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Effects of Organic Additives in Ceria Slurry on Enhanced Oxide-to-Nitride Removal Selectivity in Shallow Trench Isolation Chemical Mechanical Polishing

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Chemical mechanical polishing (CMP) is an essential process in contemporary Ultra-Large-Scale -Integrated circuits (ULSI) device fabrication. In Shallow Trench Isolation (STI) planarization, the residual thicknesses of thegap-filling oxide (SiO_2) and mask nitride layers after CMP must be controlled to within a few ten nanometers. It is a great advantage for ceria (CeO_2) slurry with organic surfactant and amines to offer high oxide-to-nitride (Si_3N_4)selectivity in the polishing removal rate; however, its mechanism has not been clear. We carried out a systematical experiment on polishing removal rate and removal selectivity of oxide and nitride films with varying the surfactant concentration and organic amines in ceria slurry.

Ceria slurry was prepared with varying an organic surfactant and amines concentration of up to 3.0 wt%, respectively. The oxide removal rate decreased as the surfactant concentration was increased for all the slurries, but it's slightly increase with increasing the organic amine concentration in slurry. Hence, the nitride removal rate decrease and saturated with increased the surfactant concentration. In addition, with additionally organic amines added in ceria slurry, the nitride removal rate is more decreased. The removal selectivity of oxide-to-nitride films was significantly enhanced with addition of organic amines after added surfactant in ceria slurry suspension. It supports our model based on the hydrodynamic movement of the abrasive near the film surface as well as the model with the selective adsorption and chemical reaction between film surface and organic additive in slurry.

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Keywords: Organic Amine, STI-CMP, Cerai, Selectivity

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Effect of Alkaline Agent in Colloidal-Silica Slurry on Polysilicon Chemical-Mechanical Polishing Process.

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Chemical Mechanical Polishing process is widely used to planarize the film surface in wafer during a floating gate manufacturing process of NAND flash memory, in which the design rule is below 65 nm to high processing speed and stable storage performance. Recently colloidal-silica slurry with addition of alkaline agent and organic amines have become used in Poly-Si CMP. Because they have high Poly-Si -to-oxide removal selectivity and improved Poly-Si surface uniformity, however its mechanism has not been clear. Therefore, we carried out a systematical experiment with different concentration of alkaline agent (NaOH, KOH, TMAH) in colloidal-silica slurry. Colloidal-silica slurry was prepared the abrasive size of around 30 nm with different concentration of up to 9.3 wt%. We also added an alkaline agent with amount of up to 1 wt% in slurry suspension. We additional added organic amines of up to 0.06 wt% to accelerate the removal rate of Poly-Si film. The Poly-Si film was deposited on the oxidized substrate in an LPCVD system at 530℃. The films were polished with a Strasbaugh 6EC. The films thickness variation of the Poly-Si and oxide film of before and after CMP was measured with Nano-spec 180 (Nanometrics) and Ellipsometer (Ellipso tech.).Cross-sectional viewing was measured by SEM (Hitachi). We found that the Poly-Si removal rate decreased after slightly increase throughout the experimental range of alkaline agent concentration while a maintaining a low removal rate of below 50Å. But, the removal rate was almost independent Poly-Si of alkaline agent concentration. In addition, TMAH solution with colloidal silica abrasive and organic amines showsa good surface roughness of Poly-Si film after CMP.

Keywords: Poly-Si CMP, alkaline agent, colloidal-silica slurry, uniformity