Chapter 5

Summary & Conclusions

The conducting polymer polyaniline has been extensively studied in recent years. However, the serious issue of polyaniline i.e. problem of stability for electrochemical performance particularly for supercapacitor is yet to be resolved. The intercalation of metal / metal oxide / metal sulphide in polyaniline became a new area for improvement of stability of polyaniline. Hence, the research has been focussed on such PANI nanocomposites.

Nanoparticles of metal oxides /metal sulfide / metal intercalated in conducting polymer are useful for various applications such as supercapacitor, humidity sensor, battery etc. The polyaniline – vanadium oxide or other metal oxide have some disadvantages such as in-situ polymerization of aniline in acidic medium. Therefore, it is important to synthesize nanocomposites of polyaniline and other metal oxide / metal sulphide nanocomposites for vivid applications. For the synthesis of these nanocomposites in -situ polymerization method is preferable and has been used in the present work.

In chapter 1, we have given general introduction from the literature survey about polymer, conducting polymer, conducting polymer - metal oxide / metal sulfide / reduced Graphene oxide etc. nanocomposites. We have also presented the functionalities of these nanocomposites for supercapacitor and humidity sensing applications. We also reported the advantages and disadvantages of the polymer and conducting polymer based nanocomposites. Various conducting polymers along with examples are given along with their molecular structures. The motivation of the work is also presented in this chapter.

Chapter 2 describes different synthesis methods used to preparation of conducting polymer specially polyaniline- metal / metal oxide/ metal sulphide / metal nanocomposites. The synthesis method which is useful for the preparation of metal- metal oxide nanocomposite also be introduced in this chapter. The synthesis method of polyaniline nanostructures by chemical oxidative polymerization and the synthesis method of polyaniline – metal oxide / metal sulfide nanocomposites are elucidated. The materials and methods used are also described in details.

Chapter 3 comprises the synthesis and characterization of silver vanadium
oxide - polyaniline nanocomposite, silver vanadium sulphide-polyaniline nanocomposites and reduced graphene oxide- polyaniline nanocomposites. Synthesis and characterization of nanostructure of polyaniline nanofibers and reduced graphene oxide, graphene oxides were also carried out. The outcome of this chapter is polyaniline nanofibers itself acts as a nanocomposite of silver- polyaniline nanofibers nanocomposites. SVO-PANI nanocomposite clearly shows uniform distribution of SVO in PANI due to in-situ polymerization. Structural study also showed the formation of SVO in PANI. The SVS-PANI nanocomposite has been prepared at low temperature by in situ polymerization. Morphological study showed very uniform distribution of SVS nanospheres. The novel nanostructures of reduced graphene oxide and reduced graphene oxide –polyaniline nanocomposites are presented. The FESEM study reveals the nanorose flowers, honeycomb and nanobookey of flowers (bouquet) which are interesting morphology of reduced graphene oxide and reduced graphene oxide- polyaniline nanocomposites. The proposed formation mechanism has also been explained in detail. The controlled synthesis of lithium vanadium oxide - silver nanotube nanocomposite is also presented. The silver nanoparticles were observed on the nanotubes of LVO. The detail characterization was performed all systems and results are discussed.

In chapter 4, the applications of nanocomposites such as electrochemical study and humidity sensing have been demonstrated. The nanostructures particularly nanofibers of polyaniline showed specific capacitance, 570 F/g. This indicates the use of nanofibers in supercapacitor. The silver vanadium oxide - polyaniline nanocomposite is multifunctional nanocomposite where it showed 365.5 F/g specific capacitance. The humidity sensing study showed response and recovery time 4 and 8 seconds, respectively. Uniform distribution of silver vanadium sulphide in polyaniline opens new avenue for supercapacitor applications which shows enhanced specific capacitance (440 F/g). The interesting morphologies of reduced graphene oxide and reduced graphene oxide- polyaniline showed different capacitance. However, the honeycomb nanostructure of polyaniline-reduced graphene oxide nanocomposite showed more capacitance (470 F/g) because of high surface area. The lithium vanadium oxide / silver nanotube nanocomposite showed capacitance around 124 F/g.
Chapter 5 describes the summary of the research work where outcome of physico-chemical characterization, electrochemical study of all systems have been exemplified.

**Future Scope**

1. To synthesize and characterize other conducting polymer like PEDOT which shows more conductivity. To check feasibility of PEDOT nanocomposites for electronic applications.

2. The nanocomposites of PEDOT- reduced grapheme oxide is more preferable.