ABSTRACT

In this research work, we have demonstrated the synthesis, spectroscopic characteristics, thermal behaviour and DC conductivity of a few nanostructured composites, substituted conducting polymers (ICPs) and composites of ICPs. The physical properties of aforementioned composites are significantly changed by the doping with HCl, H_2SO_4, HNO_3, H_3PO_4, or acrylic acid. The charge transport properties of these polymeric materials have been studied in detail because of their potential application in gas sensor application.

In the chapter 1, we present introduction on different polymeric and composite materials that were prepared and characterized in this work. In chapter 2, we present the materials and methods for the synthesis of different polymers and detail characterization techniques employed to measure various properties of the as-prepared materials. In chapter 3, we report the synthesis of different nanostructured composite materials using polyaniline (PANI) as conducting matrix and layered structured nanoclays such as Cloisite 20A as filler. A variety of route was employed to synthesis the PANI-ES/Cloisite 20A (4 wt%) nanocomposites in acidic medium using aniline hydrochloride (AnHCl) as precursor. The spectroscopic, thermal stability, enthalpy of fusion, room temperature DC conductivity and temperature dependent DC conductivity measurements with and without magnetic was carried out with as-synthesized materials. The charge transport mechanism was understood with and without loading Cloisite 20A in PANI-ES. The conductivity data supported the temperature-dependence relationship $\sigma(T) = \sigma 0.\exp[-To/T)^{1/4}]$ and followed characteristic of three-dimensional variable-range hopping (3D–VRH) mechanism.

The synthesis of acrylic acid (AA) doped PANI polymer, N-substituted aniline monomer using acrylic acid and aniline precursors and its corresponding polymer, and PAA/PANI composite is present in chapter 4. The AA based synthesised PANI polymer was found with higher solubility, improved thermal properties along with comparable electrical properties than that of PANI-ES. The presence of different functional groups in the synthesised monomers and AA based PANI polymers were confirmed using FTIR. The UV–Visible absorption spectroscopy has shown mainly two different bands, which are found at 250–450 nm and 500–800 nm region. The thermal and electrical properties of these polymers are studied in detail and presented in this chapter.

In chapter 5, we present *in situ* synthesis of DL−PLA/PANI-ES composites and mainly their electrical properties. The ATR−FTIR spectra indicated the presence of different functional groups in the as-prepared DL−PLA/PANI-ES composites. The UV−Visible absorption spectroscopic analysis showed the presence of polaron band suggesting PANI-ES form. The Room temperature DC conductivity, temperature variation DC conductivity (in presence and absence of magnetic field), and magnetoresistance (MR) were analysed. The highest room temperature DC conductivity value was obtained from H_2SO_4 doped DL−PLA/PANI-ES composites and all prepared conductive composites were followed ohms law. The low temperature DC conductivity was carried out in order to study the semiconducting nature of prepared materials. The Mott type VRH model was found to be well fitted the conductivity data and described the density of states at the Fermi level which is constant in this temperature range. From MR plots, a negative MR was observed, which described the quantum interference effect on hopping conduction.

In chapter 6, we present the methane gas response of as-prepared DL−PLA/PANI-ES composite film. At 500 *ppm,* the methane gas response was found to be 9 %.

Keywords: Polyaniline, Nanocomposites, N-substituted polymer, Doping, Conductivity, Variable range hopping (VRH), Magnetoresistance, Methane gas sensor