Influence of Polyalkyl Glycol Polymers on Copper Filling of Damascene Interconnects

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Common open-source suppressors used for copper filling of damascene interconnects include polyalkyl glycols, such as polyethylene glycol (PEG), polypropylene glycol (PPG), and copolymer structures of the two. Differences in the configuration and structure of these suppressors generate variations in polarization strength, surface adsorption rate, and SPS displacement rate. These properties were measured by electrochemical transient analysis and coupled with the results of time-evolved partial fill plating experiments to determine the effect of electrochemical property variations on the gap-fill characteristics. Examples of such data can be seen in Fig. 1 and 2.

The high polarization strength of PPG, along with its greater dependence on concentration was found to greatly increase the bottom-up growth rate during copper filling, while the improved resistance to accelerator displacement of PEG resulted in better sidewall protection. Both these gap-fill characteristics were evident when PEG and PPG were combined together as a mixture of separate homopolymers or in copolymer structures, although the overall influence was dependent on the size and configuration of the copolymer. These data sets provide a more fundamental understanding of PEG, PPG and their different configurations role in the metallization of damascene interconnects. The method described can also be used to screen new suppressor candidates by inferring their relative gap-fill performance based on comparison of the electrochemical properties.

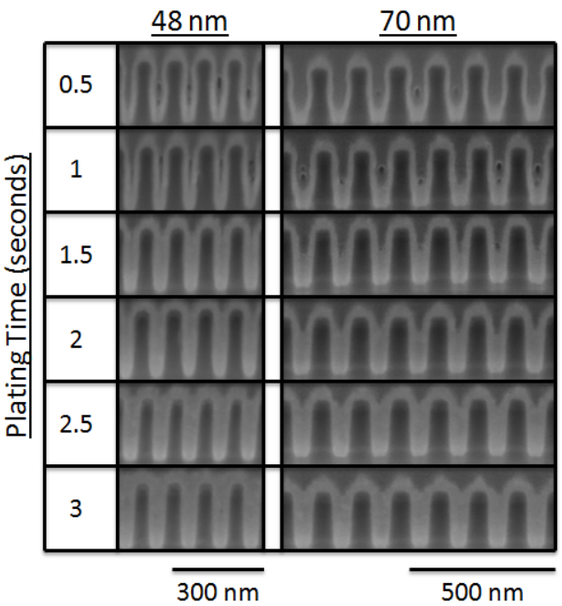

Figure 1: Representative image series of the time evolution of partial fill at 200 ppm PPG. Trench fill occurs in ~1.5 seconds in the 48 nm trenches and ~ 2.5 seconds in the 70 nm structures.

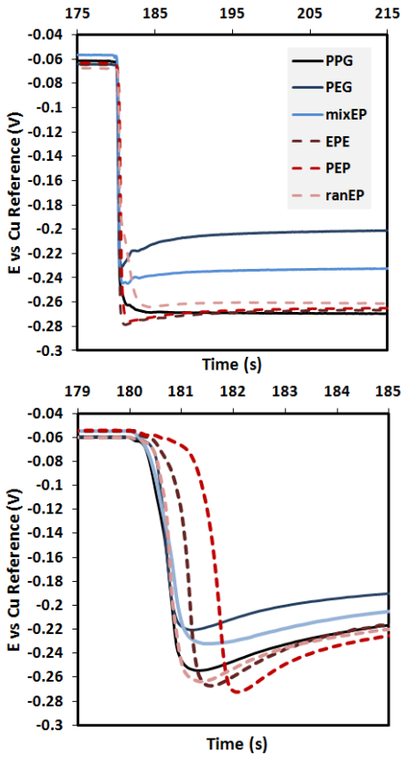

Figure 2: Electrochemical traces of injection studies of the suppressors. Both injection of the suppressor alone (top) and a co-injection with SPS (bottom) are shown.

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