Tata Institute of Fundamental Research
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Internal Seminar

Materials for giant spin Hall device

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Spin-orbit coupling in metastable β-W generates spin-orbit torques (SOT) strong enough to flip the magnetic moment of an adjacent magnetic layer. In a magnetic tunnel junction (MTJ) stack these torques can be used to switch between high and low resistive states. Deposition conditions selective to β-W need to be understood for the large-scale fabrication of SOT-MTJ devices or charge coupled spin-logic devices. We demonstrate two different techniques to grow 5-20 nm thick β-W films by introducing either O_2 gas or N_2 gas during the deposition on SiO_2/Si or SiN/Si substrates. The flow rate of these gases had significant impact upon the crystallinity and formation of β-phase W. X-ray diffraction patterns, resistivities, X-ray photoelectron spectroscopy and X-ray reflectivity were utilised to determine phase, bonding information and thickness respectively. These results demonstrate a reliable technique to fabricate β-W films up to 20 nm thick on bare Si and Silicon dioxide, while providing insights that enable deposition of these films anywhere in the device stack.

Recent spin Hall effect studies in the beta phase Ta and W show that transverse spin currents are strong enough to switch an adjacent magnetic layer. Films with perpendicular magnetic anisotropy (PMA) can exhibit uniform magnetisations and higher thermal stability. Inserting a 1 nm thick Ta insert-layer between the CoFeB and W induces PMA which is confirmed by vibrating sample magnetometer and anomalous Hall voltage measurements. β-W(5nm)/Ta(1nm) channel and the adjacent CoFeB/MgO/Ta layers are patterned into a 100 nm wide Hall bar structures. Effect of in-plane current induced change in coercivity was studied during a sweep of the in-plane magnetic field. An empirical model to quantitatively understand the switching mechanism will be presented.

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14:30 Hrs

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