A Novel CMP (Chemical Mechanical Planarization) Abrasive of Nanocluster colloidal ceria; Surface Topology, Crystallinity, activity, and Oxide Removal rate

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As the most advanced self-stopping abrasives for the CMP process of semiconductor manufacturing, two types of colloidal ceria abrasives are compared: Nanocluster form of low-crystalline ceria and cubic-fluorite form of high-crystalline ceria. Each average diameter is 108 and 117 nm with standard deviation of 10.3 and 22.5. The nanocluster ceria has spherical and smooth surface with tiny granules (< 5 nm). Quite differently, the cubic-fluorite ceria shows lattice planes and pointed edges. The crystallite size and crystallinity are 4.4 nm and 70.5% for the nanocluster ceria and 45.5 nm and 95.8% for the cubic-fluorite ceria, respectively, which means the nanocluster abrasive may well ameliorate scratch defects in CMP and enhance reliability in semiconductor manufacturing. The Ce^{3+}/Ce^{4+} representing the surface activity are 48.4 and 39.5 for the nanocluster and cubic-fluorite ceria, respectively, which is associated with the isoelectric point (IEP) at pH = 6 and 9. The RR of each abrasive is measured as 3500 and 2200 Å/min for 0.3 wt% slurry and 8900 and 3400 Å/min for 3.0 wt% slurry. Overall, a novel nanocluster ceria abrasive demonstrates a physically-soft and chemically-active nature giving great potential in CMP processing.