

## Particle Size Analysis of Fumed Silica

### Outline

Chemical Mechanical Polishing (CMP) technology is used as an indispensable fundamental technology in the manufacturing process of ultra-large-scale semiconductor integrated circuits (ULSI). CMP is a technique in which the surface of a substrate is softened, removed or flattened by chemical etching and frictional abrasion with a chemical slurry that contains abrasive particles. Fumed silica abrasive particles are synthesized in a gas phase reaction in flame and are dispersed as secondary particles that are aggregates of primary particles. They are known to have thixotropic properties. Although the rate of polishing is high for fumed silica, its polishing precision is inferior to that of colloidal silica.

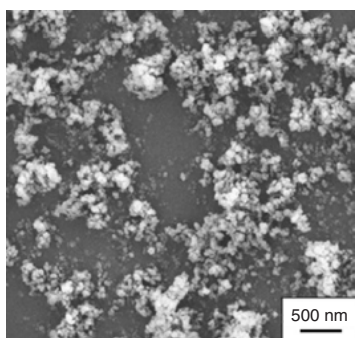


Fig. 1 SEM image of fumed silica  
Source: X.Feng et.al, "Effects of different silica particles on quasi-static stab resistant properties of fabrics impregnated with shear thickening fluids", Materials and Design 64 (2014), P457, Figure 2(a)

\* The image of fumed silica used here is independent of the below measurement result.

### Method

Apparatus: HORIBA Partica CENTRIFUGE  
Measurement mode: Homogeneous  
Samples: Silica CMP slurry (Original concentration: 5.8%)  
Particle: Silica (Refractive index: 1.450, Density: 1,600 kg/m<sup>3</sup>)  
Medium: De-ionized water (Refractive index: 1.333, Density: 996 kg/m<sup>3</sup>)  
Particle size distribution (PSD) base: Volume based  
Calculation setting: QC mode

### Results

1,500  $\mu$ L of sample was micropipetted into a cell and measured undiluted by Partica CENTRIFUGE. Fig. 2 shows five repeated measurements that have been overlaid. The PSD was calculated on volume basis using QC mode. The average mean diameter was 77.1 nm, with a standard deviation of 0.0008 nm and a CV of 0.8%.

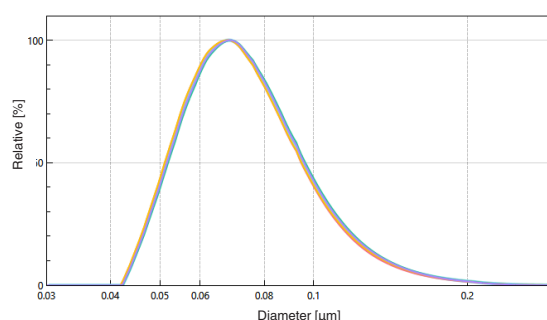


Fig. 2 Volume-based PSD

### Conclusion

Fumed silica, which has a high tendency to aggregate is difficult to measure as a CMP slurry. A sample of fume silica CMP slurry was measured using homogeneous sedimentation method to confirm the reproducibility of the measurement results. The CV of 0.8% was obtained for 5 repeated measurements. It was a very good reproducibility for such an unstable sample. In addition, it was found that the distribution width could be measured with a reproducibility that could not be obtained by other measurement methods. Taking advantage of this feature of the equipment, it will be easy to perform the quality control of CMP slurry and check for daily fluctuation during production.