BOC Edwards
Chemical Management Division
3901 Burton Drive
Santa Clara, CA 95054-1583
USA

Settling Characteristics of Chemical Mechanical Polishing Slurries

Rakesh K. Singh, Ph.D., P.E. and Benjamin R. Roberts, Ph.D., P.E.
BOC Edwards, Chemical Management Division
3901 Burton Drive, Santa Clara, CA 95054-1583, USA

Extended Abstract

With decreasing feature-size, consumables have an increasingly important role in the Chemical Mechanical Polishing (CMP) processes. To achieve uniform and efficient wafer planarization, the CMP slurry abrasive particles must be uniformly suspended during handling [1]. To be able to specify the agitation requirements for the storage tank and daytank as well as the required minimum velocity for the slurry flow in the global distribution loop to keep abrasive particles suspended, the comparative settling characteristics of different slurries must be known [2]. In the present study, a number of common oxide, tungsten, copper and shallow trench isolation (STI) CMP slurries were analyzed using a commercially available liquid dispersion optical analyzer (Beckman Coulter QuickSCAN™*) to measure the settling characteristics in terms of the changes in turbidity (transmission and back scattering signals) of various layers in the slurry sample [3]. The transmission and back scattering raw data were analyzed using the absolute thickness and mean value graphs to study the settling behavior of slurries. It is possible to quantify the settling rate of slurry from the absolute thickness plots. This technique allows detection of minute concentration and particle size variations in the slurry sample earlier than observation by the naked eye, making this method especially useful for the measurements of concentrated suspensions. The CMP slurries analyzed in these experiments included Cabot Semi-Sperse® SS-25, Semi-Sperse® W2000, EP-C5001 and EP-C5003; Rodel® ILD 1300, Klebosol® 30N50, MSW 1500 and Cu-S1-3116; EKC MicroPlanar™ CMP3500™, MicroPlanar™ CMP9001™ and MicroPlanar™ CMP9003™, and Hitachi Chemical HS-8005.

The above slurries (abrasive components or one component slurries) and normal blends (abrasive and additive components) of selected slurries were analyzed to determine the changes in the settling characteristics of mixtures as compared to only the abrasive component. The slurry samples were analyzed in a cylindrical glass measurement cell. The detection was composed of a pulsed near-infrared light source (Λ = 850 nm) and two synchronous detectors. The transmission detector received the light which passed through the sample (0°), while the back scattering detector received the light back scattered by the sample (135°). The detector head scanned the entire length of the sample (about 65 mm) vertically, acquiring transmission and back scattering data every 40 μm, or 1,625 acquisitions in transmission and in back scattering per scan. This technique can be used for the samples ranging from slightly turbid to concentrated and opaque (0 to 60 weight % solids) with particle size ranging from 0.1 – 1,000 μm and without prior dilution. If a slurry blend remains stable with time, the transmission and back scattering graphs do not change and different time plots superimpose on the reference line. Progressive changes in the graphs indicate mixture destabilization. An increase in transmission and/or decrease in back scattering values in the top layers (for example) of the slurry sample would illustrate the abrasive particle migration to the bottom of the sample as a result of settling. Insignificant changes in the overall transmission and back scattering values along the entire length of the graph suggest insignificant settling during the test.

This study is the first of its kind applied to CMP slurries and provides useful quantitative insight on settling characteristics of a variety of slurries. Selected results of transmission and back scattering (the profile graphs), and absolute thickness and mean value (the kinetic graphs) for different slurries are presented in Figures 1-7. In present experiments, the data acquisitions were executed once every minute in an automatic mode. The transmission and

*Quickscan is now called Turbiscan Classic and is manufactured by Formulaction, 10 impasse Borde Basse 31240 L'Union France, wwww.formulaction.com