Role of Hydrogen Peroxide and Glycine on Ta-CMP

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Tantalum is a very important and useful metal for use as a diffusion barrier and adhesion promoter layer of copper interconnects on dielectric material. The primary objective of the present investigation was to study the effect of solution pH, oxidizer, and inhibitor on the electrochemical behaviour of Ta to understand and to design suitable slurry for chemical mechanical planarization (CMP) of Ta. High purity Ta-discs were used to study the dissolution and oxidation kinetics in various solutions in acidic and alkaline pH regimes. The oxidizer and inhibitor used in the present study in various proportions were hydrogen peroxide and glycine, respectively. The affected surface layers of the statically etched Ta-disc were investigated using X-ray photoelectron spectroscopy (XPS), atomic force microscopy (AFM) and secondary ion mass spectrometry (SIMS). Ta metal was observed to oxidize in aqueous solutions at pH 2, 4 and 12 in absence of H2O2. The oxidation process follows the parabolic kinetic law and oxidation rate was observed to be higher in alkaline region than in acidic region. In the presence of H2O2, however, Ta dissolved in alkaline region. The dissolution was more at pH 12 mainly because of enhanced dissociation of H2O2 in alkaline region. At pH 2, on the contrary, mass gain was observed probably due to an increase in OH- content on the top surface as confirmed by XPS and SIMS depth profile studies. XPS study also revealed that at higher pH values, Ta gets oxidized at a rapid rate and forms soluble oxotantalate and hydroxotantalate in the presence of hydrogen peroxide. AFM study validates both the XPS and the SIMS results, indicating formation of a thin impervious oxide layer at pH 2 in 5a porous layer at pH 12 under similar conditions. Consequently the dissolution rate in alkaline region was enhanced which was confirmed by electrochemistry and XPS studies. The glycine played an important role in inhibiting the oxidation reaction and dissolution further.