellicle. Our research will be a basic experiment for a carbon-based pellicle capping layer.

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