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Electrical and microstructural properties of ultrathin copper films grown by DCMS and HiPIMS

Felipe Cemin[1], Daniel Lundin[1], Thomas Maroutian[2], Davide Cammilleri[1], Gregory Abadias[3], P. Lecoeur[2], T. Minea[1]

[1]LPGP, Université Paris-Sud, Orsay, France [2]IEF, Université Paris-Sud, Orsay, France [3]Institut Pprime, Université de Poitiers, Poitiers, France

felipe.cemin@u-psud.fr

Copper has attracted much attention in microelectronics industry as an interconnect material for submicron ultra large scale integrated circuits due to its low electrical resistivity and good electromigration resistance. More recently, this material has also been studied as a spacer layer between two ferromagnetic layers in spin valve structures based on giant magnetoresistance for sensor and memory applications. In all cases, the interest of having ultrathin copper layers with both resistivity and roughness as low as possible is central for the proper functioning of such devices. However, as the thickness reaches the nanometer scale, increase in electrical resistivity of a metal thin film is expected, which is normally associated with higher grain density, not fully covered surface, and inhomogeneous film growth. Although these undesired effects are usually observed in ultrathin copper layers grown by conventional direct current magnetron sputtering (DCMS), there are no reports of such investigations using high power impulse magnetron sputtering (HiPIMS), which generates a high ionization fraction of the sputtered vapor and allows better control of film growth. In the present work we compared and studied the electrical and microstructural properties of ultrathin copper layers grown by DCMS and HiPIMS for different deposition conditions. Films were deposited onto p-type Si(100) substrates using argon to bombard a pure copper target at the same average power (100 W) and pressure (0,5 Pa). The initial results show a significant improvement in terms of reduced copper resistivity for ultrathin films (< 100 nm thick) grown by HiPIMS compared to DCMS. The findings will be correlated with microstructural investigations including detailed studies of the early stage growth in order to describe the dominating mechanisms responsible for these beneficial process conditions.

Keywords
HiPIMS
DCMS
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