Quantifying Superconformal Flling of Submicrometer Features Through Surfactant Catalyzed Chemical Vapor Deposition

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This work presents the fundamentals for understanding the superconformal filling of fine features observed during surfactant catalyzed chemical vapor deposition (CVD) of copper. The mechanism underlying the bottom-up deposition process is noted to be identical to that underlying the "superfill" process of copper electrochemical deposition used for fabricating metallizations in fine vias and trenches.

The curvature enhanced accelerator coverage (CEAC) mechanism of superconformal deposition is shown to quantitatively predict experimentally observed superconformal deposition of copper during iodine-catalyzed chemical vapor deposition of copper.

An example of the bottom-up deposition characteristic of superconformal filling of a via of aspect ratio (height/width) four is seen in Fig. 1.

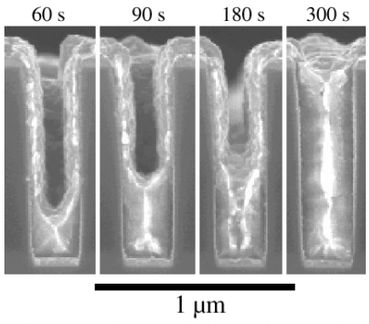

Figure 1: Superconformal filling of a via during iodine-catalyzed CVD of copper at 120 °C.

An example of modeling predictions for superconformal filling of a 1.3 aspect ratio trench is shown in Fig. 2.

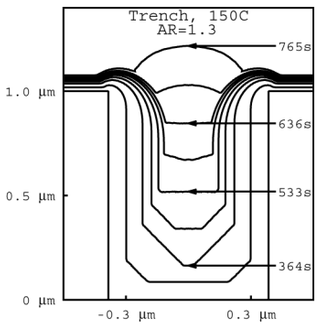

Figure 2: Predicted superconformal filling of a trench during iodine-catalyzed CVD of copper at 150 °C.

The CEAC mechanism includes the impact of local area change during growth on the coverage of deposition rate enhancing catalyst adsorbed on the surface. Predictions of feature filling obtained using the CEAC model are made with no fitting parameters: all kinetics are obtained from studies of iodine-catalyzed deposition rates conducted on planar substrates.

CEAC based predictions are shown to be consistent with experimental filling of both trenches and vias with a range of aspect ratios over a range of processing temperatures. All experimentally observed features are predicted: inception of superconformal deposition at the bottom corners of the filling feature, bottom-up superfill, and ultimate formation of a bump over the filled feature due to "momentum" deposition.