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ABSTRACT OF THE DISCLOSURE

The present disclosure pertains to particular Ti/TiN/TiN_x barrier/wetting layer structures which enable the warm aluminum filling of high aspect vias while providing an aluminum fill exhibiting a high degree of aluminum {111} crystal orientation. It has been discovered that an improved Ti/TiN/TiN_x barrier layer deposited using IMP techniques can be obtained by increasing the thickness of the first layer of Ti to range from greater than about 100 Å to about 500 Å (the feature geometry controls the upper thickness limit); by decreasing the thickness of the TiN second layer to range from greater than about 100 Å to less than about 800 Å (preferably less than about 600 Å); and, by controlling the application of the TiN_x third layer to provide a Ti content ranging from about 50 atomic percent titanium (stoichiometric) to about 100 atomic percent titanium. Preferably the TiN_x third layer is formed at the end of the deposition of the TiN second layer and exhibits a Ti content gradient which begins at a stoichiometric, 50 atomic percent, Ti content and ends at a Ti content of about 100 atomic percent. The thickness of the TiN_x third layer preferably ranges from about 15 Å to about 500 Å. The improved Ti/TiN/TiN_x barrier layer enables the deposit of a warm aluminum interconnect or a warm aluminum via fill where the aluminum exhibits a high {111} crystallographic content. Further, the aluminum layer obtained exhibits a reflectivity of 150 percent or greater at 436 nm. A Ti/TiN/TiN_x barrier layer having this structure, used to line a contact via, enables complete filling of via with sputtered warm aluminum, where the feature size of the via or aperture, is about 0.25 micron or less and the aspect ratio ranges from about 5 : 1 to as high as about 6 : 1.