



Note

Electrochemical synthesis of EDOT–ECZ–EDOT copolymer on carbon fiber micro-electrodes

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Abstract

3,6 bis(3,4-ethylenedioxythiophenyl)-9-Ethylcarbazole (EDOT-ECZ-EDOT or EEE) films are coated electrochemically onto carbon fiber micro-electrodes. Deposition conditions on the electroactivity of the resulting polymers are studied. Structural studies of the polymers have been conducted using different techniques such as cyclic voltammetry, ATR-FTIR, scanning electron microscopy and four-point probe conductivity.

1. Introduction

Conducting and redox active polymers have attracted attention due to their wide application, and their inexpensive and potentially processable nature [1]. Functional conjugated polythiophenes, in which the electronic properties inherent to the p-conjugated systems are associated with new specific properties afforded by covalently attached functional groups, have been the focus of considerable attention during the past decade [2–9]. 3,4-ethylenedioxythiophene (EDOT) is a new thiophene derivative combining high conductivity of its polymer, low band gap, good electrochemical properties and exceptional thermal stability in the oxidized state [10–13].

The processibility of EDOT based materials can be improved by incorporating solubilising segment such as *N*-alkylcarbazole in the PEDOT main chain [14–16, 20] and poly[3,6-bis(2-(3,4-ethylenedioxy)thienyl)*N*-methylcarbazole] was employed as anodically colored material in an electrochromic device.

Previously it has been reported that bis-heterocycle-substituted arylene monomers polymerize easily to form stable electroactive polymers [9–19]. They exhibit very low optical band gap and switch between different colors, which is potentially useful for electrochromic devices.

Further control of the electropolymerization conditions, such as the use of different substrates and the stability of the resulting polymer can contribute to expand the scope of the technological applications of conducting polymers, i.e., reinforcement of carbon fibers

(CFs). CFs were electrochemically deposited by electroactive monomers, such as pyrrole, thiophene, carbazole, 3-methylthiophene and aniline [21–26].

In this study 3,6 bis(3,4-ethylenedioxythiophenyl)-9-ethylcarbazole was synthesized by Stille coupling instead of Grignard coupling, as reported before for *N*-methyl derivative [16], and the determination of the optimum conditions for preparation of an electroactive polymer on CF was studied.

2. Experimental

2.1. Materials

All chemicals were used as received from Aldrich Chemical without further purification. High strength (HS) CFs C 320.000A (CA) (Sigri Carbon, Meitingen, Germany) containing 320 000 single filaments in a roving were used as working electrodes. All the electrodes were prepared by using CF (diameter = 7 μm) attached to a copper wire with Teflon tape. The electrode area was kept constant ($\sim 6.0 \times 10^{-4} \text{ cm}^2$) by adjusting the dipping length and covering the rest of the fibers with the Teflon tape.

2.2. Fiber surface morphology

Surface morphology of all electrografted fibers were analyzed by scanning electron microscopy (SEM) using a Hitachi S-2700 SEM (Nissei Sangyo GmbH, Rathingen, Germany), which was connected to an energy dispersive X-ray microanalyzer (EDX) (Kevex type

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