ABSTRACT

Polymers have been considered as insulators before three decades and were not believed that polymers could conduct electricity. But now such belief has been changed by simple modification of ordinary organic polymers. These are called electrically conducting polymers, these materials combine the electrical properties of metals with the advantages of polymers such as light weight, workability, corrosion resistant and the lower cost. These materials find specialized applications in the area of space, aeronautics, electronics, photovoltaic and optics. These materials have advantages of simple fabrication methods and their low cost. Reinforcement of polymers by salts and nano materials results in polymer nano composites, which are characterized by the enhanced conductivity, mechanical properties and thermal properties.

In present research reinforcement of polymers by salt and nano materials results in polymer nano composites. These nanocomposite has good electrical properties as well as good mechanical strength and thermal properties for electronic and photovoltaic applications. The study is focused to synthesize and characterize the polymer nano composites with various combinations of salt and nanoparticles.

Polyvinyl Pyrolidone, a water soluble polymer was used as a base polymer matrix and Potassium Iodide, Sodium Iodide, Potassium Hydroxide and Ammonium Iodide salts are used as doping agent. Further the nano particles of Aluminum Oxide, Aluminum Nitride, Zinc Oxide, Barium Titanate and Nickel Oxide nano particles are used as dopants to improve the conductive, impedance, electric modulus and dielectric properties. Further structural, thermal and mechanical properties of polymer nano composites are characterised.

The experiments were conducted on synthesized polymer nano composites. The experiments such as Impedance Spectroscopy, Ionic Transfer Number, Tensile test, Microhardness test, Degree of solubility, Solubility of film, TGA, DSC, SEM, FTIR and XRD were conducted. The polymer nano composites specimens are characterized for electrical properties, dielectric constant, tensile strength, micro hardness and structural characterization to determine various properties of the polymer nano composites.
The nanocomposites PVP+30%KI+4%Al$_2$O$_3$ found to be highest conductivity. The electrical conductivity increased with increasing dopant concentration. The increase in conductivity with dopant concentration may be due to the formation of charge transfer complexes. The increase in conductivity at higher dopant of salt concentrations is attributed to the formation of charge transfer complexes or decrease in the crystallinity. The decrease in dielectric properties (dielectric constant) with an increase in the frequency occurs because of space charge polarization at the electrode-electrolyte interface. The Ionic Transference number test reveals that ions are having major contribution in conduction process of polymer electrolyte and nanocomposites.

The improvement in tensile strength and microhardness was observed with the addition of nano particles. The nano particle lodges at the interface between the different phases and enhance the load carrying capacity and this results in the enhancement of tensile strength of the nano composites. The enhancement in tensile strength can be attributed to introduction nano fillers of higher modulus in polymer. The improvement in the Thermal properties was observed due to salt and nano dopants.

SEM study showed a uniform dispersion of salt and nano materials in PVP polymer matrix.

FTIR revealed that after adding nanoparticle, it does not make any bond with the polymer. Since there is no change in peak position of the (PVP+ Salt) composite, nor there is any new peak. So it is confirmed that the system is a polymer nano composite (PVP +Salt+ nano particles)

In XRD investigation PVP polymer shows broad hump and not even a peak indicating its high amorphous nature. The sharp peaks correspond to the crystal planes of salt and nanomaterials which are crystalline. The salts get dissolved in PVP and therefore its peak disappears. This is confirmation of composite nature of the system. The composite film shows peaks of nanomaterials superimposed on PVP.

The study has been carried out on photovoltaic cell that has been fabricated by using the developed polymer nano composite.