# Atomically Controlled Cu Thin Film Deposition at Ultra-low Temperature

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Copper has been commonly accepted as a material of choice for advance interconnections due to its very low resistivity. However, with the aggressive downsizing of semiconductor devices the utilization of standard deposition techniques such as iPVD is not expected to meet the requirements in term of film continuity and conformality under deep and narrow trenches or 3D structures.[1] Copper deposition by more advanced deposition techniques such as vapor phase deposition is needed but obtaining thin and conformal films is very challenging: it needs to be performed at low temperature (100°C or less) to form a smooth and continuous seed layer.

This work presents a solution being the combination of a specifically designed copper precursor, AbaCus, and its use with an advanced deposition technique, plasma enhanced atomic layer deposition (PEALD). AbaCus is a thermally stable liquid precursor with a good volatility making it suitable for a variety of processes; the plasma enhanced process is bringing the energy needed to fully complete the reaction at very low temperature.

ALD regime has been assessed with simple hydrogen plasma as reducing gas. A stable growth rate, ~0.26A/cycle is demonstrated in the [30,85°C] temperature window [Fig.1]. Such low temperatures will be shown to bring following process advantages: AFM analysis show that the deposited films in optimized conditions are smooth and it correlates with a very low resistivity and high continuity. The film composition analysis by AES (Auger Electron Spectroscopy) revealed low contamination, demonstrating a good reduction of the $H_2$ plasma. Depositions on structures with 4:1 aspect ratio show that copper coating is conformal on trench structures allowing a successful subsequent ECD filling of the structure. [Fig.2] Film quality details such as grain size, adhesion on various substrates and film continuity will be presented.

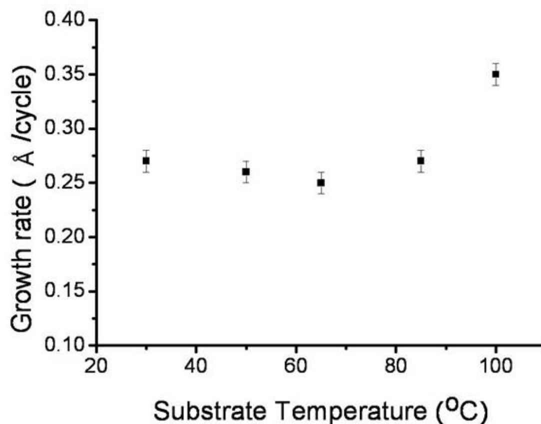


**Fig. 1** Process window for PEALD Cu AbaCus

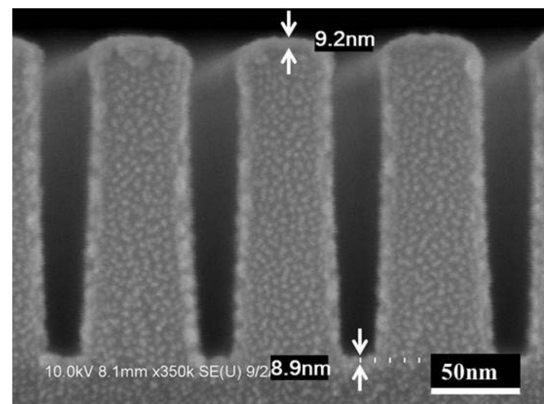


**Fig. 2** SEM of conformal ~9nm Cu thin films on trenches

References:

[1] H. Kim, “Atomic layer deposition of metal and nitride thin films: Current research efforts and applications for semiconductor device processing,” *Journal of Vacuum Science & Technology B: Microelectronics and Nanometer Structures*, vol. 21, no. 6, p. 2231, 2003.