Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

Thickness driven metal-insulator transition in PLD grown Ga doped ZnO thin films: experiment and first principle studies[1] JOYNARAYAN MUKHERJEE, B. R. K. NANDA, M. S. RAMACHANDRA RAO, IIT Madras — Electrical transport properties of Ga doped ZnO thin films, grown using pulse laser deposition technique, are investigated as a function of thickness (6 – 75 nm) and further substantiated through density-functional calculations. We find that while the thinnest film exhibits a resistivity of 0.05 ohm-cm, lying on the insulating regime, the thickest has resistivity of 4.8 x 10^{-4} ohm-cm to make the system metallic. Our analysis reveals that the Mott-VRH model governs the insulating behavior in the thinner Ga:ZnO whereas the weak localization theory is appropriate to explain the metallicity in the thicker Ga:ZnO. Complementing the experiment through first principle calculations on two extremes – 2 unit cell film (1.04 nm) and bulk, we show that for the film, crystalline disorder sets in with Ga doping which in turn creates highly localized states in the vicinity of the Fermi level (EF) and restrict the electron mobility. Such is not the case with bulk, where EF is occupied with a dispersive band carrying the electron donated by the dopant.

[1]DST, India

Joynarayan Mukherjee
IIT Madras

Date submitted: 11 Nov 2016 Electronic form version 1.4