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Electroplating Techniques and Applications

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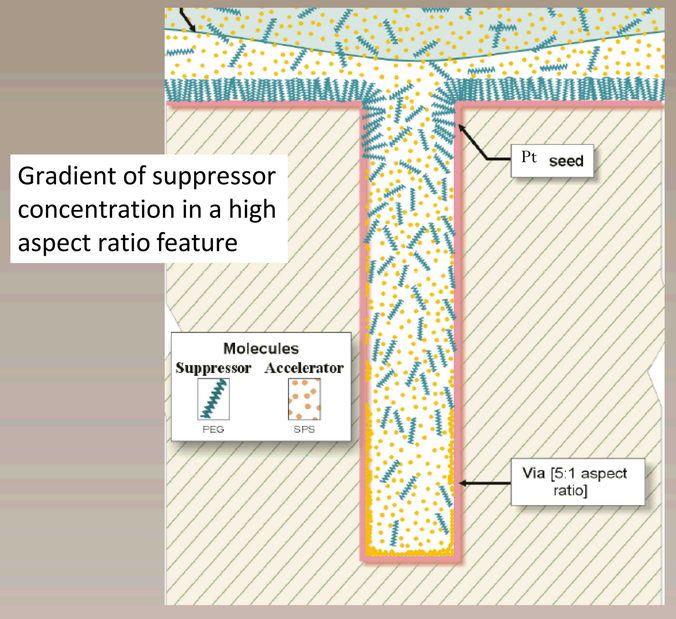
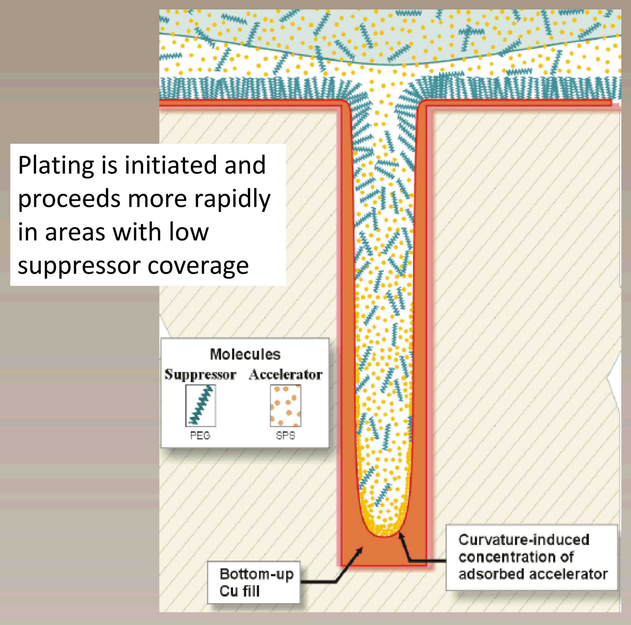
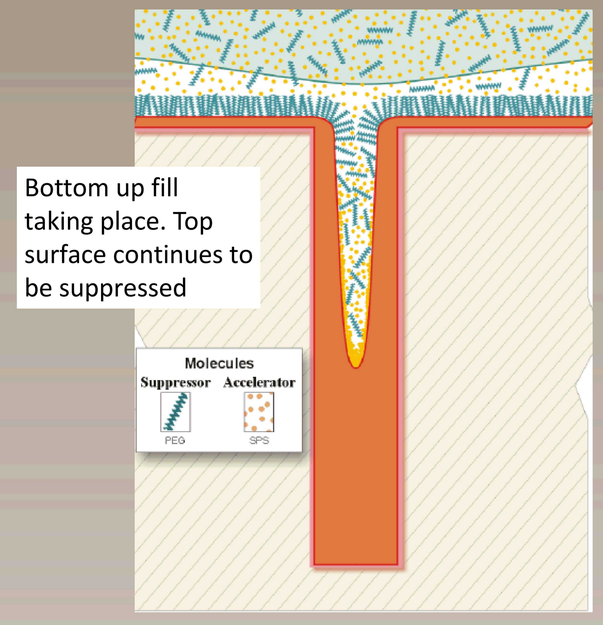
Plating Additives

Additives are an essential key to the quality of an electroplated film. Non-reacting chemicals are added that adsorb or modify the surface. They highly influence factors such as: grain refining, stress relief, leveling, and brightening. Suppressors competitively adsorb to the surface at sites where the metal atom could adsorb, or they modify the electrical double layer to reduce the frequency of plating. Levelers are a special type that adsorb preferentially at "hot spots" of high electric field and tend to flatten the macroscopic roughness of the deposit.



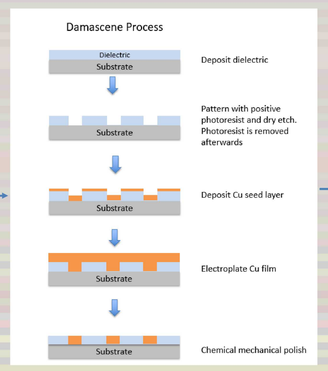




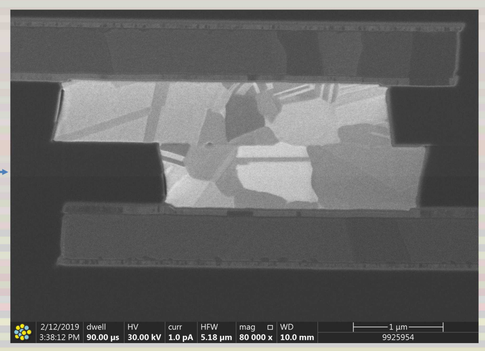
Damascene Process

The Damascene process is named after the ancient inlay technique used to make swords and shields in the 4th century A.D. in Damascus, Syria. It was achieved by hammering precious metals such as gold, copper, and silver into steel armory. The excess material was then polished from the surface to reveal ornately decorated metal armory. We can use this same concept for fabrication of Cu interconnects.

Historic Damascene Process[3]



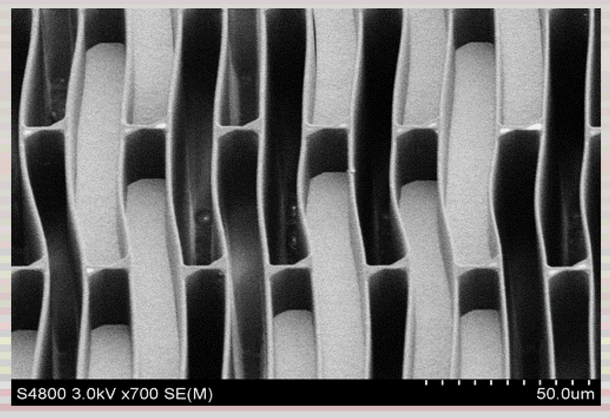
Cu Damascene Process



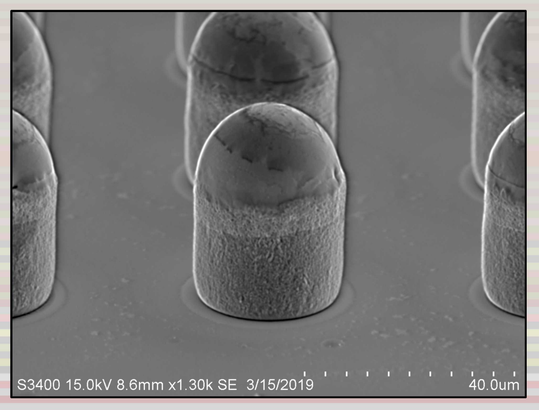
Example of 2 Cu damascene plugs hybrid bonded

Through Mask Plating

Through mask plating is achieved via a substrate patterned with photoresist. Ideally a positive photoresist works best in that the removal process is done with standard solvent cleans. This process is highly efficient in that only the open areas on the substrate are accessible to the plating chemistry.



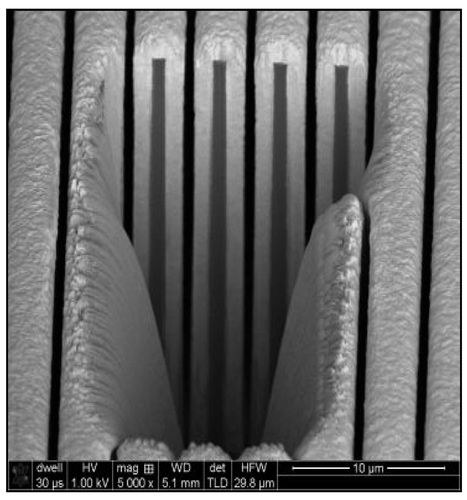
High aspect ratio mask in SUEX



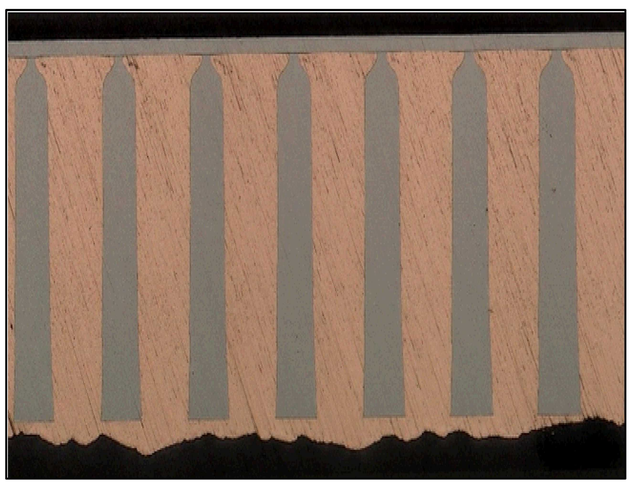
Cu pillar bump with SnAg cap formed via through mask plating and reflow

High Aspect Ratio and TSV

High aspect ratio features may be plated by modifying the electrical double layer. Using suppressing additives we can achieve bottom up filling of through silicon vias (TSVs)



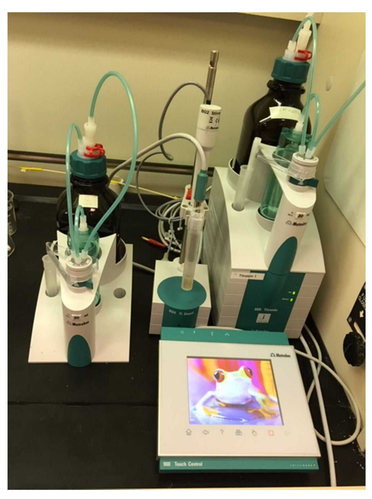
Cross Section FIB-SEM of high aspect ratio optical grating conformally coated



Cross Section of full wafer thickness TSVs bottom up filled with copper

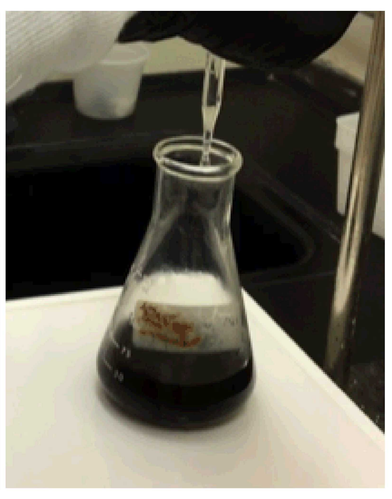
Chemical Analysis

Chemical analyses for the Mfab Au plating baths are done in-house right here in the MESA complex. Traditionally, plating bath samples are shipped out to a third party vendor for analysis.



K4P Titration

X-Ray Fluorescence



Conducting Salt Titration

1. Keigler, A., et al. "Sematech 3D Equipment Challenges: 300mm Copper Plating." *NEXX Systems (2008).*
2. Yosi Shacham-Diamand, Tetsuya Osaka, Madhav Datta, Takayuki Ohba. "Advanced Nanoscale ULSI Interconnects". 2009.
3. Sword photo: Damascus Sword photo: http://www.ancientpages.com/2017/04/05/ancient-secrets-damascus-steel-legendary-metal-used-crusaders-warriors/

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