Chapter 6

Conclusion and Future Scope

6.1 Conclusion:

In this stated detailed work, synthesis of rare earth RE (Ce, Dy, Er, Eu, Pr, Tb, Tm) doped TiO_2 / ZrO_2 nanoparticles has been successfully synthesised by hydrothermal technique with 0.1 mol% & 0.2 mol% doping concentration of rare earth elements. Synthesized material incorporated with polyacrylicacid with 1 mol% & 2 mol% respectively to develop thin films of RE doped TiO_2 / ZrO_2 – polyacrylicacid (PAA) nanocomposites.

Rare earth doped TiO_2 – PAA nanocomposites were prepared using hydrothermal and doctor blade method. The XRD results revealed the formation of material as nano crystallite and confirms the material is in anatase phase, which matches with the standard JCPDS results. The average crystallite size was found to be between 5.22 nm to 8.20 nm. The EDS spectra of samples clearly indicates the presence of Titanium, Oxygen and rare earth elements. DLS results give particle size distribution in nano meters. The FTIR spectra confirms the presence of different functional groups with respective wavenumber, which indicates the small variation in the wavenumber as a function of RE doping content.

The Photoluminescence study exhibits wide peaks centered at 300 nm in UV emission band and other emission peaks between 380 nm to 495 nm in the violet-blue emission band.

The optical properties of material were analysed by UV- Visible Spectroscopy. The optical bandgap of all the samples lie between 3.75 eV to 4.25 eV. The bandgap values are between pure TiO_2 which was reported 3.2 eV and for PAA it's very high as it is a polymer material. The refractive index of the samples vary in a very short range from 2.10 to 2.20. Overall, we are getting higher RI with compare to PAA, which was reported 1.395. The variation of absorption coefficient with wavelength shows higher absorption below 325 nm. After that the absorption remains constant. The value of extinction coefficient is also higher for all the samples. The results of the optical studies are correlated and can be used for its possible applications.

Rare earth doped ZrO_2 – PAA nanocomposites were prepared using hydrothermal and doctor blade method. The XRD results revealed the formation of material as nano crystallite and it matches with the standard JCPDS results. The average crystallite size was found to be between 5.18 nm to 8.11 nm. The EDS spectra of samples clearly indicates the presence of expected elements. DLS results give particle size distribution in nano

meters. The FTIR spectra confirms the presence of different functional groups with respective wavenumber, which indicates the small variation in the wavenumber as a function of RE doping content.

The PL study exhibits wide peaks centered at 330 nm in UV emission band and other emission peaks centered at 400 nm to 470 nm in the violet-blue emission band.

The optical properties of material were analysed by UV- Visible Spectroscopy. The optical bandgap of all the samples lie between 3.75 eV to 4.25 eV. The bandgap values are intermediate, compared to pure ZrO_2 which was reported 3.6 eV and for PAA it's very high as it's a polymer material. The refractive index of the samples vary in a very short range from 2.11 to 2.20. Overall, we are getting higher RI with compare to PAA, which was reported 1.395. The variation of absorption coefficient with wavelength shows higher absorption below 310 nm. The value of extinction coefficient is also higher for all the samples.

The results of the optical studies are very convincing for its possible applications and we successfully synthesis Rare Earth doped Transition metal oxide- Polyacrylic acid nanocomposites as an important material for UV-Shielding films.

6.2 Lacunae:

- This study is limited to the doping of 0.1 mol% to 0.2 mol% Rare Earth in TiO_2 / ZrO_2.
- The RE:TiO_2 or RE:ZrO_2 incorporated into PAA with 1 mol% to 2 mol% in the various composite samples.
- In this study we make thin films of a single layer composites only, we can make it with multiple layer also to enhance absorption but might be the transparency get affected.

6.3 Future Scope:

At present, rare earth doped transition metal oxide nanomaterials are gaining importance due to their novel properties. Polymeric nanocomposites owing to improvements in electrical, thermal, optical and mechanical properties.

We synthesis novel and less investigated RE doped transition metal oxide- polyacrylicacid (PAA) nanocomposites and study its optical properties. One can also use different synthesis techniques to synthesis nanoparticles as well as polymer nanocomposites as per requirement of appropriate applications.

Material can be explored and characterised in such a way that one can investigate a specific application out of the potential applications of the synthesized nanocomposites.

By varying the RE doping concentration and by selection of different rare earth elements used in present work, one can be able to find other unique properties of the synthesised material also.

This is the first study of its kind and can be taken further with other combination of dopants and metals to focus on other properties of polyacrylicacid like thermal, electrical and mechanical.

The enhancement of the optical properties can be further explored to correspond with other physical parameters and can give rise to potential applications for measurement of such parameters.