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ELECTROCHEMICAL PLANARIZATION OF COPPER

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Conventional chemical mechanical polishing (CMP), using abrasives and oxidizing aqueous media is used for polishing patterned silicon wafers with copper interconnects. New technologies utilizing low-K dielectrics may require less aggressive planarization techniques in order to minimize damage to the low K materials. Since conventional Cu-CMP slurries contain mechanically hard abrasives, many scratches and defects are generated on Cu surfaces. To obtain a clean and scratch-free surface, electrochemical polishing is considered as replacement to CMP. Electrochemical polishing offers higher polishing rate, lower waste stream, no scratching, and no applied pressure on substrates. However, current controlled electro polishing has not been used to obtain true planarization of wafer surfaces since large surface areas may exhibit undulating finishes. Recently, TSMC and SONY announced novel planarization approaches by integrating Cu electro polishing [1,2].

The principal objective of this research is to demonstrate on a laboratory-scale experiment that electrochemical polishing can be used as an alternative to conventional CMP for defect-free polishing of copper.

Polishing experiments have been performed on 2cm×2 cm blanket plates and wafers as a function of electrolyte composition, sample rotation and temperature. Preliminary results obtained indicate uniform polishing of the copper sample can be accomplished in a matter of minutes. The best results have been obtained with a 1:1 solution of phosphoric acid with the addition of 10^{-3} M glycine and 10^{-4} M 3-amino triazole (ATA), at room temperature, under potentiostatic control.

Figure 1 shows the potentiodynamic curves of copper at various electrolyte compositions. With the addition of glycine, the electrochemical dissolution current at the plateau region almost doubled.

Figure 2 shows the transient current vs time as the potential of 1.5V was applied. It takes 30 seconds for the current to reach the steady state. The planarity of the polished surface is achieved during the steady state current.

References

1. M. H. Tsai, et al., p. 80IEDM, Washington, DC (2001)
2. S. Sato, et al., p.84, IEDM, Washington, DC (2001).

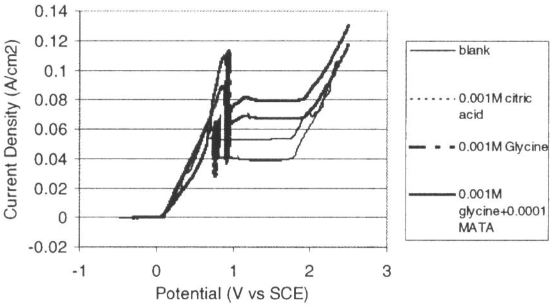

Figure 1. Potentiodynamic curves of copper in various electrolytes.

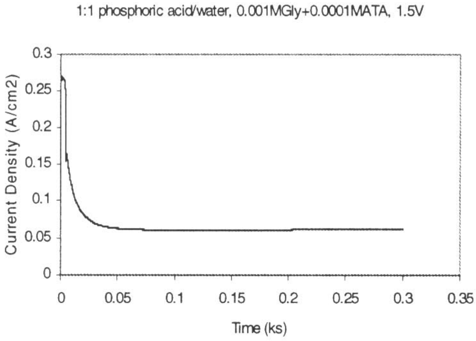

Figure 2. Transient current vs time of copper at anodic potential of 1.5V.