Slurry Characterization Services

Analytical Tests to Enhance Yields

Chemical mechanical polishing (CMP) slurry quality directly affects CMP efficiency and yield. Slight changes in slurry properties due to contamination, chemical degradation, abrasive content, or applied shear can change polish performance and impact yield. Correlation of slurry property measurements with evaluations of wafer polish rate, planarity and defectivity provides insight into the root cause of degradation in polishing.

Balazs™ NanoAnalysis analyzes a variety of slurries such as oxide, tungsten and copper CMP. Tracking the parameters in the table bellow has helped our customers identify issues with slurry quality and distribution.

Characterization of critical slurry parameters such as pH, weight fraction of particles, particle size distribution and viscosity at various points of distribution gives insight into many of these components and ensures the consistency of slurry quality and improved device yield.

Table 1. Slurry properties routinely measured

Property	What it Determines
pH	Concentration of stabilizing medium; Accidental dilution/contamination
Specific Gravity	Indirect measure of suspended matter; accidental dilution/contamination
Abrasive Content	Directly affects polishing performance by changing the mechanical rate of removal
Shear Stability	The impact of shear imposed by constant recirculation in slurry distribution systems
Viscosity	The "ease" of flow of a slurry in a distribution system as well as on the polishing pad in contact with the wafer
Mean Particle Size	Bulk removal rate of material being polished
Profile of Large Diameter Particles	Macro/micro scratches on wafer surface, which directly impact process yields.
Component Assay	Measures concentration of active chemical species, such as corrosion inhibitors and oxidizers, which impact removal rate and selectivity

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CMP slurries are complex solutions with many components. Certain aspects of a slurry might affect removal rate or cause scratches on the wafer surface, or a combination of the two.

The correct choice of analytical testing can help understand these problems and enhance yield.

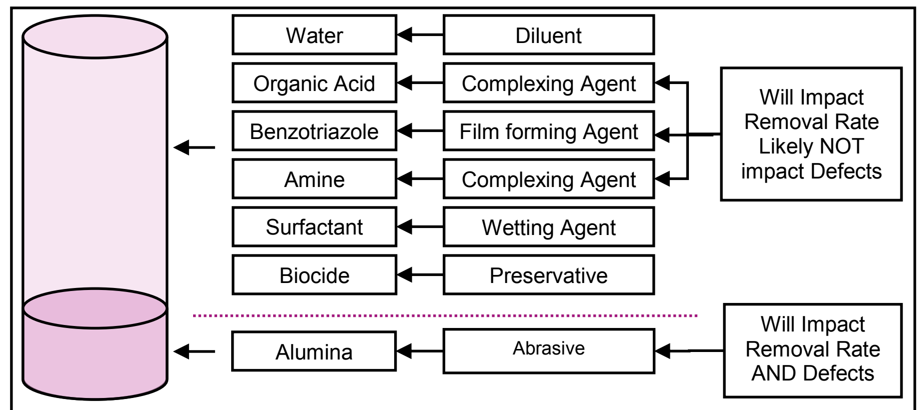

Figure 1. Increasing complex slurries with multi-components

Case Studies

Scratches

Micro scratches during Oxide CMP are a major source of yield loss and back end of line defects. Scratches caused by the CMP process can cause serious revenue loss if not controlled and subsequently eliminated. While macro scale CMP scratches can cause catastrophic yield loss on individual wafers, CMP micro scratches have a larger contribution to yield loss as they are typically intrinsic to the process.

Delivery System

Slurry performance on the polish pad can be influenced by the complex delivery systems that are employed in the fab. Pumps used for re-circulation and filters used to remove large, defect causing particles can impart increased shear to the slurry and provide enough energy to the particles that they surmount their repulsive force barriers and come into contact.

Particles

Irregular particle size and counts in the processing slurry can produce wafer scratches or gouges from large particles, contaminants within the slurry, and from particle agglomerates. Silica particles are susceptible to shearing and agglomerating, whereas aluminum and ceria particles, tend to settle faster and can result in inconsistent polishing and removal rates. Mean particle size data provided by slurry manufacturers often use simple Gaussian analysis techniques to determine the mean particle size, which can be misleading. At Balazs™, mean particle size is determined by a Dynamic Light Scattering technique. In addition to simple Gaussian representations, the software can detect bi-modal particle sizes. This NICOMP analysis often more accurately represents the complex, multi-modal particle size distributions common in CMP slurries. In this way, the number of large particles in the tail of the distribution (at sizes >0.5 microns), which can impart scratches onto the wafer surface, can be determined.

Slurry Inconsistency

Slurries may vary from lot to lot, and from the drum, dilution tank through distribution system to the production tool. Assay analysis at selected sampling points can verify consistency throughout the distribution system and can also verify the accuracy and precision of blending systems. Aging slurry, deterioration of time sensitive chemical additives like oxidizers, and variations in corrosion inhibitors and biocides can result in increased polydispersity, corrosion, wafer residues, reduced slurry polishing efficacy, and yield degradation. Although pH levels can be used to perfect selectivity in copper slurries, particle dissolution can occur in most other slurries if pH levels are too basic (>12). These are just some examples of how slurry health can effect CMP and effect yield. We are glad to assist you with your specific CMP characterization needs.

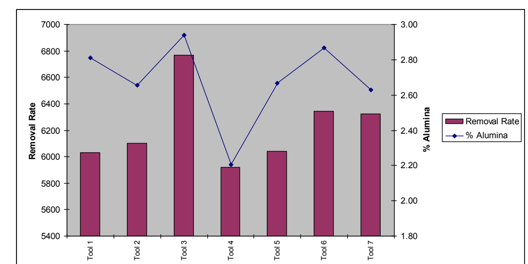

Figure 2: Abrasive content and removal rate at the wafer surface

Balazs™ NanoAnalysis operates ISO 17025 certified laboratories that identify, analyze and resolve contamination issues for high-tech industries around the world. The Microcontamination Experts™ at Balazs provide rapid and accurate analyses and expertise for water, air, chemicals, process gases, components, wafers, consumables and any other contamination sources.

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