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Electrosynthesis and study of carbazole–acrylamide copolymer electrodes

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Abstract

Polymerisation of *N*-carbazoles in the presence of acrylamide has been studied by electrochemical polymerisation onto platinum and indium tin oxide (ITO), electrodes from an acetonitrile solution of the monomers and tetraethylamonnium perchlorate-supporting electrolyte. The influence of polymerisation conditions such as electrode potential, monomer concentration, type of solvent and supporting electrolyte on the mechanical and electrochemical properties of final polymers have been studied. The redox behaviour of the polymer-coated electrodes was checked in solution containing ferrocene and dopamine solution by cyclic voltammetry. Depending on the conditions the electrode response may be reversible or quasi reversible. Cationic polymerisation of monomer is initiated either by the monomer cation radical or by the proton generated by the coupling reaction of the cation radical of carbazole. For the characterisation of copolymers Cyclic Voltammetry, UV–vis and FT-IR spectrophotometric, solid state conductivity and SEM measurements were used.

Keywords: Carbazole–acrylamide copolymers; Electrocopolymerisation; Sensor materials

1. Introduction

Many heterocyclic nitrogen compounds, especially carbazole based polymer systems, can be chemically polymerised to yield materials with interesting properties. Most studies examined the chemical oxidation of carbazole [1–6] and its derivatives [7–9]. Polycarbazole (PCz) and its derivatives have been suggested for a number of applications such as redox catalyst, photoactive devices, sensors and electrochromic displays.

The π-electron system along the polymer backbone, which confers rigidity, and the crosslinking points between polymer chains, make polycarbazole insoluble, infusible and therefore poorly processable. Co-processing of polycarbazole may, therefore offer improvements in mechanical properties and processing technology. Carbazole-based polymer systems have received much attention [10–13] because of their interesting thermal, electrical and photophysical properties. Researches have continued for important properties of carbazole polymers by means of chemical modification or copolymerisation of *N*-vinyl carbazole with the other monomers [14–16]. No attempts were reported to obtain polyacrylamide (PAAm)—polycarbazole (PCz) composite or copolymer by electrochemical polymerisation.

In our studies, homopolymerisation of N-substituted carbazoles and acrylamide and characterisation of the resulting product have been investigated in detail previously [17–26], hence our choice of carbazole acrylamide is not random. It has been known that acrylamide polymers have good thermal stability and stable behaviour [27], however mechanical properties of carbazole homopolymer is weak, they show fluorescence, photoactivity and conductivity properties [28,29]. In order to test the effect of acrylamide onto carbazole structure, thermal and surface character of copolymers have been studied [30]. According to the ellipsometric and thermal (DSC) measurements of AAm–Cz copolymers which have been prepared under these conditions support the idea that optical and thermal properties of resulting copolymer have been effected by oxidation potential, reaction medium and can be improved as compared with homopolymers.

The present article deals with the incorporation of acrylamide during the polymerisation of carbazole prepared electrochemically with the aim of obtaining a new polymer, which may exhibit properties of different monomers incorporated within. Therefore, acrylamide–carbazole copolymer would exhibit the combined properties of both polycarbazole and polyacrylamide.

The electrochemical oxidation of dopamine at the polycarbazole electrode was previously examined [31,32] and exhibits semi-reversible behaviour in the buffer solution (pH = 7.35–7.40). In this study, cyclic voltametric response

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