Is Foam Wafer Cleaning and Drying the Future?

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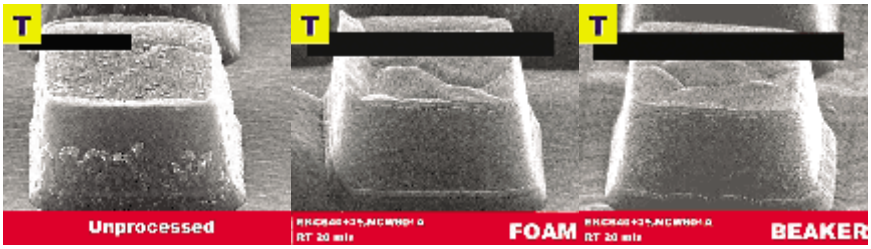
Is an aqueous foam alternative the future for wafer cleaning and drying? Preliminary results from Aquafoam Inc. (Concordville, Pa.), in cooperation with EKC Technology Inc. (Hayward, Calif.), demonstrate that an aqueous foam-based cleaning system can potentially replace ultra- or megasonics cleaning.

Foam consists mostly of gas, so the quantity of small particles delivered to a substrate by the liquid component of the foam is significantly smaller than the quantity of particles delivered by the same volume of a liquid. Many other advantages to working with foam exist. Energy to create foam can be added to the gas/liquid mixture without subjecting the wafer to the energy input; drainage rate can be controlled; the expansion ratio of foam reduces the volume of reactants and solvents by the factor 1.0/(E/R); and foam bubble walls provide surface tension gradients. Until now, particle removal using foam has been demonstrated only in single-bubble experiments.



SEMs compare the unprocessed wafer (left) with cleaning results using foam (middle) or liquid (right) medium, demonstrating equivalent cleaning results. (Source: Aquafoam).

Aquafoam developed a system in which surface cleaning, chemical treatment and drying of wafers is accomplished using aqueous foam instead of condensed phase liquid. The cleaning and drying can be done in the same treatment vessel. Foam is introduced into an overflow vessel and passes over the wafer. The cleaning treatment uses foam consisting of gas bubbles and a liquid component. Drying can be done using only carbon dioxide gas in a pressurized vessel. Carbon dioxide reduces the surface tension of the water equivalent to that of isopropyl alcohol, the conventional drying medium.

Liquid phase vs. foam phase experiments were done with EKC Technology. The liquid phase cleaning experiments involved suspending a photoresist residue wafer fragment in the stirred cleaning medium at room temperature for a designated time period. The corresponding foaming compositions were placed in a cylindrical vessel with a nitrogen gas dispersion tube. Proper adjustment of the gas flow generated foam "head" above the liquid phase. The same wafer fragment was suspended in this foam for the same time period. When the treatment process was completed, the wafer fragments were rinsed with DI water for 2 min and dried with nitrogen gas. Initial results show chemical cleaning compositions delivered to a wafer in either a liquid or foam produce equivalent cleaning results (Figure).

These preliminary experiments confirm that collapsing aqueous foam bubbles can offer an alternative cleaning method with reduced chemical usage, and further suggest that aqueous foam is a possible substitute for ultra- or megasonics cleaning.

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