Post Charge Separation Grid Ion Flux Evaluation in Inductive Coupled Plasma Source Downstream Asher

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With semiconductor device shrink and gate dielectric thickness decrease, the potential for device damage at the photoresist strip level increase. It is desired to develop the downstream plasma asher producing high active radical concentration with low ion concentration while still maintaining excellent ash rate for different strip application. Therefore, it is critical to understand the population of charge species that can reach the wafer surface. In this study, an inductive coupled plasma (ICP) source with patented grounded Faraday shields is used [1], which offers superior resist strip capability to leading edge memory, logic and foundry applications. Faraday shield is used to reduce ion energy and electron temperature from plasma generation to obtain the better plasma damage performance. To further reduce the ion concentration on the wafer surface, charge separation conductive grid [2] is also added between the top plasma source and heated pedestal. By optimizing grid pattern, uniform gas and radical distribution can be obtained, thus the wafer uniformity can be improved. Ion flux underneath the grid are evaluated with different diagnostic tools to evaluate the grids effect including Langmuir probe and Retarding Field Energy Analyzer. The Langmuir probe with plasma detect limit 10^8 cm-3 is inserted plasma at 1cm above the pedestal is used to detect the ion flux underneath the grids. RFEA (Retarding Field Energy Analyzer) is equipped on the pedestal, which measures ion energy and ion flux directly. Both the diagnostics tools show that ion density is below the detection limit after charge separation grid. To further characterize the grid effect, one self-made thick probe with length 10mm and diameter 3.8mm inserted to the plasma with biased at negative voltage to measure ion saturation current, Pico amp accuracy ammeter is used to measure the collected current. It is found that grid dramatically reduce the ion saturation current, one thousandth of ion saturation current at Oxygen plasma detected under double grids compared to no grid condition. Different plasma chemistry and different grid are also evaluated.

[1] Stephen E. Savas, Brad S. Mattson, Martin L. Hammond, Steven C. Selbrede, Patent US 6143129

[2] Stephen E. Savas, Brad S. Mattson, Patent US 5811022