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Fabrication of Dye Doped polymer composite and specific resistance

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Abstract: We fabricated the polymer Polyvinyl alcohol (PVA) composed dye doped (K_2CrO_4) composites. The electrical properties as a function of dye loading were disclosed by using an Impedance analyzer. The optimized specific resistance (Rp) was demonstrated in the range of 10^3 to 10^5. The resistance was controlled by using an external DC bias voltage (0-25 volts). This investigation may be useful for optoelectronic and device fabrication.
Keywords: Polymer, Composite, Impedance, specific resistance.

Introduction

Polyvinyl alcohol (PVA) is a hydrophilic, biodegradable, biocompatible and non toxic synthetic polymer which has been widely used in different areas of research including biological and medical field [1-3]. PVA is manufactured by the hydrolysis of polyvinyl acetate (PVAc). The final properties of PVA are affected by the polymerization, hydrolysis and drying conditions. The excellent physical and chemical properties of PVA have resulted in broad industrial applications [4]. PVA is a semi crystalline polymer and has various interesting properties such as glossy nature, adhesive, easy film forming compactable for various applications [5-7]. Whereas, PVP draws a special attention amongst the other polymer because of excellent wetting properties and readily film form by solution casting. PVP presents a remarkable combination of useful properties such as toxicological safeness, transparency and gloss, chemical/biological inertness, crosslink ability and long lasting adhesion which makes it a unique polymer [8, 9]. The addition of inorganic salts in polymer matrix has been one of the focused areas of research both from a fundamental point of view and the application point of view. Inorganic additives such as transition metal salt have significant effect on the electrical and optical properties of PVA [10,11]. However, studies on K_2CrO_4 doped PVA has not been reported to the best of our knowledge. Therefore, the current work is devoted to study the effect of K_2CrO_4 on the structural, optical and electrical properties of K_2CrO_4 filled PVA films.

Experimental

Materials and Methods:

Polyvinyl alcohol of molecular weight 125000 g/m with degree of hydrolysis 86-89 % was procured from S. D. Fine Chem. Ltd. Mumbai, India. K_2CrO_4 of molecular weight 194.19 g/m was purchased from Sisco Research Laboratories Pvt. Ltd., India. PVA and PVA/ K_2CrO_4 composites films with different concentrations of K_2CrO_4 (5, to 30 % w/w) were prepared by the solution-casting method. First, PVA powder was dissolved in distilled water at 80^oC with constant stirring to get complete dissolution. The required quantity of K_2CrO_4 was also dissolved separately in distilled water and added to the polymeric solution with continuous stirring. The solution so obtained was poured onto a cleaned glass petri dish and kept overnight in an oven at 60^oC for slow evaporation of the solvent. The films were peeled from the plate and kept in vacuum desiccators for further study. The electric properties of PVA/ K_2CrO_4 was measured using Newton's 4th Impedance Analyser (Newtons 4th UK). All the electrical parameters reported here were studied at room temperature at frequencies from 50 Hz to 35 MHz.

Results and Discussions

The electrical properties specifically volume resistance (R_p) was evaluated using PVA/ K_2CrO_4 function of dc bias is shown in Fig. 1 (a-f). R_p of these composite films are increasing with dc bias as well as with the change in frequency. As the concentration of K_2CrO_4 increases in PVA the value of R_p also increases but only at certain dc bias voltage. After a particular dc bias the values of R_p remains constant. This is because the after a particular voltage the movement of electrons are restricted and shrinking of energy band gap is also reduced. But for higher concentration of K_2CrO_4, the highest resistance values were evaluated at high voltages. This is because the high amount of energy was required to bombard the electrons from one band to other. Hence for higher concentration, high amount of voltage is required for higher values of resistance.

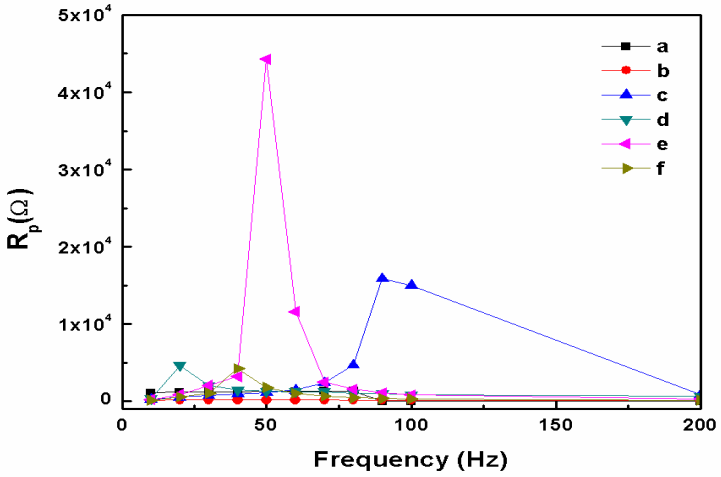

Fig.1. Specific Resistance of PVA/ K_2CrO_4 for a) 95:5, b) 90:10, c) 85:15, d) 80:20, e) 75:25 and f) 70:30 with function of dc bias at varying range of frequency.

Conclusion

Potassium Chromate (K_2CrO_4) is a lemon-colored compound that is in the form of a crystalline solid, and it is very stable. The thin film was prepared using K_2CrO_4 as a dopant in PVA polymer by solution casting method. The electrical characterization of prepared thin films was performed by using impedance analyzer tool. In this study we are specifically concentrated on volume resistance (R_p) of PVA/ K_2CrO_4 composites. The highest R_p value of PVA/ K_2CrO_4 $4.5x10^4$ Ω is obtained for 20 V dc bias at 200 Hz frequency. This results shows that this materials is having good dielectric properties.

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