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Polymer Film Coatings on Metallic Electrodes Through Post-Polymerization of Acrylamide

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Electro-initiated post-polymerization of acrylamide in aqueous zinc chloride system on aluminium anode and steel cathode is successfully carried out. It has been observed that the cathode is coated uniformly with poly-acrylamide during post polymerization. Appreciable polymer coatings have been obtained when the system is allowed to stand undisturbed for few hrs after electroinitiation.

INTRODUCTION

In course of electroinitiated polymerization, Palit[1-3] observed a new phenomenon in which polymerization continued even after switching off the current. He termed this phenomenon as "Post-polymerization". Subramanian et.al.,[4-6] reported coating of polymer on electrodes through electro-polymerization. To our knowledge polymer film coating on metal through post-polymerization has not been studied till date. This paper reports coating of polymer film on metallic electrodes through post-polymerization.

EXPERIMENTAL

The electrolytic cell in which the post polymerization experiments were carried out, consists of round bottomed 250 ml flask, provided with three inlets, two at sides (B_{12} joints) for the electrodes and one in the middle (B_{24} joints) for nitrogen inlet. Another electrolytic cell used is double chambered cell separated by one sintered glass disk (G_4) and provided with two inlets (B_{24} joints). The electrical potential was applied between the treated electrodes by means of variable D.C. power supply unit (Network make). All the experiments were carried out at normal temperature and pressure.

The dried nitrogen gas through its inlet is fluxed in the aqueous system containing monomer acrylamide (5.0 M) and electrolyte zinc chloride (0.25 M). Electric current at 5 volt (D.C.) was passed for one minute between the treated, dried and weighed aluminium anode and steel cathode. Electrodes were then taken out, washed, dried and weighed so as to get the coating weight during electropolymerization. The cell was then again charged with the same monomer-electrolyte-solvent system and current passed for one minute under similar conditions. The system and the electrodes were then left undisturbed for 2 hrs, after switching off the current. The electrodes were then taken out, washed gently with distilled water, dried and weighed to get coating weight, during post polymerization of 2 hrs. Similar experiments were repeated for 4, 6, 8, 10 and 24 hrs of post-polymerization and respective coating weight were obtained. The effect of change in concentration of monomer on coating weight was studied during post-polymerization.

RESULTS AND DISCUSSIONS

The Table-1 represents the different stages that were encountered in post-polymerization of successful system. The amount of polymer formed per unit area, *i.e.* coating weight, increased regularly with the time during post-polymerization, but an uniform and sticky coating of polymer on cathode was obtained when the post-polymerization was allowed for 4-10 hrs. It is also observed that the coating weight of polymer increases with the increase in concentration of the monomer.

TABLE 1

COATING OF POLYACRYLAMIDE BY ELECTROINITIATED POLYMERIZATION AND POST–POLYMERIZATION OF ACRYLAMIDE USING ALUMINIUM ANODE AND STEEL CATHODE DUE TO PASSAGE OF CURRENT OF 5 VOLT (D. C.) FOR 1 MINUTE.

System	Coating weight during Electro-initiated polymerization (Gm/cm^2)	Time for post-polymerization (Hours)	Coating weight during post-polymerization (Gm/cm^2)
Acrylamide (5.0 M)	0.02	2	0.088
Zinc chloride (0·25 M)		4	0.16
Distilled water (50 ml)		10	0.305
		24	0.32

The IR, NMR spectra and elemental analysis confirms that the material coated at cathode is poly-acrylamide. In IR spectrum of the polymer the absorption band based on terminal methylene appeared at 920 cm^{-1} and vinyl group stretching at 1645 cm^{-1} were absent. It gave NH and CO bond stretching vibration at 3300 cm^{-1} and 1630 cm^{-1} respectively. In the NMR spectra of the polymer sample the methylene proton appears as broad doublet at 2.25 δ and methyne proton as complex triplet at 4.0 δ. The proton attached to amide nitrogen appear at 6.5 δ. The intrinsic viscosity changes very slightly with progress of polymerization which illustrates that the termination takes place by the transfer with monomer, creating a new active, center, which can either recombine to form a cross linked polymer or interact with electrodes to form a polymer layer, bonded to the electrode surface.

CONCLUSION

The present work reports for the first time, a highly unconventional technique of polymer film coatings on electrodes through post-polymerization. Minimum expenditure of energy is needed for coatings of electrodes in the present technique.

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