Carbon nanotubes (CNTs) have been recognized as potential candidates for mainstream device fabrication and technologies. CNTs have become a topic of interest worldwide due to their unique mechanical and electrical properties. In addition, CNTs possess high aspect ratio and low density that make them an important material for various technological applications. The field of carbon nanotube devices is rapidly evolving and attempts have been made to use CNTs in the fabrication of devices like field emitters, gas sensors, flow meters, batteries, CNT-field effect transistors etc. These molecular nanostructures are proposed to be an efficient hydrogen storage material. CNT cylindrical membranes are reported to be used as filters for the elimination of multiple components of heavy hydrocarbons from petroleum and for the filtration of bacterial contaminants of size less than 25 nm from water. Recently, CNT bundles have been proposed to be a good material for low-temperature sensing.

CNTs have also been considered as promising filler materials due to extraordinary characteristics mentioned above. Fabrication of nanocomposites using CNTs as reinforcing material has completely renewed the research interest in polymer composites. The conductive and absorptive properties of insulating polymer doped with conducting filler are sensitive to the exposure to gas vapors and hence they can be used in monitoring various gases. The application of fibre reinforced polymer composites in aeronautic industry are well known due to their high mechanical strength and light weight. Also, the conductive composite materials can be used for electromagnetic
shielding. Desired properties in CNT-composites can be attained by adding small amount of CNTs in comparison to traditional filler materials. Due to high aspect ratio and low density of CNTs, percolation threshold in CNT-polymer composites can be achieved at 0.1 vol. %, as compared to \(~16\) vol. % in case of carbon particles. The research work reported in this thesis includes the preparation of multiwall carbon nanotube (MWNTs) and MWNT-polystyrene composites, experimental investigations on low temperature charge transport, and magnetic properties in these systems.

This thesis contains 7 chapters.

**Chapter 1** provides an overview of CNTs and CNT-polymer composites. This chapter briefly describes the methods for synthesizing CNTs and fabricating CNT-polymer composites, charge transport mechanisms in CNTs and composites, and their magnetic properties as well.

**Chapter 2** deals with the concise introduction of various structural characterization tools and experimental techniques employed in the present work. An adequate knowledge of the strengths and limitations of experimental equipment can help in gathering necessary information about the sample, which helps in studying and interpreting its physical properties correctly.

**Chapter 3** describes the synthesis of MWNTs and their use as filler material for the fabrication of composites with polystyrene (PS). The characterization results of as-prepared MWNT and composites show that MWNTs possess high aspect ratio (\(\sim4000\)), and are well dispersed in the composite samples (thickness \(~50-70\ \mu\text{m}\)). The composite samples are prepared by varying the MWNT concentration from 0.1 to 15 wt %. The as-
fabricated composites are electrically conductive and expected to display novel magnetic properties since MWNTs are embedded with iron (Fe) nanoparticles.

**Chapter 4** presents the study of charge transport properties of aligned and random MWNTs in the temperature range 300-1.4 K. The low temperature electrical conductivity follows the weak localization (WL) and electron-electron (e-e) interaction model in both samples. The dominance of WL and e-e interaction is further verified by magneto-conductance (MC) measurements in the perpendicular magnetic field up to 11 T at low temperatures. The MC data of these samples consists of both positive and negative contributions, which originates from WL (at lower fields and higher temperatures) and e-e interaction (at higher fields and lower temperatures).

**Chapter 5** contains the results of charge transport studies in MWNT-PS composite near the percolation threshold (~0.4 wt %) at low temperatures down to 1.4 K. Metallic-like transport behavior is observed in composite sample of 0.4 wt %, which is quite unusual. In general, the usual activated transport is observed for systems near the percolation threshold. The unusual weak temperature dependence of conductivity in MWNT-PS sample at percolation threshold is further verified from the negligible frequency dependence of conductivity, in the temperature range from 300 to 5 K.

**Chapter 6** accounts on the experimental results of magnetization studies of MWNTs and MWNT-PS composites. The observation of maxima in coercivity and squareness ratio at 1 wt % of Fe-MWNT in a polymer matrix show the dominance of dipolar interactions among the encapsulated Fe-nanorods within MWNTs. The hysteresis loop of 0.1 wt %
sample shows anomalous narrowing at low temperatures, which is due to significant contribution from shape anisotropy of Fe-nanorods.

**Chapter 7** presents brief summary and future perspectives of the research work reported in the thesis.