INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

More, faster, better, cheaper are the modern mantras and demands of our device-happy and data-centered world. To achieve these, one requires technologies for processing and storing information. With thin connection, the new field of research, termed as spintronics, is focused in multidisciplinary level and intensified by a strong synergy between breakthroughs in basic science and industrial applications. The key elements of semiconductor spintronics are injection, manipulation, transfer and detection of spin-polarized carriers across a semiconductor device. Therefore, the topic of diluted magnetic semiconductor has received extensive interest for spintronics.

Thus, in this thesis work, we first prepared nanocrystalline NiO by using high-energy planetary mill process under dry mill conditions in a ball mill filled with high purity argon gas. Systematic studies of evolution of nanocrystalline structure, vibrational, electronic, magnetic and resonance properties of NiO powders were carried out as a function of milling speed to tune the properties of NiO powders. The ball mill process produced single phase face centered cubic (*fcc*) nanocrystalline NiO powders with the average crystal size of nanometer range (~ 11 nm) without any impurities within the detection limit of the techniques utilized. The milled NiO powders were subsequently heat treated at elevated temperatures under air atmosphere and the changes occurring in the structure and physical properties were evaluated to study the origin of ferromagnetism in these nanocrystalline NiO powders.

Subsequently, NiO targets were prepared from the milled NiO powders with different crystallites and fabricated NiO thin films with different thicknesses directly on thermally oxidized Si substrate at ambient temperature. The as-deposited NiO films showed large lattice constant due to the existence of interstitial argon atoms and/or increase of nickel vacancies created from the non-stoichiometry. With increasing annealing temperature, the lattice constant and strain decreased due to the release of interstitial argon atoms. The observation of thickness dependent decomposition reaction of NiO into Ni under vacuum annealing was explained based on the ideal model. The effects of initial crystal size of the NiO powders used for fabricating NiO target on the dynamics of thickness dependent thermal decomposition and the resulting magnetic properties of NiO thin films were investigated. This revealed a considerable decrease in the decomposition temperature (by about 100 °C) for the NiO films. To compare the results of annealed samples under vacuum conditions, the as-deposited NiO films were also post annealed under oxygen environment, which showed only AFM nature without any decomposition.

Finally, the fabrication of NiO thin films was also attempted through thermal oxidation of Ni thin films and investigated the effect of thickness dependent phase formation, nature of oxidation mechanism and the effect of thermal oxidation on vibrational, magnetic and electrical transport properties. The systematic investigations brought out several interesting results: (i) understanding of physical properties in nanocrystalline NiO powders under different milling speed and (ii) the study of thickness dependent thermal decomposition of NiO into Ni and thickness dependent thermal oxidation of Ni into NiO and the resulting FM properties with tunable competing exchange interaction between Ni and NiO phases.

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