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Optical and Microstructural Studies on Chalcone Doped PMMA

V. Ravindrachary[(1)*], S. D. Praveena[(1)], R. F. Bhajantri[(1)], Ismayil[(1)], J Seetharamappa[(2)], Vincent Crasta[(3)]

(1) Department of Studies in Physics, Mangalore University, Mangalagangotri-574 199, India
(2) Department of Chemistry, Karnatak University, Dharwad- 580 003, India
(3) Department of Physics, St. Joseph Engineering College, Vamanjoor, Mangalore 575 028, India
* Corresponding author, e-mail: vravi2000@yahoo.com

Abstract: Poly(methyl methacrylate) (PMMA) films embedded with functional material 1-(4-methylphenyl)-3-(4-N,N, dimethyl amino phenyl)-2-propen-1-one (MPDMAPP) chalcone derivative are efficiently prepared using solution casting technique. The structural and optical properties of these films were investigated by FTIR, UV-visible and Fluorescence spectroscopic techniques. The Fluorescence microscopic imaging for these samples shows interesting optical properties ie yellow colored film emits Blue color under 330 nm excitation; Green color under 470 nm and Red color on 510 nm excitation. The behavior of these samples indicates that the films are photochromatic in nature and good candidate for Write Once Read Many or digital optical storage devices.

The intensified interest in polymers is due to their low cost, easy processability and light weight as well as some special structural and optical properties. These properties of polymers can be tuned by doping it with some organic compounds. PMMA is a clear, colorless polymer has proven to be a potential candidate for many applications. It is an important thermoplastic material with excellent optical transparency and low birefringence. Among the organic NLO chromophores, chalcone derivatives embedded in a polymer shows good optical properties like polarization, color change, polymorphism, molecular refraction, halochromism behavior etc. Hence the optical properties of these chalcone chromophore doped polymers should be extensively studied [1].

PMMA films doped with different wt% of MPDMAPP were prepared by solution casting method using Dichloromethane as a common solvent. The FTIR study was carried out using Thermo Nicolet Avatar 330 FTIR spectrophotometer in the range 400-4000cm^{-1}.The UV-visible study was performed using SHIMADZU (UV-1601) UV-Visible Spectrometer in the wavelength range 195-700nm. The Fluorescence spectrometric measurements were conducted using Hitachi F-2000 Fluorescence Spectrophotometer with 500W Xenon lamp as an excitation source by exciting the sample with 270 nm and 450 nm wavelengths. The Fluorescence images of the films were taken using OLYMPUS BX-51 optical microscope with different optical filters of wavelength ranges: 330-385nm, 470-490nm and 510-550nm.

From the FTIR spectra it is understood that there is a small shift and variation in intensity indicates that there exists a strong inter/intramolecular interaction of chalcone with polymer, which modifies its microstructure. The UV-Visible spectrum reveals that there are three absorption bands at 220, 260 and 365nm for the doped PMMA attributed to $n\rightarrow\pi^*$, $n\rightarrow\pi^*$ and $\pi\rightarrow\pi^*$ transitions respectively. It is observed that these bands shifted to 225, 265 and 402nm respectively, for higher dopant concentration. The optical energy band gap E_g is determined by translating the absorption spectra into Tauc's plots. Here three optical band gaps were observed and are decreases with increasing dopant level. The fluorescence spectroscopic studies have been carried out for 270nm and 450nm excitation wavelengths. The fluorescence peak intensity increases and emission wavelength shifts to higher wavelength upon doping. The fluorescent behavior of MPDMAPP molecules within the PMMA matrix shows "aggregation-induced enhanced fluorescence emission". This is mainly due to the dominant nonradiative intermolecular fluorescence resonance energy transfer (FRET). The MPDMAPP contains donor-acceptor system in which a donor starts to emit when the excited molecule (donor molecule) sees a nearby molecule (acceptor molecule) within a few nanometers. The emission peak (497nm) for higher doping suggests that there is a strong hydrogen bonding interactions between PMMA and chalcone which create charge transfer groups. The Fluorescence microscopic imaging for these samples shows interesting optical properties. The yellow colored film emits Blue color under 330nm excitation; Green color under 470nm and Red color on 510 nm excitation. This behavior of our chalcone doped PMMA samples shows photochromatic behavior [2]. Hence the incorporation of such multifunctional photochromic chalcone derivative in polymers represents the future of digital optical storage.

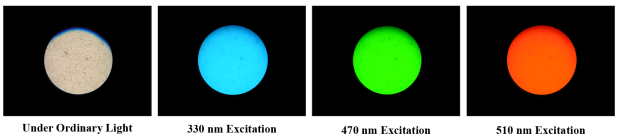

Figure 1: Fluorescence microscopic images of the PMMA/MPDMAPP composite film

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