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COMPARISON OF OPTICAL PROPERTIES OF poly(vinyl acetate)/polyindole COMPOSITE FILM PREPARED USING DIFFERENT OXIDANT

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ABSTRACT :

In present research paper, comparison of optical properties of poly(vinyl acetate)/polyindole composite film prepared using different oxidants via chemical oxidative polymerization method. The developed composites films were characterized via ultraviolet–visible (UV–Vis) and X–ray diffraction (XRD) technique. The XRD pattern ofcomposite represents the semi crystalline nature of the prepared materials. The PVAc/PIN composite films developed through oxidant ferric chloride has higher optical energy band gap as compared to via chromium chloride. The optical band gap energy represents the application potential in optical devices.

KEYWORDS : *Poly(vinyl acetate)/polyindole;composite; optical; band gap.*

1. INTRODUCTION

The polymers are generally known as insulator. The worldwide use of polymers as insulating material is at large scale. Recently, the new trend is emerged to prepare the conducting polymers rather than the traditional polymers (insulating materials). The conducting polymers like polyaniline, polypyrrole, polythiopene, polyindole are synthesized and modified in last few decades. Moreover, the derivatives, co–polymers, composites and nanocomposites of conducting polymers are developed through different synthesis methods in recent years. Also, there various properties are widely studied like, electrical properties, optical properties, thermal properties and sensing properties on the basis of their application point of view. The polyindole is a newest and least investigated conducting polymer as compared to other. Therefore, polyindole got more research interest than other in last few years.Polyindole is prepared via various synthesizing techniques and represents the remarkable application potential in various fields [1–16].

Some researchers were reported the their work on synthesis and application of PIN, Its copolymers and composites with various polymerization technique like, Giribabu et al. synthesized polyindole nanowires by oxidative polymerization and studied electrochemical properties [17].Bhagat et al. reports the UV–VIS spectroscopic studies of novel one pot synthesized polyindole/poly(vinyl acetate) (PIN/PVAc) composite films chemically using an oxidant nickel nitrate [18].Gupta et al. reported interfacial synthesis as well as miscible solvents aqueous phase synthesis of polyindole moreover development of polyindole microspheres and nanorods [19].Sari et al. synthesized polyindole (PIN) and polyindole/polyethylene (PIN/PE) conducting composites, having different amounts of PIN by chemical polymerization using $FeCl_3$ as an oxidant and taking the ratio of salt:monomer.Moreover, studied conductivities, sedimentation stabilities, ER properties as well as creep–recovery response of the prepared materials [20].Bhagat et al. investigated optical parameters and thermal analysis of Cu doped poly(vinyl acetate)/polyindole composites using cupric chloride as an oxidant [21]. An et al. reported a comparative study of the microemulsionas well as interfacial polymerization for polyindole [22].

The aim of the present work is to developed the composite material where indole is polymerized in presence of polymer matrix by a simple, inexpensive and environment friendly chemical oxidative polymerization technique to prepare poly(vinyl acetate)/polyindole composite film.

This paper presents the comparison of optical properties of poly(vinyl acetate)/polyindole(PVAc/PIN) composite film prepared using different oxidants like ferric chloride and chromium chloride. The synthesized composites films were characterized by ultraviolet–vis (UV–Vis) and X–ray diffraction (XRD) technique.

2. EXPERIMENTAL

All chemicals were analytical grade (AR). Moreover,indole as monomer, ferric chloride ($FeCl_3$), and chromium chloride ($CrCl_3$) used as oxidants, methanol used as organic media and all were procured from SD Fine Chemicals, India. The poly(vinyl acetate) (PVAc) used as polymer procured from Himedia Chemicals, India.

The poly(vinyl acetate)/polyindole (PVAc/PIN) composite films were synthesized at room temperature by chemical oxidative polymerization technique. The ferric chloride ($FeCl_3$), and chromium chloride ($CrCl_3$) were used as oxidant. Mixed solutions of PVAc and methanol were developed by suspendingpolyvinyl acetate (1 g) in methanol (9 ml) and mixed about 1 h and kept it for 24 h to create homogenous solution. Subsequently, indole (0.5 g) (monomer)was added into poly(vinyl acetate) solutions and constantly stirred for 60 Min. The monomer indole was chemically polymerized by adding oxidants $FeCl_3$ and $CrCl_3$(each 0.08823 g) (15 wt%), respectively, and constantly stirred about 120 Minute to complete reaction of chemical oxidative polymerization.PVAc/PIN composite solutions were kept for 60 Minute to obtain settled solutions. Then, these mixed solutions of PVAc/PIN were poured on optically plane and chemically cleaned glass plates to developed films.

The composite films were dried out by an isothermal evaporation of organic solvent. Consequently,complete assembly was located in a dust–free chamber retained at steady temperature. After evaporation of organic solvent isothermally, films were rinsedby hot distilled water and take out from glass plates. Then, PVAc/PIN films were once moredried out for 6 h at room temperature. In that manner, PVAc/PIN composites with different oxidants were prepared.

The Ultraviolet–Visible (UV–Vis) spectroscopy was carried on Agilent Technologies, Cary 60 UV–Vis, toestimate optical band gap and studied the %absorption of material. The X–ray diffraction patterns were deliberateviaCu$K\alpha$ (λ = 1.5406 Å) radiation. The intensity was considered as a purpose of 2θranges over 10–70° at room temperature.

3. RESULTS AND DISCUSSION

X–ray diffraction (XRD) analysis

The figure 1. reflects XRD patterns of PVAc/PIN composite films. The broad hollow and noisy peaks presents in XRD patterns are attributed to presence of polyindole, demonstrating its amorphous nature. The polymer chain separation has been estimated using the relation given in equation [21],

$$R = \frac{5\lambda}{8\sin\theta} \qquad (1)$$

Where, λ = Wavelength of X–ray source used for XRD pattern analysis and θ is diffraction position. The values of polymer chain separation of PVAc/PIN composite films were estimated viathe peak value of the broad hollow. The 2θ position ranges over 16.45–26.61° and the average polymer chain separation was in the range 5.3954 and 4.6178 Å respectively.

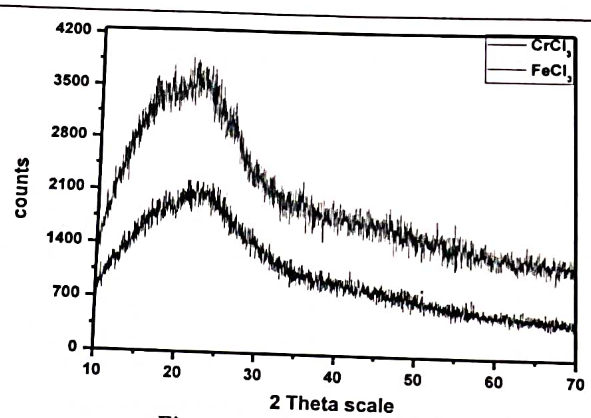

Figure 1. : XRD pattern.

The 2θ position of broad hollow and value of average polymer chain separation of synthesized PVAc/PIN composite films are listed in table 1.

Table 1: Broad hump at 2 theta position, average polymer chain separation.

Sample	Broad hump at 2 theta position	Average polymer chain separation R (Å)
$FeCl_3$	16.45–25.69	5.3954
$CrCl_3$	17.84–26.61	4.6178

UV–Vis Analysis

The UV–Vis spectrum of PVAc/PIN composite filmsranges over190–450 nm reflects in figure 2. Moreover, it is observed that the higher wavelength has lower percentage absorption and lower wavelength side has higher percentage absorption. It was undoubtedly observed that the strongest peak of the absorption for chromium chloride ferric chloride emerges at wavelength 225 nm and owing to the optical transition to the conduction band from valence band [23–25].

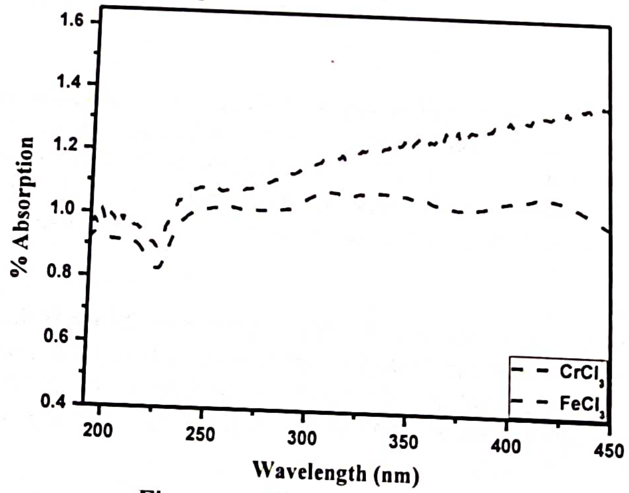

Figure 2. : UV-Vis spectrum.

Optical Band Gap

The optical band gaps of PVAc/PIN composite films has been calculated from figure 3as well as following equation [26, 27],

$$\alpha = \frac{A(hv - Eg)^n}{hv} \quad (2)$$

where,hv is the incident photon energy, α is the absorption coefficient, E_g is the optical band gap of material, and A is the constant. The figure directly shows that PVAc/PIN composite films prepared through oxidizing agent chromium chloride have lower optical energy band gap value than ferric chloride. The values of optical band gap energy of the developed composites were determined as 3.31 and 2.459 eV for oxidants ferric chloride and chromium chloride, respectively.These composite materials have application potential in the polymeric optical devices, photo catalytic activities, as well as polymeric solar cells that is observed from optical energy band gap values of both materials.

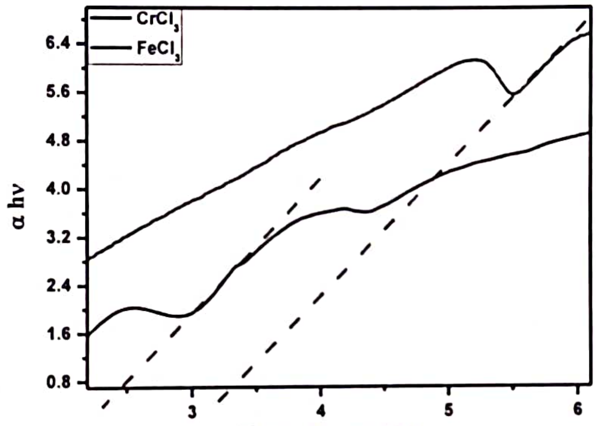

Figure 3. : Optical band gap.

The optical energy band gap of PVAc/PIN composite filmsshows the little difference in values, it may due to structural change in synthesized materials due to different oxidants used for synthesis. Moreover, it is cleared that, PVAc/PIN composite films synthesized using oxidant chromium chloride has lower optical energy band gap as compared to using ferric chloride.

4. CONCLUSION

The successful developments of PVAc/PIN composite films were done by chemical polymerization technique through two different oxidants. The values of optical band gap energy of the prepared composites were estimated to be 3.31 and 2.459 eV for oxidants ferric chloride and chromium chloride, respectively. The optical band gap energy has represents the potential for photovoltaic activities. Therefore, it concludes that PVAc/PIN composite film potential of application in the polymeric solar cells and optical devices.

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