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Effects of Non-Prestonian Behavior of Ceria Slurry with Anionic Surfactant on Abrasive Concentration and Size in Shallow Trench Isolation Chemical Mechanical Polishing

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Ceria (CeO_2) slurries with surfactant are widely used in shallow trench isolation (STI) chemical mechanical polishing (CMP). Ceria slurry that exhibit non-Prestonian behavior with respect to the polishing rate as a function of pressure, resulting in high-planarity polishing, are expected to be used in the future for both oxide film and metal applications. In this study, we investigated the effects of the non-Prestonian behavior of ceria slurry with anionic surfactant on the size and concentration of abrasive particles by performing CMP experiments. In this experiment, the grain size of the ceria was controlled through to be 30 to 50nm and secondary particle size controlled by applying ball mill with a target size range of approximately 72 to 290 nm. The milling time was varied with duration of 8, 28, and 36 hrs for slurries designated as A (Large), B (Medium) and C (Small), respectively. Hence, we diluted each of slurry with de-ionized water to produce final ceria abrasive concentration of 0.25, 0.5, and 1 wt% for slurry B with and without surfactant addition (0.8 wt%). We found that not only the abrasive size but also the abrasive concentration with surfactant addition influences the non-Prestonian behavior. Such behavior is clearly exhibited with small abrasive sizes and a higher concentration of abrasives with surfactant addition, because the abrasive particles can locally contact the film surface more effectively with applied pressure during STI-CMP process.

The Korea Ministry of Science and Technology supported this work through the National Research Laboratory (NRL) program. We thank SUMCO Corp. and Hynix Semiconductor, Inc. for helping us with our experiments.
Keywords: CMP, Shallow Trench Isolation, non-Prestonian, Ceria, Surfactant

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Influence of Bead Size during Ceria Abrasive Milling Process on High Selectivity and Light Point Defect (LPD) Formation after STI-CMP

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Ceria (CeO_2) slurry with surfactant is widely used in shallow trench isolation (STI)-chemical mechanical polishing (CMP), because the it has high oxide to nitride removal selectivity and a lower micro-scratches and defects. Milling process is widely used in synthesizing ceria slurry to reduce the average particle size, to disperse the agglomerated particle, and to control abrasive particle size distribution in slurry suspension. In this study, we investigated how the beads size effect during ceria abrasive milling process and the varied calcination method affect the formation of light point defect (LPDs) and maintaining a high oxide removal rate. We prepared the three kinds of ceria powder that was calcined by one step (710℃) and two step (680℃/580℃, 650℃/550℃). And each ceria powders were milled by 0.2 to 0.8mm beads. Particle size distribution was measured by HR-TEM and particle sizer (Horiba). And CMP test was progressed by a Strasbaugh 6EC Laboratory CMP machine. We used ceria slurries that has less fine portion and narrow distribution of abrasive particle with different surfactant concentration (0 to 0.8wt%). And the number of LPD was measured with optional bright field channel of a Surfscan SP1. The slurry that was calcined at 710℃ has high oxide removal rate but it has many LPD. And the slurry calcined at 650℃/550℃ has lower removal rate of oxide film and it has less LPD than previous one. But it has a problem of the high removal rate of nitride film. Finally the slurry calcined at 680℃/580℃ has higher removal rate of oxide film than the slurry calcined at 650℃/550℃ and it also has less LPD. Moreover, this slurry shows higher process margin of nitride removal-rate than the slurry calcined at 650℃/550℃.

*The Korea Ministry of Science and Technology supported this work through the National Research Laboratory (NRL) program. We thank SUMCO Corp. and Hynix Semiconductor, Inc. for helping us with our experiments.
Keywords: bead, ceria, LPD, Milling, selectivity