Microelectronics

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Application Bulletin

Dilute HF Aqueous Cleaning Using Asymmetric Polyarylsulfone Membrane Filtration

Wet cleaning a wafer involves a series of steps, the majority of which occur when preparing or conditioning the surface for oxidation, deposition, and annealing. The RCA method, or some variation of it, is typically used for wet cleaning. This procedure involves applying different chemical mixtures, in a sequence of steps, to remove specific types of contaminants. As shown in Figure 1, these steps include SPM, DHF, SC1, SC2, and HF last.

During wet cleaning, oxide layers can form on the wafer surface. Any particles and organic or metal contaminants present in the oxide must be eliminated. If contaminant removal is to be immediately followed by the deposition of epitaxial silicon, the native oxide would be a contaminant and would also have to be removed.

During front end of line (FEOL) processing, mixtures of hydrofluoric acid (HF) are used to remove films of silicon dioxide that were grown or deposited on silicon substrate wafers. A dilute mixture of HF and DI H_2O (1:50 or 1:100) effectively etches away the thin layer of native oxide on silicon, leaving behind a hydrophobic surface that strongly attracts oppositely charged particles and is sensitive to organic contamination. As a result, the HF must be kept as free of particles as possible.

Ongoing challenges of contamination reduction

Point-of-use continuous filtration on immersion tanks or single wafer process tools is necessary to successfully control contamination. Reducing contaminants requires a filter that provides good chemical compatibility and particle retention, high ionic purity and minimal flow resistance. The need for cleaner HF, with fewer particles and lower metal ion and organic extractables, is directly related to the continual reduction in the size of device features. As new materials and device structures are introduced, it is necessary for wafer cleaning processes to evolve. They must accommodate the latest technological developments while keeping environmental impact and costs low.

Significant decrease in particle counts with Ultipleat® SP DR filters

The Ultipleat® SP DR filter was developed specifically to meet the requirements of HF filtration in advanced semiconductor manufacturing. As shown in Figure 2, this

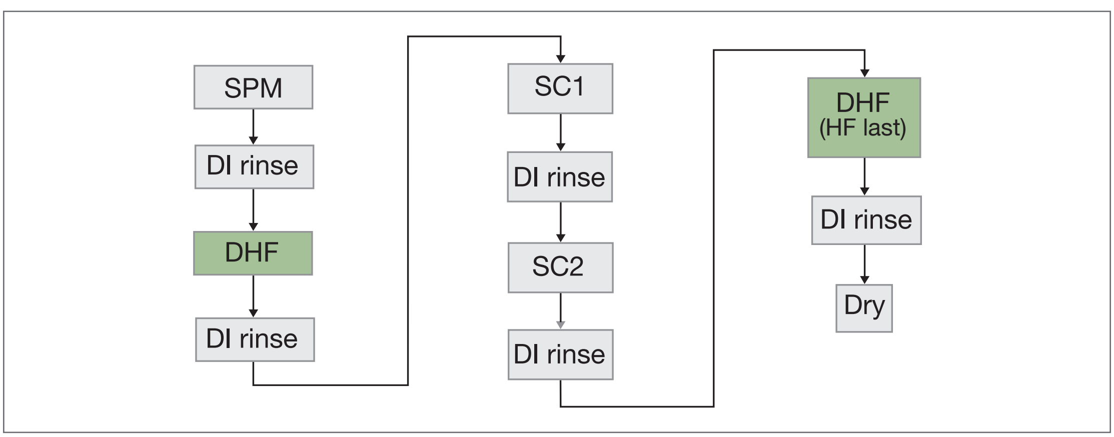

Figure 1. Typical Scheme for RCA Clean

*Filtration. Separation. Solution.*SM

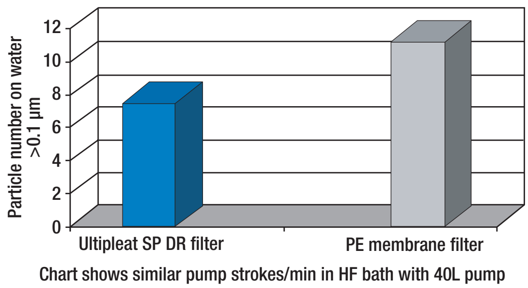

Figure 2. Average particle counts on wafer after HF bath

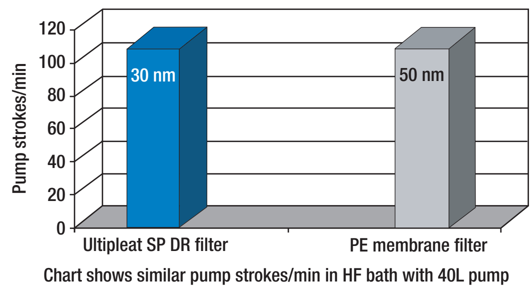

Figure 3. Pump speed vs filter type @ 15 L/min

filter can reduce average particle counts by almost 40% more than a PE filter.

The filter's patented, highly asymmetric polyarylsulfone membrane minimizes flow resistance, so a 30 nm-rated Ultipleat SP DR filter can replace a conventional 50 nm-rated filter. Figure 3 shows that a 30 nm-rated Ultipleat SP DR filter and a traditional 50 nm-rated filter in an HF bath with a 40L pump produce a similar number of pump strokes/min. Maintaining bath turnovers is critical for the rapid removal of particles from the bath, which reduces cycle time and minimizes the work required of the pumping system.

The Ultipleat SP DR filter membrane provides a non-PTFE membrane alternative that reduces operating cost, improves performance and is environmentally friendly.

Many benefits to choosing Ultipleat SP DR filters over PE filters

The specific design and construction of the Ultipleat SP DR filter accounts for its many advantages over PE filters. These advantages make it the filter of choice for dilute HF aqueous cleaning. Refer to Table 1 for a list of some of the benefits of using the Ultipleat SP DR filter.

Table 1. Ultipleat SP DR filter attributes and benefits

Attributes	Benefits
Improved retention (>99.9% efficiency @ 30 nm)	More particles are removed from the chemical, so fewer remain on the wafer. This results in decreased defects and higher process yields.
Improved permeability (0.5 psid/gpm per 10 inch filter)	Faster flow through the filter increases the bath turnover rate. With higher turnover, the bath is cleaned faster, reducing qualification time and increasing throughput.
	Lower flow resistance permits upgrading to a more retentive filter without changing the system pressure budget.
	When flow resistance is lower, the load on the pump is less. The result is that energy is conserved, and maintenance is not required as frequently.
Hydrophilic membrane (easily wets with dilute HF)	Without the need for prewetting, the qualification time is shorter.
	Hydrophilic membranes do not cause gas blockages, a condition with the potential to reduce flow over time.
Highly asymmetric membrane (100:1 pore size ratio)	The larger upstream pores act as a prefilter, protecting the filter in case of large particle excursions. This extends the service life of the filter.
	The large pores inside the membrane can hold more contaminant. This extends the service life of the filter.
	Pores of varying sizes in the same membrane provide dual retention for consistent filtration under changing process conditions.
Me-Kleen℠ option (<5ppb metal ions per 10 inch filter)	By guaranteeing metal ion cleanliness, this process eliminates a potential source of defects in the critical HF last process.

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