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ORIGINAL RESEARCH

Novel vinyl-modified sepiolite-based polymer nanocomposites: synthesis and characterization

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Abstract
An environmental-friendly synthesis of polymer clay nanocomposites (PCNs) was carried out by incorporation of nanoclay into polymer matrix for their potential application as sorbent of metals present in aqueous media. Polyacrylonitrile was chemically grafted onto 77% vinyl triethoxysilane-modified sepiolite. The polymerization was carried out with benzoyl peroxide (BPO, $C_{14}H_{10}O_4$) initiator in three different weight ratios of 1.0, 2.0, and 3.0%. The maximum polymer grafting of about 83% was obtained in nanocomposite initiated by 2.0% ratio of BPO. The surface modification of nanocomposites was carried out using hydroxyl amine hydrochloride ($NH_2OH{\cdot}HCl$). The prepared nanocomposites were characterized by Fourier transform infrared spectroscopy, X-ray diffractometry, thermogravimetric analysis, and Brunauer–Emmett–Teller technique. The copper removal tendency of nanocomposites was studied by atomic absorption spectroscopy. The maximum adsorption of copper was 86%, which could be achieved by nanocomposites synthesized with 2% initiator. The results have revealed the practical potential of the prepared PCN as efficient adsorbents.

Keywords Polymer nanocomposite (PNC) · Vinyl triethoxysilane (VTES) · Polyacrylonitrile (PAN) · Cloisite 30B · Sepiolite

Introduction

Synthesis of polymer/clay nanocomposites (PCNs) is one of the most evolutionary steps in polymer nanotechnology and has attracted wide attention not only in fundamental scientific research and industrial application but also from their fundamental point of view [1]. They potentially render remarkable improvements in optical, mechanical, thermal, and barrier properties as compared to pristine polymer and traditional composites [2]. These wonderful "composite materials" have now become an essential part of advanced materials because of some major promising benefits including light weight, surface protection from rusting/abrasion, and high fatigue strength [3].

They fulfil the major requirements of packaging industry such as transparency, toughness/strength, flavour/odour, heat resistance, and resistance to oil, fats, and grease. They exhibit excellent properties such as high modulus, structural strength, and delay in fire propagation, high scraps, and lower deformation qualities. These characteristics enable such composites as substitutes for metals in automotive industry [4, 5].

The composites are formed by combination of materials having different physical, chemical, and structural properties [6]. Tree trunk is an example of natural bio-composite consisting of a matrix made up of lignin which is reinforced by natural fibers of cellulose [7]. The primeval artificial composite materials are bricks prepared by combination of straw and mud [8]. Polymer composites are formed through the combination of polymer and synthetic or natural reinforcing agents. Such substances are used to improve the desired characteristics of the polymer and to lessen the price of resultant material [9].

PAN is a synthetic, semi-crystalline polymer, and thermoplastic as well, but does not melt under normal conditions [10]. It is a multipurpose polymer used to produce diversity of products such as ultra-filtration membranes, hollow fibers for reverse osmosis, fibers for textiles, and a chemical precursor for high-quality carbon fiber [11].

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