

**Abstract of the thesis submitted by
Mr. Atta-ur-Rahman, PhD scholar, DMME, PIEAS**

The chemical co-precipitation method has been employed to prepare pure and doped CoFe_2O_4 nanoparticles. The ferric and cobalt salts were used as precursor while oleic acid was used as surfactant. The X-ray Diffraction and Transmission Electron Microscopy analysis demonstrate the single phase of nanoparticles with particle size around $15 \pm 5\text{nm}$. The electron transport in CoFe_2O_4 nanoparticles has been investigated using impedance spectroscopy from 300K to 400K in a wide frequency range (20Hz-2MHz). The impedance spectroscopy of CoFe_2O_4 nanoparticle reveals a semiconductor to metal transition around 330K. The semiconductor to metal transition has been attributed to the existence of mixed valance states of Fe cations, reverse cation distribution among octahedral and tetrahedral sites and various type of interaction between these cations. The variation of the exponent 's' with temperature suggests that overlapping large polaron tunneling is the dominant conduction mechanism in cobalt ferrite nanoparticles. The Mössbauer spectroscopy demonstrates the mixed inverse spinel structure of the CoFe_2O_4 nanoparticles. X-ray Photo electron Spectroscopy analysis has been carried out to study the oxidation states and environment of Fe and Co cations. The electrical properties of Sn^{2+} and La^{3+} doped CoFe_2O_4 nanoparticle have been studied in detail. The dielectric constant and ac conductivity of CoFe_2O_4 nanoparticles vary with dopant concentration. The temperature induced delocalization of charge carriers and metallic phase in $\text{Co}_{0.6}\text{Sn}_{0.4}\text{Fe}_2\text{O}_4$ nanoparticles has been explained using $M(H)$ loops and impedance spectroscopy. Metallic nature of $\text{Co}_{0.6}\text{Sn}_{0.4}\text{Fe}_2\text{O}_4$ nanoparticles above 360K has been attributed to dominancy of delocalized charge carriers $\text{Fe}^{3+}-\text{Fe}^{2+}/\text{Co}^{3+}-\text{Co}^{2+}$ interactions over localized charge carriers $\text{Fe}^{3+}-\text{O}^{2-}-\text{Fe}^{3+}/\text{Co}^{2+}-\text{O}^{2-}-\text{Co}^{2+}$ interactions. This was suggested that the wasp - waist magnetic hysteresis loop is due to simultaneous existence of ferromagnetic and antiferromagnetic domains in the system. The $M(H)$ loops of $\text{Co}_{0.6}\text{Sn}_{0.4}\text{Fe}_2\text{O}_4$ nanoparticles indicate that at lower temperatures the superexchange interaction is dominant as compared to double exchange interaction while at higher temperatures double exchange interaction become more strong. The open $M(H)$ loops $\text{Co}_{0.6}\text{Sn}_{0.4}\text{Fe}_2\text{O}_4$ nanoparticles indicate the absence magnetic saturation. The temperature dependent electrical behavior of the grain boundaries is reported and has been discussed in terms of depletion space-charge layer in the vicinity of grain boundaries.