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ORIGINAL RESEARCH

New electroactive and photosensitive polyamide/ternary LDH nanocomposite containing triphenylamine moieties in its backbone: synthesis and characterization

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Abstract

The new ternary (Mg–Zn–Al–) layered double hydroxide (LDH) with an organic modifier-containing azo group (LDH–SHDBS) as a guest anion was prepared by a co-precipitation through one-step synthetic method. The novel electroactive polyamide (EPA) was successfully prepared by direct polycondensation reaction of azelaic acid with a new synthetic diamine **4**. The structure of diamine **4** was confirmed by FTIR and ^{1}H NMR spectra. Also, polyamide/ternary LDH nanocomposites were prepared by resulting EPA and modified ternary LDH under ambient condition. The resulting data using scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDS), and X-ray diffraction (XRD) showed ternary LDH were successfully distributed into the EPA matrix. Thermal behavior of the EPA and its nanocomposites were studied by thermogravimetric analysis (TGA) and derivative thermogravimetry (DTG). The presence of LDH layers into EPA matrix improved thermal stability (T_5, T_{10}, char yield) in both air and nitrogen atmospheres. Also, photoisomerization and electrochemical behaviors of EPA and resulting nanocomposites were measured using UV–Vis spectroscopy and cyclic voltammetry (CV), respectively. The UV–Vis spectrum of the obtained nanocomposites showed two peaks at $\lambda_{max} = 422$ and 480 nm related to π–π^* and n–π^* transitions of *trans* azobenzene. Moreover, *trans* to *cis* isomerization of azomoieties was studied by irradiation of the nanocomposites under 254 nm photons. The CV pattern of EPA exhibited a reversible anodic peak around 0.84 V, corresponding to the nitrogen atom of triphenylamine unit into polymer backbone that improved by incorporation of LDH–SHDBS into EPA matrix.

Keyword High-performance polyamide · Electroactive · Photosensitive · Nanocomposite · Layered double hydroxide

Introduction

Polyamides as high-performance polymers show good mechanical properties, high transparency, low flammability, thermal stability, and chemical resistance [1–3]. However, some limitations such as high melting temperature and low solubility into organic solvents decreased their industrial applications through strong intermolecular interactions and rigidity of the backbone. To overcome these problems, some flexible bonds, polar or bulky groups, and aliphatic chain are incorporated into the polymer structure [4, 5]. Recently, some researchers showed that introducing triphenylamine (TPA) moieties into polyamide backbone improved solubility without any exchange in thermal properties, but also increasing their application as electroactive and electrochromic materials [6–8]. Therefore, polyamide-contained TPA shows interesting electrochromic properties and is a proper candidate for commercial applications. Also, the electroactive polyamides are useful materials due to excellent electrochromic properties such as high coloration efficiency, fast response time, and a wide range of color [9, 10].

Some properties of polymers could be seriously enhanced by incorporation of a small amount of nanoparticle material in polymers matrices [11–13]. One of the most important of nanofillers that has been widely used in polymer composites

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