

Biological Activity and Electrical Behavior of Newly Synthesized Nanoporous Terpolymer Resin Derived from Dithiooxamide with Formaldehyde

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Abstract:

The terpolymer (2, 2'-HBDF) synthesized in the presence of acid catalyst by the condensation of 2, 2'-Dihydroxybiphenyl (2, 2'-HB) and Dithiooxamide (D) with Formaldehyde (F) using 1:1:2 molar proportions of the reacting monomers. The copolymer possesses antimicrobial activity for certain bacteria such as *Staphylococcus aureus*, *Escherichia coli*, and fungi *Aspergillus niger*, *Candida albicans*. Linear graph are found by the plots of $\log \sigma$ vs $10^3/T$ over a wide range of temperature, which indicate that the Wilson's exponential law $\sigma = \sigma_0 \exp(-\Delta E/kT)$ is obeyed. From the electrical conductivity of these copolymers, activation energies of electrical conduction have been evaluated and values lies in the range 7.1×10^{-20} to 4.5×10^{-20} J/K. On the basis of above studies, these copolymers can be ranked as semiconductors.

Keywords: Antimicrobial screening Terpolymer, synthesis, electrical conductivity

Introduction:

The use of terpolymers in all spheres of life has been abundantly increases in recent years because of novelty and versatility. They occupy the pivotal position in the field of polymer science. A copolymer involving 2, 4-dichlorophenylmethacrylate and vinyl acetate was reported as a significant inhibitor for the growth of microorganisms (Patel MM et.al 2003). The progress in this field has been extremely rapid, as they are generally useful in packing, adhesives and coating in electrical sensors, ion exchangers, organometallic semiconductors, activators, catalyst and thermally stable materials, high temperature flame resistant fibers (Niley SN. 2018). Terpolymer approach for controlling the crystalline behavior of naphthalene diimide. based polymer acceptors and enhancing the performance of all polymer solar cells (Kim Y. et al.2016). Although carbon nano tubes are effective fillers to enhance the mechanical and electrical properties of polymers, they cannot be dispersed easily in a solvent or a polymer matrix due to the Vander Waals forces (Vedejo R. et. Al. 2011, Vaia RA et al. 2004). Pal TK reported electrical conductivity of Salicylic acid-Biuret/ Dithiooxamide/ Dithiobiuret- Trioxane terpolymer resins (Pal TK et al 1989). A variety of conjugated organic molecules are known as semiconductors, the carrier mobility in them is usually low. This is due to the difficulties in, which electrons jumps from one molecule to another and hence, the carrier mobility in the compound of this type increasing molecular size. Kanda S. reported the rubeanato-copper semi conductive polymers and studied their AC and DC conductivity (Kanda S. et al., 1961). The resin HBUE-II shows the semiconducting behavior (Kapse SK and coworkers 2013). Poly (3, 4-ethylene dioxythiophene)s are the conducting polymers (CP) with the biggest prospects in the field of bioelectronics due to their combination of characteristics (Mntione D et al 2017).

Synthesis of 2, 2'-Dihydroxybiphenyl (2, 2'-HB)-Dithiooxamide (D)-Formaldehyde (F) i.e. 2, 2'-HBDF Terpolymer Resins:-

Terpolymer resin (2, 2'-HBDF-I) was prepared by condensing 2, 2'-dihydroxybiphenyl (1.86 gm, 0.1 mol), dithiooxamide (1.20 gm, 0.1 mol.) and formaldehyde (7.5 ml of 37 %, 0.2 mol.) in the presence of 2M HCl (200 ml) as a catalyst at $122 \pm 2^\circ\text{C}$ in an oil bath for 5 h (Sanjiokumar S. Rahangdale et.al 2019, 2020, 2021, Santosh P. Chakole, 2020). The solid product obtained was immediately removed from the flask as soon as the reaction period was over. It was washed with cold water, dried and powdered. The powder was repeatedly washed with hot water and methyl alcohol to remove unreacted monomers. The air-dried terpolymer resin was extracted with diethyl ether to remove copolymer. It was further purified by dissolving in 8 % NaOH and then was filtered. The terpolymer was then precipitated by drop wise addition of 1:1 (v/v) conc. HCl/water with constant stirring and filtered. The process was repeated twice. The resulting polymer sample was washed with boiling water and dried in a vacuum at room temperature. The purified terpolymer resin was finely ground to pass through a 300 mesh size sieve and kept in a vacuum over silica gel. The yield of the terpolymer resin was found to be 70%.

Similarly, the other terpolymer resins, 2, 2'-HBDF-II, 2, 2'-HBDF -III and 2, 2'-HBDF -IV were synthesized by, varying the molar proportion of the starting monomers i.e. 2, 2'-dihydroxybiphenyl, biuret and formaldehyde in the ratios 2:1:3, 3:1:4 and 4:1:5 respectively. The samples yield and reaction details are tabulated in Table 1.