Surface Preparation Challenges With Cu/Low-k Damascene Structures

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Competition is continuously driving die size smaller while at the same time Customer demand drives higher levels of performance. In the recent past, these competitive forces resulted in metal pitch shrinking below 0.40um. Below 0.4um pitch, Subtractive Aluminum metallization schemes ran into fundamental problems with ElectroMigration (EM) performance. At the same time, device performance improvements required either speeds surpassing the 1 GHz range or greatly reduced power consumption to expand functionality of battery operated devices. To meet these challenges, semiconductor companies are switching to Copper Dual Damascene (DD) with Low-k Dielectrics.

When cleaning wafers that use Cu dual damascene interconnects with low-k dielectrics, a whole host of new surface preparation challenges will be encountered. These include the standard Back End of Line (BEOL) cleaning problems of low cleaning efficiency and excessive etch rates leading to shifts in critical dimensions and metal corrosion. In addition, one must deal with shifts in dielectric constant, compatibility with Cu, corner rounding, collapsing trench walls, film delamination, new drying challenges, post CMP with an exposed copper and Photo diode Induced Copper Redeposition (PICR). Even the standard BEOL problems come with new concerns since particles that used to create shorts create opens with DD. Processes that performed a controlled etch of the Subtractive Aluminum surface tended to increase device yield and provide margin. For Copper DD, similar process capability can lead to shorting.

This paper will lead the audience through a brief review of what is Copper dual damascene, why would one want to use it and a comparison of typical integration schemes. Integration schemes will be discussed relative to Surface Preparation challenges. Documentation will be provided for typical defects and potential Surface Preparation solutions in use around the industry today. Finally the author will propose key issues for the future.