Electrochemical Studies on the Selectivity of Tantalum Barrier Layer in Copper CMP

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Tantalum and its nitride have been identified as the diffusion barrier/adhesive layer for Cu metallization. However wide differences in properties between Cu and Ta layers result in selectivity problems during CMP process. Differences in chemical and physical properties between Cu and Ta lead to variations in removal rates. This may result in dishing during CMP of copper layers. The aim of this work is to obtain a better understanding on the slurry selectivity for Cu and Ta. In this work, we use a single slurry for the CMP of Cu and Ta. The composition of the slurry is adjusted by the addition of oxidizers and inhibitors so that the selectivity of Cu to Ta is appreciably close to the ideal value of 1:1.

The work was carried out using bulk targets 1" in diameter and 0.25" in thickness of Cu and Ta (99.99% purity). The studies included polishing and electrochemical measurements. Polishing of the targets was done in a Buehler-Minimet 1000 polisher. The removal rate was calculated through weight loss measurements. A variety of commercially available slurries with varying pH, oxidizers, with and without inhibitors were used. Electrochemical measurements were performed using potentiodynamic polarization and electrochemical impedance spectroscopy (EIS) methods. Potentiodynamic polarization data were taken using EG&G PARC 273 potentiostat/galvanostat while EIS measurements were taken with Zahner-IM6e impedance measurement unit.

Results show that when the same slurry is used for CMP of Cu and Ta with H2O2 or KIO3 as the oxidizer and no inhibitor, the selectivity of Cu to Ta is very high. The addition of inhibitor (BTA) improves the selectivity by a large extent and brings it closer to the ideal value of 1:1. Additionally the mechanism of Ta removal is compared with Cu removal based on electrochemical measurements. This type of information can lead to design of slurries that are suitable for better selectivity between the metal and the barrier layer.