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Highly Ionized PVD for Through Silicon Vias with Aspect Ratios up to 20:1Jürgen Weichart¹, Kay Viehweger²¹Evatec AG, Trübbach, Switzerland ²Fraunhofer IZM ASSID, Moritzburg, Germany

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Highly ionized sputtering (HIS) based on HIPIMS has been developed at Evatec for the deposition of metal barrier and copper seed layers in Through Silicon Vias (TSV) with very high aspect ratios. The process flow for TSVs consists of deep silicon etch, oxide liner deposition, seed deposition and electroplating on TSVs. Aspect ratios up to 10:1 has been developed in a joint development project between Evatec and Fraunhofer IZM ASSID. In the newest experiments it was intended to find out the limits of HIS in even higher aspect ratios up to 20:1. Therefore vias with 10 μ m diameter and 200 μ m depth were etched in 300mm wafers and a seed layer of ~300nm Ti and ~2.2 μ m Cu has been deposited using the Evatec CLUSTERLINE@300 with HIS. The 20:1 vias were cut and analyzed by cross-section SEM showing that the minimal seed thickness for a successful electroplating process of >20nm was achieved in every location of the via. Subsequently a liner has been deposited by electroplating. The SEM cross-section shows that the seed layers is free of defects. The plated liner was used to verify the completeness of the liner over the entire 300mm wafer by using X-ray tomography showing that all vias have received a flawless liner. In conclusion this means that PVD seed can still be used with all its advantages of equipment and process costs as well as integration issues. Evatec's HIS solution still uses a comparatively close target-to-wafer spacing resulting in high specific deposition rates and target utilization as well as easy to handle sputter shields, thus providing a very good cost-of-ownership compared to other directional sputtering techniques. In addition the same PVD module allows to deposit UBM and/or RDL metal layers at even lower target-to-wafer spacing without the need of a re-configuration or venting of the tool.

Keywords

HIPIMS

TSV