Nanostructured materials and related technologies are being extensively pursued during the past few years owing to their innovative applications in all walks of science and technology. The work presented in the thesis deals with the realization of novel polymer nanocomposites with enhanced functionalities and prospects of applications in the fields related to nanophotonics. The development of inorganic/polymer nanocomposites is a rapidly expanding multidisciplinary research area with profound industrial applications. The incorporation of suitable inorganic nanoparticles can endow the resulting nanocomposites with excellent electrical, optical and mechanical properties.

The first part of the thesis deals with the synthesis and characterization of ZnO nanoparticles and transparent ZnO/polymer nanocomposite films. Zinc oxide (ZnO) is a technologically important transparent conducting oxide material noted for its efficient blue-green luminescence and excitonic ultraviolet (UV) laser action at room temperature. These attributes make ZnO/polymer nanocomposite materials potentially interesting for photonic applications in the UV region of the spectrum. Polystyrene (PS) and poly methyl methacrylate (PMMA), which are transparent and flexible thermoplastics with excellent film forming properties are used for the synthesis of ZnO/polymer nanocomposites. The optical characterization of these materials provides rich information about various optical and electronic phenomena, vital for various device fabrication technologies. In the present work, extensive investigations on the size dependent linear and nonlinear optical properties of ZnO/PS and ZnO/PS-PMMA blend
nanocomposite films have been carried out. ZnO shows quantum confinement effects in the experimentally accessible range of sizes. The immiscibility of heterophases of the polymer and ZnO constituents has been resolved by ultrasonicating the mixture, which has ensured the homogeneous dispersion of ZnO nanoparticles in the polymer matrix.

Comprehensive characterization of the ZnO/polymer nanocomposite materials has been undertaken using a wide range of techniques such as XRD, FT-IR, AFM, FESEM, TEM, HRTEM, Raman spectroscopy, TGA, UV-Vis- NIR absorption spectroscopy, Photoluminescence, and Z-scan. The homogeneous ZnO/PS nanocomposite films of about 1µm thickness exhibit enhanced UV- shielding effects in the UVA (400-315 nm), UVB (315-280 nm) and part of UVC (280-100 nm) regions even at low percentage of ZnO loading. The excellent UV shielding effects observed in the ZnO/PS and ZnO/PS-PMMA nanocomposite films offer ample prospects of applications as efficient UV-protection coatings. The nonlinear optical properties of ZnO/PS, ZnO/PMMA and ZnO/PS-PMMA nanocomposite films have been investigated in detail using Z-scan technique. All the nanocomposite films exhibit good optical limiting behavior. Out of the three polymer nanocomposite film systems investigated, the ZnO/PS-PMMA system shows the highest optical limiting efficiency and can be of application as efficient optical limiters to protect sensors from damage due to high intense radiations.

The second part of the thesis deals with the synthesis of polypyrrole (PPy, a conducting polymer) films with appreciable crystallinity and high electrical conductivity. The polypyrrole films prepared from the solution in m-cresol are found to show quite high extent of crystallinity in the XRD
analysis, which has not been reported earlier. Crystallinity influences many of the polymer properties and hence, while selecting polymers for specific applications, it plays an important role. The percentage crystallinity of the PPy films has been determined using XRD and Differential scanning calorimetry (DSC) analysis. There are no earlier reports related to the synthesis of PPy films with exceptionally good crystallinity and the quantitative assessment of the percentage crystallinity. It is the first time that PPy films with high degree of crystallinity have been synthesized and reported. Raman, DSC and TGA studies of the PPy films also give ample support to the observed high extent of crystallinity in the XRD data. These PPy films can be considered as semi crystalline in which highly crystalline regions and amorphous regions co-exist. Semi-crystallinity in polymers is significant because semi crystalline polymers combine the strength of crystalline nature with the flexibility of the amorphous one. The present work is quite significant from this point of view.

The thesis entitled “Investigations on some technologically important polymer nanocomposite films and semi crystalline Polypyrrole films” consists of eight chapters. The first chapter gives a general introduction to nanotechnology, nanocomposites and conducting polymers. It also emphasizes the significance of ZnO among other semiconductor materials, which forms the inorganic filler in the polymer nanocomposites of the present study. This chapter also gives general ideas on the properties and applications of conducting polymers with special reference to polypyrrole. The objectives of the present investigations are also clearly addressed in this chapter.
The **second chapter** deals with the theoretical aspects and details of all the experimental techniques used in the present work for the synthesis of polymer nanocomposites and polypyrrole samples and their various characterizations.

**Chapter 3** is based on the preparation and properties of ZnO/Polystyrene nanocomposite film samples. The optical properties of these nanocomposite films are discussed in detail.

**Chapter 4** deals with the detailed investigations on the dependence of the optical properties of ZnO/PS nanocomposite films on the size of the nanostructured ZnO filler material. The excellent UV shielding properties of these nanocomposite films form the highlight of this chapter.

**Chapter 5** gives a detailed analysis of the nonlinear optical properties of ZnO/PS nanocomposite films using Z scan technique. The effect of ZnO particle size in the composite films on the nonlinear properties is discussed.

The linear and nonlinear optical properties of ZnO/PS, ZnO/PMMA and ZnO/PS-PMMA nanocomposite films are described and compared in **chapter 6**. The excellent optical limiting and efficient UV shielding characteristics observed in ZnO/PS-PMMA nanocomposite blend films form the highlights of these investigations.

In **chapter 7**, the synthesis and characterization of polypyrrole films with exceptionally high extent of crystallinity are described. These semi crystalline polypyrrole films, synthesized by a dedoping-redoping process show excellent crystallinity not reported earlier.
The general conclusions and the scope for future investigations are included in Chapter 8.

The major highlights of the present investigations are,

1. Successful synthesis of homogeneous, transparent, spin coated ZnO/PS nanocomposite films, using pure ZnO without any surfactants, which exhibit good UV shielding properties by absorbing about 90% of UVA, UVB and part of UVC radiations, in the range from 395 to 190 nm with 10% ZnO loading in the composite.

2. The identification of ZnO/PS-PMMA blend nanocomposite films as prospective nanocomposites for efficient optical limiting and UV shielding applications. The main factor contributing towards the excellent optical characteristics of this polymer blend nanocomposite is the presence of an interpenetrating (IPN) network of PS and PMMA in the polymer blend. This is a very interesting observation which extends ample scope for detailed further investigations.

3. The synthesis of polypyrrole films with exceptionally high extent of crystallinity comparable to crystalline inorganic solids, which has not been reported earlier.

4. It is the first time that polypyrrole films with exceptionally high crystallinity have been synthesized and reported. Crystallinity influences many of the polymer properties, and thus plays an important role while selecting polymers for specific applications. The present work on highly crystalline polypyrrole films is quite significant from this point of view.