Electrostatics and Airborne Particle Control to Minimize Deposition onto Wafers

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Abstract— **As 33 nm and 22 nm technology nodes move from development phases to full scale manufacturing, wafers contamination control becomes increasingly important. Nanoparticles, with diameters between 16-40 nm can be cause IC defects. Further, cleaning these particles from a wafer surface is problematic because cany destroy fragile structures. 3-D design of new wafer generations makes nano-contamination particularly damaging.**

The focus of this paper is that

(1) airborne nanoparticles concentrations in semiconductor tools and

(2) electrostatic field intensities of charged wafers should be considered together to understand and estimate deposition velocities.

First, as the concentration of airborne nanoparticles near the wafer decreases, the probability of deposition onto the wafer decreases. Second, electrostatic attraction of charged nanoparticles is the dominant deposition mechanism. Electrostatic attraction is roughly 100 times more important than particle diffusion or impaction.

Analysis and control of nanoparticles (particularly, 10-50 nm) differs from the control of particles greater than 100 nm. When the technology node was at 180 nm, laser particle counters with 100 nm (0.1 micrometer) sensitivity provided reasonable information on defect-causing particles. And controlling electrostatic fields below about 250 volts per cm was normally sufficient. For 45 nm technology, 100 nm particle counters no longer sufficient, since killer particles are below the detection threshold. And electrostatic fields below 50 volts per cm affect nanoparticle deposition rates. For a given charge density, small particles move faster than large particles in an electrostatic field.

Measurement of 10 nm particles and the electrostatic field intensity guidelines of SEMI E78-0309 are recommended. Semiconductor equipment that passes a test at 10 nm has an extended lifetime that ranges from the 90 nm technology node to the 22 nm technology node, provided that the E78-0309 guidelines are met. Equipment vendors and integrated circuit fabricators do not have to redesign for each technology node. This positively affects profitability by eliminating redundant equipment qualifications and reducing downtime for equipment upgrades.

Physical processes of the contamination generation and deposition, as well as the means of the detection and controlling of airborne nanoparticles are considered in the presentation. New clean corona ionizers designed for operation in extended ISO Class 1 (at 10 nm) will be discussed.

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