SYNOPSIS

The thesis deals with the synthesis of nanodimensional silica based glasses containing either lithium ions or iron ions. The effect of nanosize on the ionic conductivity and/or magnetic behaviour of the glass concerned have been investigated. Also, the magnetodielectric properties resulting from these structural peculiarities have been delineated.

**Chapter 1** gives an introduction on different oxide based glasses, metallic glasses, chalcogenide glasses etc. The synthesis technique and properties are discussed. Electronic and ionic conduction of these glasses are discussed. Different nanocomposite materials with magnetic phases within the glass matrix and their magnetic properties are also reviewed. The scope and objective of the thesis are then stated.

**Chapter 2** describes different experimental techniques used to synthesize and characterize different samples. Dc, ac electrical measurement technique, current vs time measurements, magnetic measurements by MPMS, magneto dielectric measurements, nanoindentation are described briefly.

**Chapter 3** describes the synthesis of nanodimensional silicon oxide based glass doped with lithia within a compressed pellet of CuO nanoparticles. Average particle diameter of CuO was 17 nm and the thickness of the nanodimensional glass was 5 nm. Ionic conductivity of Li$^+$ was studied for these nano dimensional glasses. Electrical resistivity of the nanoglass system was found to be around four orders of magnitude less in comparison to the bulk glass of identical composition.
Li\(^+\) transport no. was found to be 0.9, i.e. 90% electrical conduction was due to Li\(^+\) ion movement. One dimensional ionic transport was achieved in our system.

**Chapter 4** describes the synthesis of lithia-silica glass in nanodimensions within a compressed pellet of ZnO nanorods of average diameter 70 nm and lengths around 270 nm. Resistivity of these nanoglasses is found to be less than three orders of magnitude from its bulk counterpart along with a 35% decrease in activation energy too. Ac conductivity analysis showed two dimensional ionic conductivity. Magnetodielectric measurements on CuO-lithia-silica nanoglass nanocomposite showed 5.3% magnetodielectric parameter at 500 kHz up to 2 tesla. This is explained on the basis of space charge polarization and Hall Effect. Similar measurement on ZnO nanorods-lithia-silica nanocomposite showed 20% to 99% magnetodielectric parameter for different frequencies up to 2 tesla. This is also explained by considering negative magnetoresistance of ZnO and space charge polarization.

**Chapter 5** describes another nanodimesional glass with iron ions within the compressed pellet of CuO nanoparticles. These nanocomposites showed room temperature ferromagnetic –like behaviour. This was ascribed to uncompensated spins contributed by Fe ions with associated copper ion vacancies. A rather high value of magnetodielectric parameter in the range 16 to 26% depending on the measuring frequency was exhibited by these nanocomposites at a magnetic field of 10 kOe. This was caused by a magnetoresistance of 33% in the iron doped CuO nanoparticles. The experimental results were fitted to Maxwell – Wagner Capacitor model developed by Catalan. These materials will be suited for magnetic sensor applications.
Chapter 6 describes the synthesis of iron ion containing nanodimensional silica glass within the 5 nm pores of mesoporous silica. The nanocomposite material showed ferromagnetic like behaviour at room temperature. This was ascribed to the presence of Fe$^{2+}$ and Fe$^{3+}$ ions within the nanodimensional glass phase and antiferromagnetic super exchange interaction between them. The nanocomposite showed large magneto dielectric coefficient (up to 51%) for a magnetic field of 1.7 Tesla. The dielectric loss (tan $\delta$) was found to be in the range 0.35 to 0.66. This was explained on the basis of Catalan’s model of space –charge polarization. From the theoretical fitting of experimental data, magnetoresistance of nanoglass phase was extracted to be 58% up to a magnetic field of 1.7 Tesla.

Chapter 7 summarizes results emanating from the thesis and discusses the scope of the future research in this field.