Modeling of CMP and Nanotopography Interactions

Personnel
B. Lee (D. Boning)

Sponsorship
ADE Corporation

Nanotopography has recently arisen as an important concern in Shallow Trench Isolation (STI) Chemical Mechanical Polishing (CMP) processes. Nanotopography describes 20 to 50 nm amplitude height variations that occur over lateral millimeter length scales on unpatterned silicon wafers. The interaction of films with underlying nanotopography and the CMP process results in localized thinning of the film, resulting in yield concerns for STI structures.

Experiments demonstrate correlation between starting wafer nanotopography and post-CMP film thickness deviation on different combinations of wafer types and CMP processes, as illustrated in Figure 3. The degree of interaction is dependent on the relative length scales of the nanotopography and the CMP process used, and models are needed in order to predict the interaction between wafer nanotopography and CMP. Three modeling methods to analyze post-CMP film thinning on wafers with underlying nanotopography have been implemented and compared. These methods range from a simple scaling model, to physically based simulations of the contact mechanics between the wafer and pad. Based on the contact wear formulation, we propose predictive mapping of the post-CMP film thickness as a means for diagnosis of the degree of impact underlying nanotopography on a particular wafer has on the possible yield of STI structures on that wafer (as illustrated in Figure 4), allowing evaluation, comparison, and development of improved wafers and STI CMP processes.

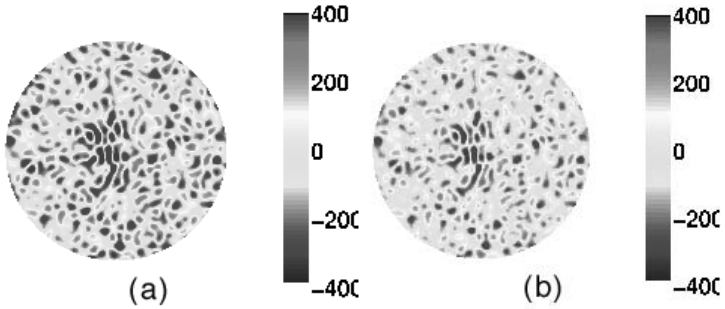

Fig. 3: (a) Initial wafer nanotopography; (b) post-CMP oxide thickness deviation from mean.

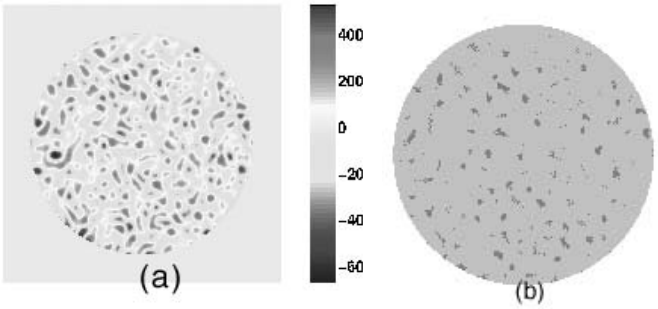

Fig. 4: (a) Initial nanotopography; (b) device failure map indicating locations of excessive nitride film thinning on the wafer.