**Spectral Analysis Method for Nanotopography Impact on Pad and Removal Depth Dependency in Oxide CMP**

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Using a spectral analysis method we have proposed, the impact of nanotopography was investigated with pad and removal depth dependency in oxide CMP. Conventional single-side-polished (SSP) wafers were prepared. Oxide films were grown on the wafer using the plasma enhanced tetra-ethyl-ortho-silicate (PETEOS) method. The oxide thickness variation of the wafer before and after CMP was measured with an Opti-probe 2600DUV from Therma-Wave. Surface height change as nanotopography was measured by an ADE NanoMapper. A Strasbaugh Model 6EC was employed to polish the oxide films. Two types of polishing pads were applied: a double-layer stacked type IC1000/Suba IV as soft-pad and an IC1000 solo with no sub-pad as hard-pad, both were from Rodel. For soft-pad, the sub pad Suba IV acts as a cushion so that soft-pad has larger compressibility than hard-pad. SS12 silica slurry, Cabot was used. The target removal depth at one time was 1500Å and the polishing was reiterated 3 times with film thickness measurement.

In Fig. 1, the raw-profiles of nanotopography and film thickness variations with repeated polishing by soft-pad are drawn. The profiles were filtered using a high-pass filter with a cutoff length of 20 mm. The peak and valley positions of the wafer nanotopography and film thickness variation coincided well with each other through reiterated polishing. Therefore, the fluctuation in the film thickness after CMP is attributed to the wafer nanotopography. The Power Spectral Density (PSD) of nanotopography and that of film thickness variation before/after CMP were calculated. Based on a theoretical point of view, we have proposed a "transfer function" as the ratio of film thickness variation PSD to nanotopography PSD. If this transfer function has a large value in certain a wavelength region, the component of the nanotopography impacts severely on the film thickness variation after CMP.

In Fig. 2, the transfer functions for removal depth dependency are shown. As the polishing goes on, the transfer function gets larger and this trend is more remarkable for the shorter wavelength region.

In Fig. 3, the transfer functions for pad dependency are shown for the removal depth of 3000Å. The transfer function for the hard pad has a clearly larger value than that for the soft pad in the longer wavelengths, which quantitatively demonstrates that the longer length component of nanotopography impacts on film thickness variation when a hard pad is applied.

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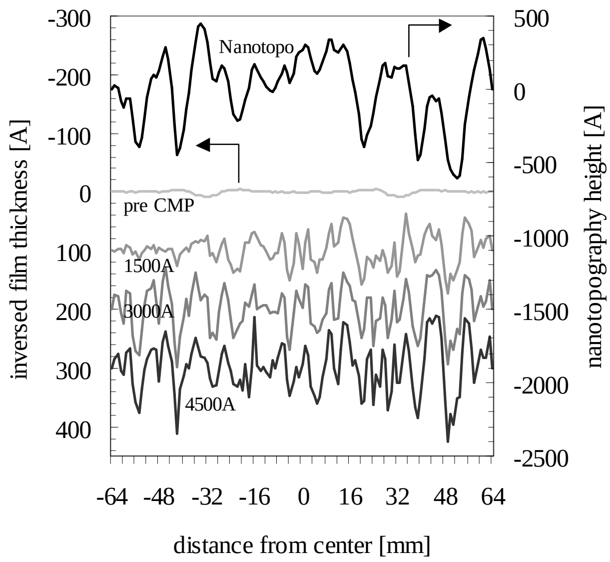


Fig.1 Nanotopography and film thickness profiles before/after CMP through the reiterated polishing of one wafer using a soft pad.

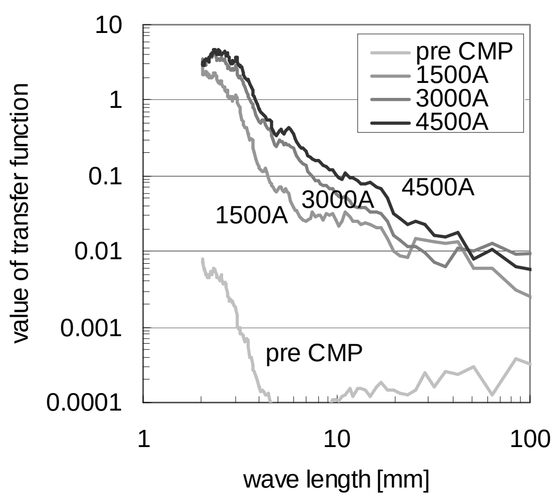


Fig.2 Calculated transfer functions as the ratio of PSD of the oxide film thickness variation to that of nanotopography using soft pad. The removal depth dependency is shown in the figure.

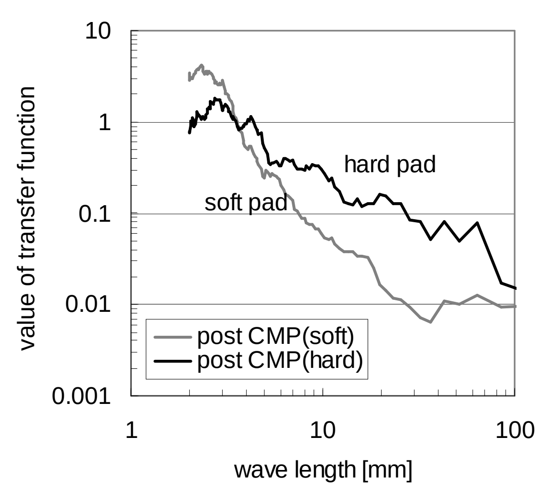


Fig.3 Calculated transfer functions as the ratio of PSD of the oxide film thickness variation to that of nanotopography using soft pad and hard pad. The removal depth was set to 3000Å.