CHAPTER - V

SUMMARY AND CONCLUSION

The development of nanomaterial application is increased over the years. Consequently nanocomposites are also developing in the recent years. Polymer nanocomposites consisting of metal oxide nanoparticles embedded in organic polymer as a host medium are able to combine the peculiar characteristics of both organic and inorganic in original functional materials. Such hybrid materials join peculiar characteristics of polymers. Since the size of the nanocomposites particles are average, the applications are high.

Among the various semiconductor materials, the MnO_2 and TiO_2 nanoparticles have received considerable attention due to a large number of technical applications. So these two metal oxides are prepared for present work.

Among organic conducting polymers, polyaniline (PANI) has attracted intense interest because of its high conductivity, excellent stability, and relatively high transparency to visible light. These properties make it one of the most applied conducting polymers. The reason for using the polymers such as PANI has been also considered in this work, to prepare PANI/MnO_2 and PANI/ TiO_2 nanocomposites are to control the growth and morphology of the nanoparticles.

In the present work, the pure MnO_2, TiO_2 nanoparticles and polymer-added MnO_2, TiO_2 (organic/inorganic) nanocomposites have been synthesized. The pure MnO_2 and pure TiO_2 nanoparticles are prepared by microwave-assisted solution method and sol-gel solution method. A method for the synthesis of organic/inorganic hybrid material such as PANI/MnO_2 and PANI/TiO_2 nanocomposite was developed in this

work. The nanocomposites are fabricated via in-situ polymerization of the monomer in the presence of inorganic nanoparticles. MnO_2 and TiO_2 nanoparticles in the concentrations of 1 wt%, 2 wt%, 5 wt%, 10 wt%, 20 wt% and 50 wt% are added to the polyaniline and these samples are synthesized.

Powder XRD studies of all the prepared samples of this work have been examined. The lattice constants of the nanocrystalline sample are determined and the X-ray spectra of MnO_2 nanoparticles, TiO_2 nanoparticles, PANI/MnO_2 nanocomposites, and PANI/TiO_2 nanocomposites show that the peaks positions are either slightly shifted towards lower 2θ values or towards higher 2θ values or no shift in the position while the concentration of the dopants are increased and the 'hkl' values are compared with the standard JCPDS files. The particle sizes of the as-prepared nanopowders of MnO_2 and TiO_2, PANI/MnO_2 and PANI/ TiO_2 are determined from XRD spectra using Debye-Scherrer's formula.

The scanning electron microscopic images of the as-prepared samples of MnO_2, TiO_2 nanoparticles, PANI/MnO_2 and PANI/ TiO_2 nanocomposites explained the morphology characterizations. The particle size, size distribution, shape, degree of agglomeration, etc. are obtained from High Resolution Transmission Electron Microscopy (HRTEM).

The optical characterization of the prepared samples in the present investigation was carried out by UV-Vis studies. All the samples are exhibited blue shifted compared with the bulk materials.

The functional groups and phase purity of the all prepared samples are analyzed by FT-IR spectral method. The functional groups of the spectra are attributed to the characteristics of the compound materials. The weight loss and decomposition of the sample are studied from thermal studies of TG/DTA.

The electrical characterization of the nanocrystalline samples synthesized in the present work is carried out using an impedance spectroscopy analyzer. The Cole-Cole plots of the as-prepared materials reveal the insulating nature for MnO_2 nanoparticles and TiO_2 nanoparticles have semiconductor nature.

The AC conductivity of the materials show an exponential increase with the frequency of the AC applied field at different constant temperatures. It also increases with the temperatures at a given frequency.

Future Scope

Development of technology in the nearest past has stimulated the importance of discovering new materials. With an interest to discover new materials, PANI/MnO_2 and PANI/TiO_2 nanocomposties are synthesized and studied in this work. Only the polymers PANI are used in the present study to alter the various properties of MnO_2 and TiO_2.

This work may be extended with doping of MnO_2 and TiO_2 with other polymers as well as other rare earth elements. The characterization of the samples may be performed with different annealed temperatures to study the effect of particle size on the property of the materials.

In the present investigation, AC impedance analysis are analyzed only at low temperature ranges and it may be extended to very high temperature ranges and also photoluminescence and Raman Spectral Studies may be carried out for all samples.

The synthesized nanocomposites of this work can be used for the fabrication of gas sensor devices, supercapacitor, coating on solar cells, and other nanotechnological devices, the efficiency of the devices could be studied in the future.