Effect of Abrasive Particles on Chemical Mechanical Polishing Performance

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Abrasive particles are vital to the chemical mechanical polishing solutions to provide material removal rate except for some new generation particle free copper CMP solutions. CMP removal rates critically depend on choice of the abrasive type, structural properties such as density, the method of preparation of abrasive particles (fumed vs. colloidal for example), particle size, particle size distribution, particle shape, etc.

In this paper, we present the dependence of chemical mechanical polishing performance on the choice of particles. We have examined three types of slurries, a low selectivity copper slurry, a non-selective barrier slurry and a selective barrier slurry. Several different particles were incorporated into these slurries to yield same percentage of the particles by weight while maintaining the same background chemistry. Performance parameters evaluated were CMP removal rates for various films, surface roughness and defectivity. Also examined was the dependence on metal ions on colloidal stability of specific particles by monitoring the zeta potential in the presence of metal ions.

An example of dependence of CMP performance in terms of removal rates on particle size for a low selectivity copper slurry is shown in figure 1. Particle size affects the number of particle present in the slurry for a constant fraction by weight. Since both particle size and the number of particles are likely to affect metal removal rates, the removal rates in the graph are calculated per particle to get a true sense of dependence of CMP removal rates on particle size. For all the three slurries tested, the removal rate per particle was found to be approximately proportional to the cube of the particle size. This indicated that the removal rate per particle is proportional to the volume of the particle. The cubic, instead of the square, dependence of removal rate on particle size possibly suggests dominance of wear by surface indentation under the polishing load over surface frictional effects in influencing removal rates.

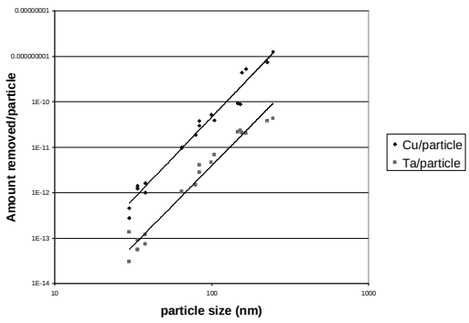

Figure 1: Dependence of removal rate normalized per particle on the particle size