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Thermal Behavior of Polythiophene Composite Thin Films doped with Iodine

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ABSTRACT

Synthesis of polymer composites poly (vinyl acetate) (PVAc) and polythiopene (PTh) was done by chemical oxidative method using ferric chloride oxidant in methanol. Thin films with PTh-PVAc polymer composite were prepared for 5.5, 10.4, 14.9, 18.9 and 22.5 wt % of Iodine as a dopant. Dielectric relaxation activation energy and relaxation time is found to be maximum for 10.4 wt% of Iodine. Bulk capacitance is found to be maximum for 5.5 wt % of Iodine.

Keywords: Poly (vinyl acetate) (PVAc), Polythiophene (PTh), Iodine, dc, ac.

I. INTRODUCTION

Numbers of applications have been proposed for PThs such as field effect transistors, electroluminescent devices solar cells, photochemical resists, nonlinear optic devices, batteries, diodes and chemical sensors [1]. Roncali [2,3] surveyed electrochemical synthesis of PThs in 1992 and the electronic properties of substituted PThs in 1997.The overall review on chemical synthesis of PThs and applications as chemical sensors, organic memory devices, photo conductivity etc. is given by many researchers[4-7].

List of optimized samples along with their wt %, sample codes and thicknesses are given in table. The present paper focuses on the thermal behavior of PTh-PVAc composite films using $FeCl_3$ oxidant and Iodine as a dopant with an aim to study durability mechanism. Thermal Gravimetry / Differential Scanning Calorimetry is useful for the determination of changes in weight in relation to change in temperature [8], determination of glass transition temperature etc. TGA/DSC for all the samples of PTh-PVAc composites doped with iodine was obtained from department of Material Engineering, VNIT, Nagpur and SAIF/CRNTS, IIT, Mumbai. In TGA/DSC temperature is maintained upto 973K. The TGA/DSC of the samples was carried out on instrument from Dupont, U.S.A. and heating rate of the sample was 10^{o}C/min.

II. RESULTS AND DISCUSSION

Miscibility between any two polymers in the amorphous state is evidenced by the presence of a single Tg [9,12]. Fig shows the TG curves of Iodine doped PTh-PVAc films in the temperature range 273 to 900 K. It is observed that the thin films lost 50.42 to 55.26 % of its weight when it was heated up to 900 K. This fact indicates that 50.42 to 55.26 % of the sample consisted of polymers and softeners. The residual 20.61 to 26.55 % considered to account for metallic compounds added as sulphides and dopants [13-14].

The two step degradation is observed from the curve [20-21]. The first step occurs in the temperature range 423 to 493 K and the weight loss in this temperature range is quite high 44.58 to 47.01 %. Beyond the temperature 493 K, the weight loss curve appears to be horizontal showing that weight loss is very small which indicating that the physical properties of the polymer content remains constant. In second step degradation the weight loss is observed to be smaller than the first, it is 3.99 to 8.25 % in the temperature range 683 to 773 K for all the samples [13-14]. Weight loss in each step and total weight loss for different wt % of Iodine are tabulated in table . The two step degradation is observed from the curve[15-16]. The first step occurs in the temperature range 423 to 493 K and the weight loss in this temperature range is quite high 44.58 to 47.01 %. Beyond the temperature 493 K, the weight loss curve appears to be horizontal showing that weight loss is very small which indicating that the physical properties of the polymer content remains constant. In second step degradation the weight loss is observed to be smaller than the first, it is 3.99 to 8.25 % in the temperature range 683 to 773 K for all the samples [13-14].

Table1: Weight loss in each step and total weight loss for different Samples.

Composition Iodine (wt%) and sample code	Weight loss (%)		Total Weight loss in step I and II (%)	Residue (%)
	Step I 448 to 513 K	Step II 480 to 683 K		
5.5	46.43	3.99	50.42	24.34
10.4	47.01	8.25	55.26	26.55
14.9	44.58	7.15	51.73	20.61
18.9	47.45	12.93	60.38	18.87
22.5	27.31	8.29	35.60	28.41

Table 2: Thermodynamic Parameters from DTA Curve

Composition Iodine (wt %)	Glass Transition temperature (T_g) (K)	Crystallization exothermic peak			
		Onset Temp.(K)	Peak Temp.(K)	End Temp.(K)	Enthalpy (ΔH_c)(J/g)
5.5(DV_1)	388	424	445	472	35.77
10.4(DV_2)	385	425	447	477	27.21
14.9(DV_3)	362	414	444	463	26.87
18.9(DV_4)	376	415	442	466	27.89
22.5(DV_5)	380	449	465	486	49.26

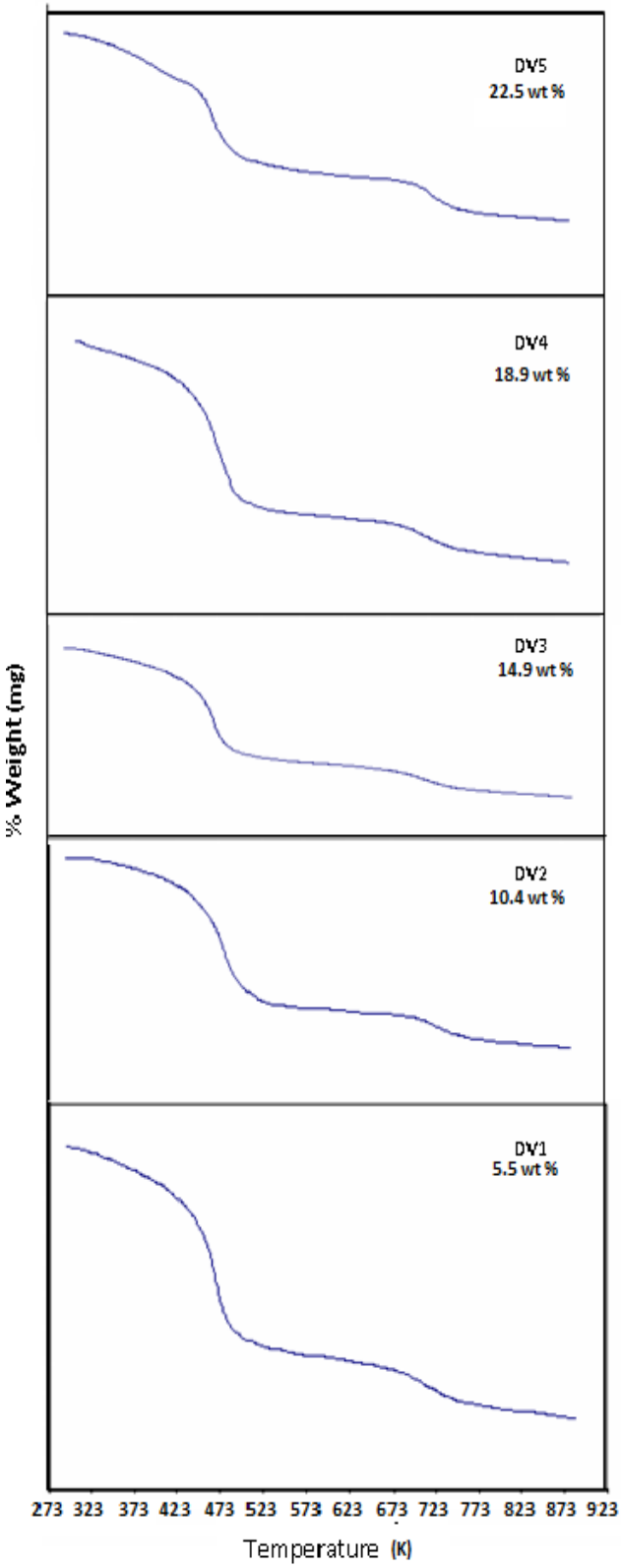

Fig.3: TG Curve for Iodine doped PTh-PVAc films

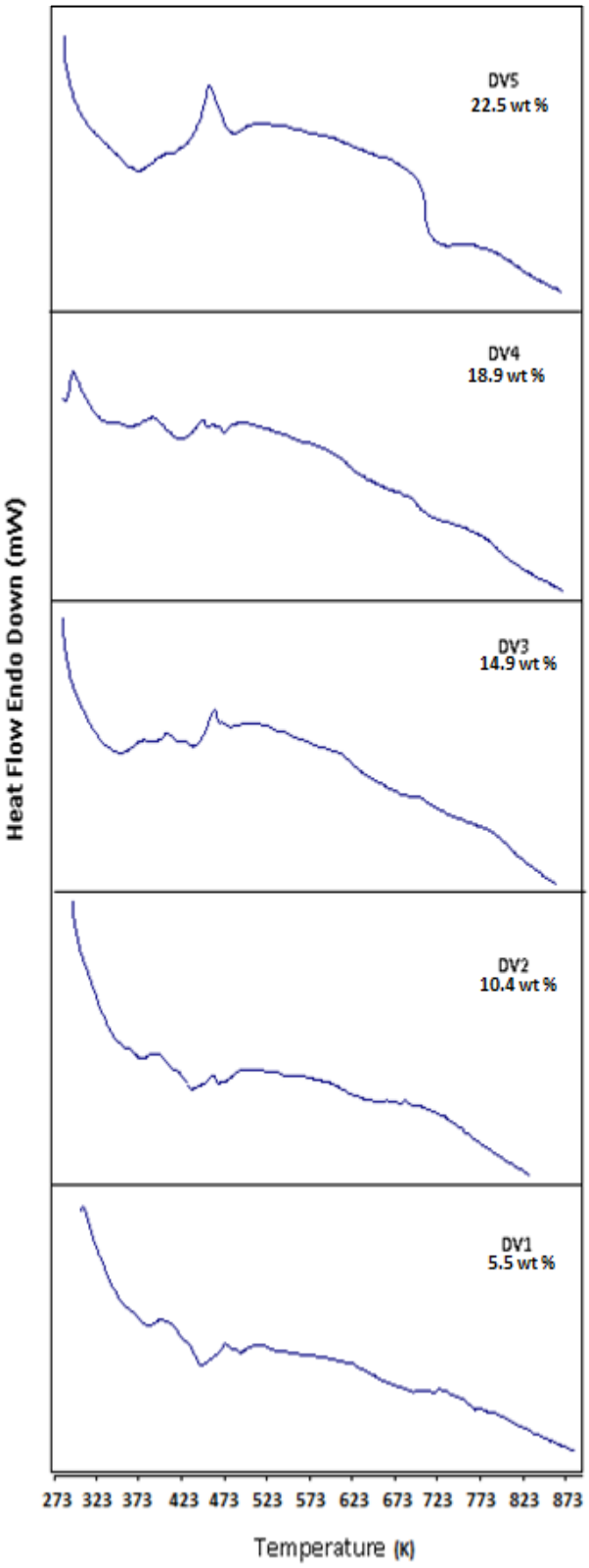

Fig.4: DTA Curve for Iodine doped PTh-PVAc films

III. CONCLUSION

It is observed that all the samples with different wt % of Iodine give the degradation in the range 75 to 81 % when heated up to 888 K. The glass transition temperature is also noted for all the samples which found in the range 362 to 388 K [20]. It is observed that the glass transition temperature decreases with increasing content of Iodine as well as Fe. This means addition of Iodine or Fe relieves the structure of polymer composites and it becomes soft. Also the enthalpy of the composites decreases with increasing content of Iodine

IV. REFERENCES

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