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Chemical-mechanical wear of monocrystalline silicon by a single pad asperity

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Abstract

Chemical mechanical polishing (CMP) processes have been widely used in many fields with the ability to obtain an ultra-smooth surface. However, a comprehensive understanding of the material removal mechanisms at single pad asperity scale is still lacking, where a large number of abrasive particles are entrapped in the pad asperity/wafer microcontact area and then participate into polishing. In this study, two different pad asperity-scale material removal models are derived based on the indentation-sliding mechanism and chemical bond removal mechanism, respectively. Furthermore, series of pad asperity scale polishing tests are conducted on monocrystalline silicon wafer surface by using a polyoxymethylene (Pom) ball to mimic a single pad asperity. The results show that under the asperity-scale, material removal is highly related to the chemical reaction time between sequential asperity-wafer interactions, indicating the chemical control of the removal rate by controlling the reacted layer thickness. In particular, it is found that the reacted layer thickness follows the diffusion equation, and atoms within not only the topmost

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