SUB-2 NM PLATINUM NANOPARTICLES GROWTH STUDY AND DEVICE APPLICATIONS

Balavinayagam Ramalingam

Dr. Shubhra Gangopadhyay, Dissertation Supervisor

ABSTRACT

This work describes a tilted-target RF magnetron sputter deposition system to grow nanoparticles in a controlled way. With detailed characterization of ultra-high density (up to 1.1×10^{13} cm^{-2}) and ultra-small size Pt nanoparticles (0.5-2 nm), it explains their growth and crystalline properties on amorphous Al_2O_3 thin films. It is shown that Pt nanoparticle size and number density can be precisely engineered by varying selected experimental parameters such as target angle, sputtering power, substrate-surface-energy and time of deposition to control the energy of the metal atoms in the deposition flux. Based on rate equation modelling of nanoparticle growth, three distinct growth regimes, namely nucleation dependent, coalescence dependent and agglomeration dependent regimes, were observed. With this control over the growth regime, a myriad of nanoparticle configurations were observed for size dependent applications.

We also demonstrate the use of these Pt NPs based floating gate devices for multi-level operation of a Non-Volatile Memory (NVM) Metal Oxide Semiconductor capacitor (MOSCAP) by controlled layer-by-layer charging. Finally, a novel application and the first demonstration of neutron sensors using Pt NP NVM MOSCAP using ^{10}B enriched dielectrics instead of Al_2O_3 are developed for their use in neutron detection. Initial results for neutron exposure on a functional ^{10}B enriched Pt NP embedded NVM device are shown, where dual layer devices exhibit a promising detection phenomena.