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Electrical And Optical Properties Of Ferric Doped PVA-PVP-PPy Composite Films

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Abstract. The analysis of experimental optical spectra & electrical properties of PVA-PVP-PPy composite films is discussed in this paper. The optical parameters like activation energy of optical transitions and the optical band gap for direct and indirect allowed transitions were determined for PVA-PVP-PPy composite films doped with different concentrations of ferric chloride. The optical band gap showed best fit for indirect allowed transitions, and there is a decrease in the optical band gap with increase in concentration of ferric chloride. The DC electrical properties of these films indicated agreement with Mott's Variable Range Hopping Model in three dimensions. The width of the forbidden band gap was determined from the Arrhenius relation after experimentally studying in-situ, the variation of DC electrical conductivity with temperature.

Keywords: Conducting polymer, Ferric Chloride, Doping, Composite, Band gap, Electrical properties, Optical properties.
PACS: 82.35.Jk, 64.70.km, 68.55.Ln, 78.40.Pg, 72.60.+g

INTRODUCTION

The variation of band gap with doping level in the case of conducting polymeric composites is a matter of contemporary research. The analysis of optical spectra yields information about the nature of optical transitions, Urbach energy, optical band gap and activation energy [1]. The analysis of the variation of DC electrical conductivity of these films with temperature yields band gap, and helps determine the mechanism of electrical conduction in these materials.

EXPERIMENTAL

The procedure of preparation of the doped composite films and their thermal characterization has been described by us elsewhere [2]. The DC electrical study was performed using a two probe set-up, PID Controlled oven, nano-ammeter & power supply; all from SES Instruments Co., Roorkee. Optical spectra were recorded for the composite films in the range 200 to 800 nm using a Hitachi UV-Visible spectrometer.

RESULTS AND DISCUSSION

The optical band gap showed best fit for indirect allowed transitions, and there is a decrease in the optical band gap with increase in concentration of ferric chloride (see figure 1 and table 1).

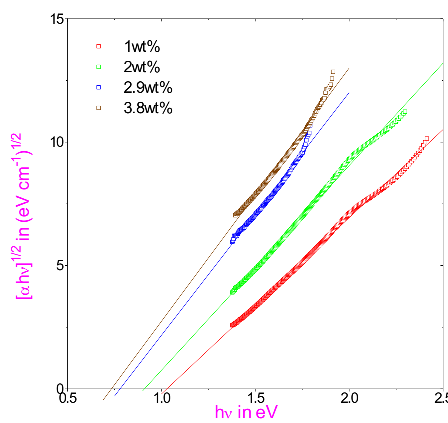

FIGURE 1. The variation of $(\alpha h\nu)^{1/2}$ Vs hν. The x-intercept of the linear fit of the absorption edge gives the energy gap due to indirect allowed transitions.

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The Urbach energy is obtained as the reciprocal of the slope of lnα with hν (see figure 2).

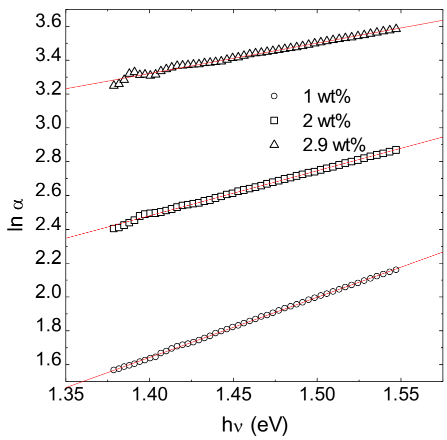

FIGURE 2. The variation of lnα Vs hν. The slope of the linear fit gives the Urbach energy, the width of band-tails in the forbidden energy gap.

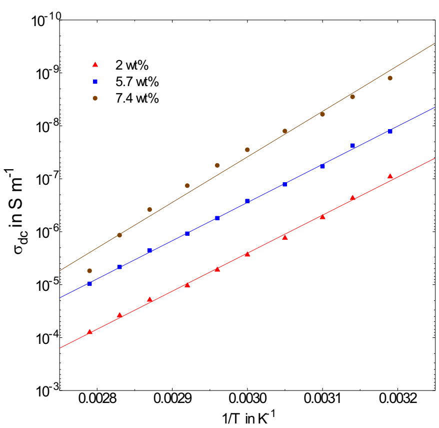

FIGURE 3. The Arrhenius plot (for DC electrical conductivity). The width of forbidden energy gap has been determined from the slope of the linear regression.

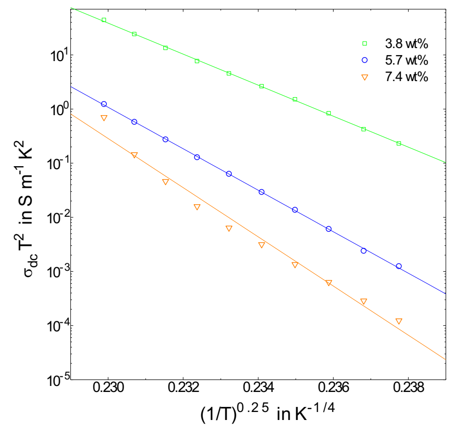

FIGURE 4. The good straight line fit for the plot of σT^2 with $(1/T)^{0.25}$ indicates agreement with Mott's Variable Range Hopping model in three dimensions.

Note the increase in Urbach energy with doping level (table 1). The electrical data was analyzed to yield plots of electrical conductivity versus reciprocal temperature (Arrhenius plot), the slope of which is used to determine the band gap(see figure 3). The plot of σT^2 versus $(1/T)^{1/(n+1)}$ is checked for linear fit, for n=1,2,3., corresponding to one, two and three dimensional Mott's Variable Hopping mode of electrical conductivity. The best straight line fit was observed for n=3 (see figure 4).

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REFERENCES

1. M.R.Ranganath and Blaise Lobo *Solid State Physics (India)* **53**, 589-590 (2008)
2. Ravikumar V Patil, M R Ranganath and Blaise Lobo *AIP Conf. Proc.* 1393, 371-372 (2011)

TABLE 1. Summary of parameters extracted from experimental data (Optical data)

Doping Level (wt%)	Band gap (Optical) in eV	Activation energy in eV	Urbach energy in eV
1.0	1.20	1.28	0.28
2.0	0.91	1.18	0.38
2.9	0.78	1.04	0.56