Chapter 5

Application

This chapter is devoted to investigate the potential applications of the synthesized nanocomposites. As mentioned earlier, because of their high transparency, high refractive index and attractive optical properties, polyacrylicacid-rare earth doped transition metal oxide nanocomposites applied in various field like anti-corrosion coatings, anti-reflection coatings, glass replacement and UV shielding films. The results of the optical studies are associated to the applications.

5.1 Introduction:

Polyacrylic acid (PAA) is a transparent and rigid thermoplastic material, it is known as acrylic sheets. PAA has many technical advantages like impact resistance, UV stability, weathering, excellent light transmittance, chemical resistance and strength over other transparent polymer.

- Impact resistance – Acrylic has higher effect opposition than glass. In the event of any harm, acrylic won't break into little pieces yet all things being equal, will crack. Acrylic sheets can be utilized as greenhouse plastic, playhouse windows, shed windows, airplane windows and so on as a choice to glass.
- UV stability – Utilizing acrylic sheets outside opens the material to conceivably high measures of UV rays. Acrylic sheets are additionally accessible with an UV filter.
- Excellent Light transmittance – Acrylic sheets send up to 92% light, while glass can just communicate 80-90% light. As straightforward as precious stone, acrylic sheets send and mirror light in a way that is better than the finest glass.
- Environment friendly – Acrylic is an eco-friendly plastic other option, with economical turn of events. After the creation of acrylic sheets, they can be reused through a rejecting cycle. In this cycle, the acrylic sheets are squashed, and afterward heated prior to being re-dissolved into fluid syrup. When the entire process is finished, new sheets can be made out of it.
- Glass like transparency – Acrylic has properties to keep up its optical clearness and sets aside an extensive time of effort to blur.
- Easily fabricated and shaped – Acrylic sheets possess good moulding characteristic. At the point when heated to 100 degrees, it very well may be effortlessly formed into different shapes including bottles, pictures edges and cylinders. As it chills off, acrylic holds to the framed shape.

- Lightweight – Acrylic weighs 50% less than glass which makes it easier to handle.
- Cost effective – Acrylic sheet can be produced at half the cost of glass. So, it is economical.
- Safety and strength – Acrylic sheets have 17 times stronger than the glass, which means it takes a lot more force to shatterproof acrylic. These sheets have been defined to give security, safety and strength simultaneously making glass look acrylic extraordinary as a substitution.

The prime necessity of optical and optoelectronic devices is most extreme productivity in the light assortment and synthesised material applicable to Anti-Reflection coating also.

Application of antireflective (AR) coatings is an attractive strategy for reducing the optical loss of numerous optical devices, such as optical lenses, flat panel displays and solar cells [2]. PAA is the good suitable materials used as AR coating due to its electrical, optical, self-cleaning and antifogging properties. In such manner, the highest covering of the solar panels has served well for the need through its better transmission and glare decrease properties, which are accomplished by the PAA coatings [3]. It has already been studied that a normal solar panel absorbs solar radiation.

In ARCs, control of refractive index (RI) is mandatory and necessary to get the desired performance. Incorporation of high-RI nanoparticles into polymer-based AR coatings on the light-emitting surface of a device, light can travel more productively in or out of the gadget, leading to better efficiency and image quality.

ARCs gives the upgrade in straightforwardness and decrease of glare. ARCs despite having exemplified their application in the field of solar cell still posture huge difficulties as to their performance throughout some undefined time frame. Appropriate among these is the issue of debonding or stripping of the ARCs applied on solar panels as well as eyeglasses.

Solar cell is an electrical device that converts the solar energy into direct current power. Further, when the light beams strike cell, the semiconductor material absorbs a part of light energy that moved to the semiconductor along these lines actuating free electrons to flow openly a specific way. Along these lines, the flow of electron produces electrical energy from light energy. In electronics and solar cell, the usage of formed polymer coatings to improve the productivity of solar cell. Polymer offers numerous forthcoming applications in solar cell innovations that can assist with accomplishing the absolute cost effectiveness by upgrading significant parameters, for example, lower cost, better design flexibility and durability as contrasted with different materials in current use [3].

The differentiation of a convoluted optical framework with multiple lenses is poor. The transmitted energy of a solar cell framework will be outstandingly lost from different reflections. As needs be, an AR coating can improve differentiation and raise the proficiency of a solar cell framework. The conversion efficiency or electrical efficiency is a crucial factor in the Solar system [4].

The integrated reflectance of the ARC structure was lessening to about a similar degree of the reflectance acquired utilizing antireflection coating deposition by traditional strategies [5].

In actuality, the materials that show higher penchant towards ductile break will in general display solidness however to endure the whole existence of a solar cell with steady execution is the thing that calls for thorough exploration and continuous testing of the antireflective coatings.

5.2 UV-shielding Films:

As shown in **Figure 5.1** there is a wide UV band in solar spectrum, UV region covers the wavelength range 100-400 nm. These UV rays are only blocked in part by the atmosphere. They are responsible for tanning of skin but too much exposure to them can lead to eye damage, redness, skin aging, sunburn and consequently skin cancer. Shorter the wavelength higher the damage, results in serious damage to commonly used organic materials as well as human health [6]. Therefore, the development of UV-shielding materials has attracted considerable attention in the field of coating and sunscreen to reduce the destruction by UV irradiation. It is necessary to search for novel UV-shielding materials with high stability.

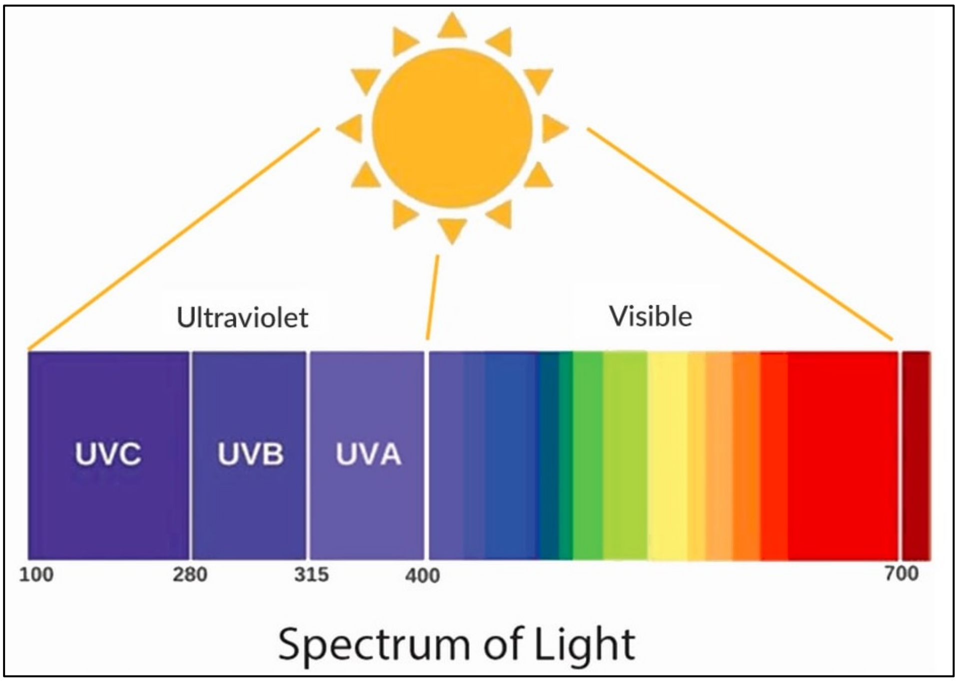

Figure 5.1: Spectrum of Sunlight [7]

As discussed in **chapter 3** and **chapter 4,** all the samples show higher absorption below 325 nm. After that, the absorption remains constant throughout the visible range. 1 mol% of RE doped TiO_2 blended with PAA **(**PTRE1) and 1 mol% of RE doped ZrO_2 blended with PAA **(**PZRE1) samples show higher absorption of UV in comparison with 2 mol% of RE doped TiO_2 blended with PAA **(**PTRE2) and 2 mol% of RE doped ZrO_2 blended with PAA **(**PZRE2) samples.

We selected composites of PTRE1 and PZRE1 for UV-shielding films. We set up an experiment to measure the UV absorption in terms of current by the samples. We made a small sample box with 1 x 1 inch^2 sample holding window, through which UV radiation will be detected by a diode (detector) and measure a current using **KEITHLEY 2400** with Source Voltage of 0.8V (Vsrc) shown in **Figure 5.2**. The whole setup was then put in a closed wooden box for a safety purpose shown in **Figure 5.3**. For UV irradiation, we used **Philips TUV 11W G11 T5 (UV source)** with a regulated power supply through **UPS**. We measure a current at a constant temperature of 25 ^{0}C shown in **Table 5.1** with compare to pure PAA and a blank glass, to ensure we put a probe of a digital thermometer inside the small sample box.

We measured a current for **Philips clear GLS Incandescent Bulb 60W (normal source)** and **Philips BR125 IR 250W (IR source)** under the ideal situation as mentioned above**.** Change in current observed, but we did not get significant change in current as our composite material shows absorption in UV region only.

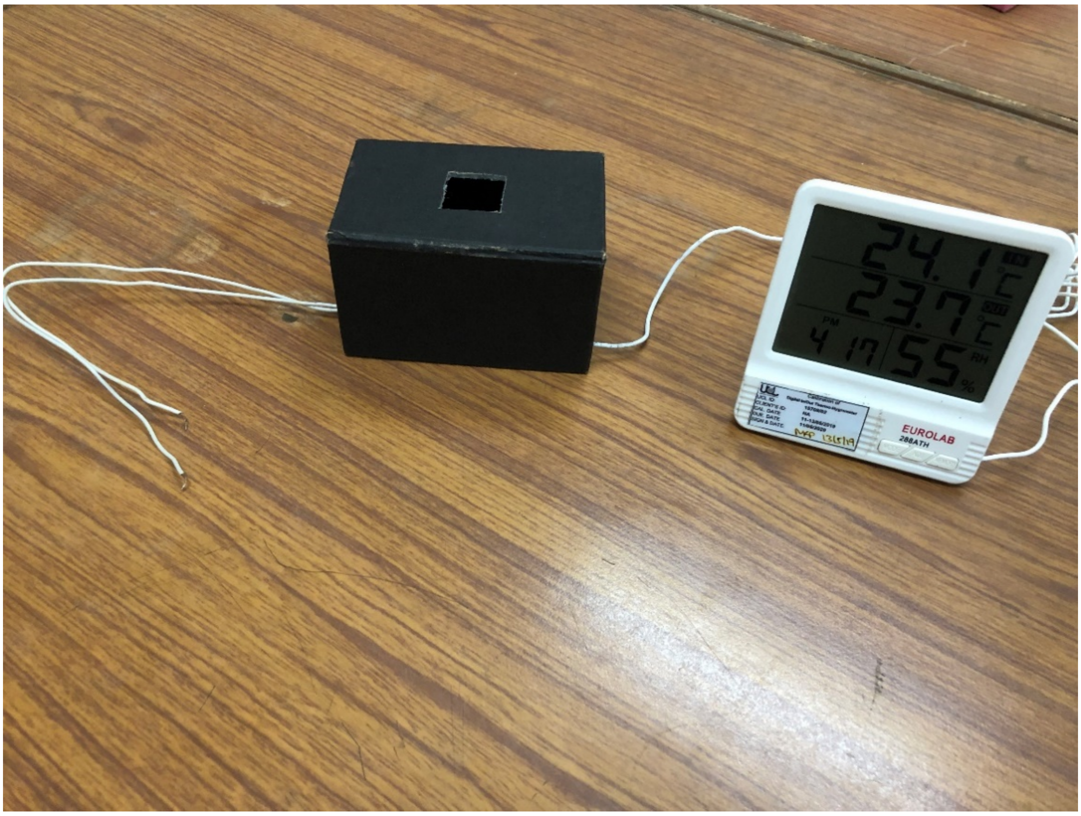

Figure 5.2: Image of small sample box

We recorded the indoor temperature change of the box as a functionf of irradiation time, but the change was negligible as UV source is not a good generator of heat.

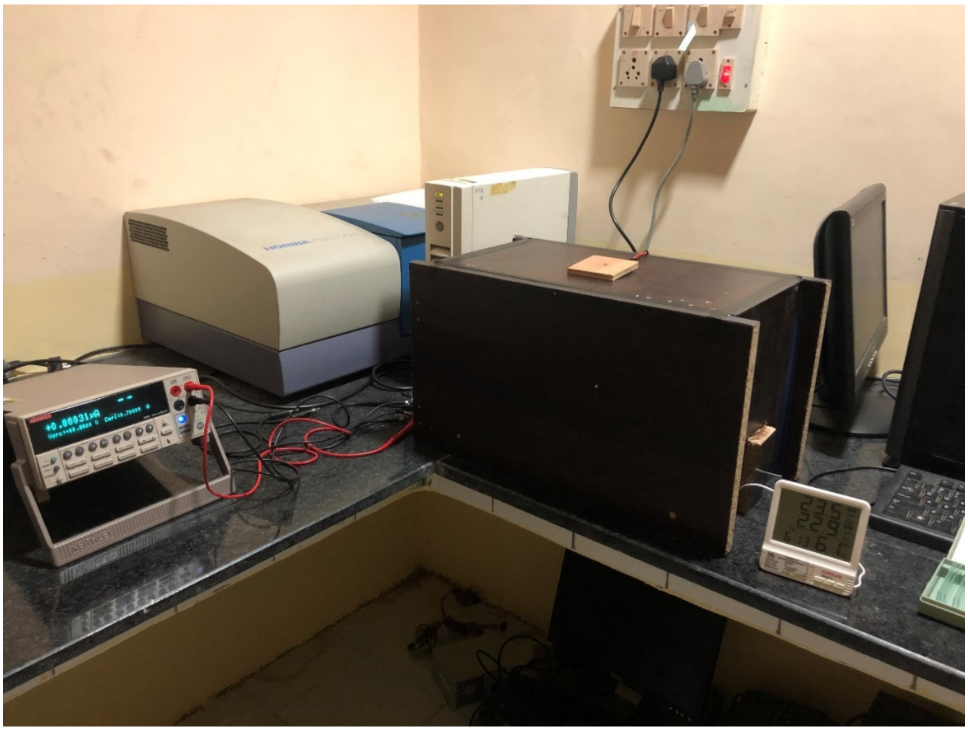

Figure 5.3: Actual image of experimental setup for UV irradiation

Table 5.1: Current measurement for UV irradiation

Sample	Current I (mA)
Blank	75.431
PAA	74.683
PTCe1	73.481
PTDy1	72.123
PTEr1	73.612
PTEu1	72.489
PTPr1	72.581
PTTb1	73.756
PTTm1	73.624
PZCe1	73.712
PZDy1	73.358
PZEr1	73.890
PZEu1	73.243
PZPr1	73.419
PZTb1	73.218
PZTm1	73.111

It is clearly seen that the value of the current for a blank glass is 75.431 mA and for a pure PAA film, it is 74.683 mA as shown in **Table 5.1**. There is a small decrement in the value of current because pure PAA also shows small absorption in UV region. The current value of all the nanocomposites (thin film) show comparatively large decrease with compare to blank glass as well as pure PAA and reinforced by the results of UV-Vis Spectroscopy where the samples show higher absorption than pure PAA.

The difference of the current with compare to blank glass represented in bar diagram shown in **Figure 5.4**. There is a significant difference observed and supported by the UV-Vis Spectroscopy results. From optical properties study, the polymer nanocomposites with higher absorbance like PTDy1, PTEu1, PTPr1, PZTm1, PZTb1 and PZEu1 show highest current difference.

The best results observed for the PTDy1, PTEu1 and PTPr1 nanocomposite thin films, which is completely in correlation with the results of UV-Vis Spectroscopy discussed in **Chapter 3**. Where RE:TiO_2-PAA composites show relatively higher absorption and found to be decreasing in a pattern given by PTDy1> PTEu1> PTPr1> PTCe1> PTTm1> PTEr1> PTTb1.

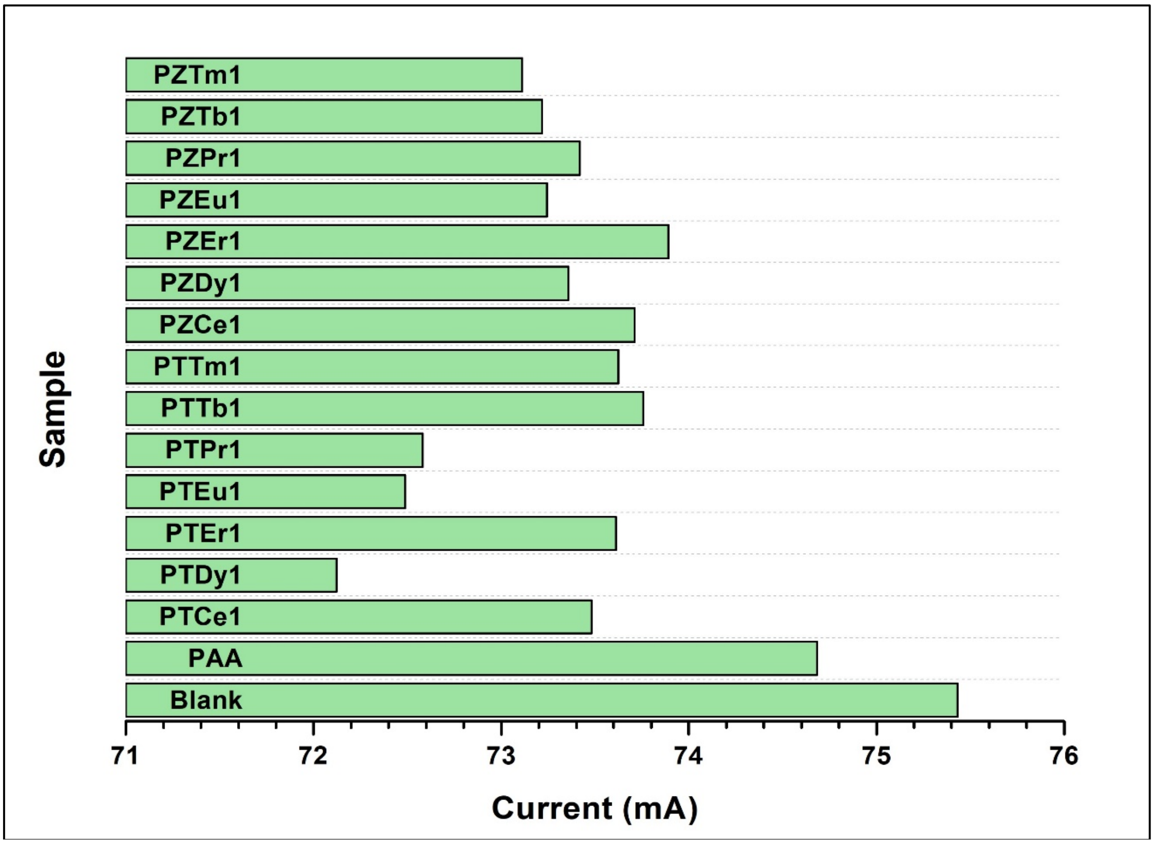

Figure 5.4: Bar diagram for Current measurement

5.3 Summary:

One of the major applications of rare earth doped transition metal oxide: Poly Acrylic Acid composite is in UV-shielding thin films, where it is expected that the materials would absorb the UV rays more effectively with compare to blank glass and pure PAA. To explore this aspect, we set up an experiment in the laboratory using nanocomposite materials as UV-shielding thin films for the study. The parameters were recorded and the results show that the current decrement in prepared thin films is more with compare to pure PAA. The best results are obtained for the PTDy1, PTEu1 and PTPr1 nanocomposite thin films. Hence, We successfully synthesis Rare Earth doped Transition metal oxide- Polyacrylic acid nanocomposites as an important material for UV-Shielding films.

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