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Fascinating thermo-mechanical features of layered hydroxides/MWCNTs nanocomposites

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ABSTRACT

Multiwalled carbon nanotubes (MWCNTs) has been synthesized using chemical vapor deposition (CVD) method. Al − Layered Hydroxide (Al–LH) and MWCNTs nanocomposites; (1-x) Al–LH + (x) MWCNTs, $0.0 \leq x \leq 1$; have been synthesized using citrate nitrate assisted hydrothermal technique. The crystal structure and the functional groups of the prepared samples were examined using X-ray diffraction (XRD) and Infrared spectroscopy (FTIR) respectively. The layered structure seemed under the high-resolution transmission electron microscopy (HRTEM), and the morphology was observed using field emission scanning electron microscopy (FESEM). Moreover, the synthesized nanocomposites were further characterized using Zeta potential, size analysis and Brunauer– Emmett–Teller (BET) surface area which showed their different characteristics as the MWCNTs content is changed. Thermal gravimetric analysis assured the thermal stability of the nanocomposites over the temperature from room up to 480 °C depending on the MWCNTs content. The obtained results revealed the improvement of all mechanical properties with the increase of MWCNTs content.

1. Introduction

Development of nanomaterials is one of the most important advances in science. Nanomaterials are substances that have at least one dimension in the nanoscale scope, which gives them extraordinary physical and chemical properties, as well as quantum effect, high-reactivity, and high-to-volume ratio. Even though nanomaterials can be manufactured in one, two or three dimensions, dual dimension nanosheets has extremely fascinated scientists because of their incomparable interaction properties [1,2].

Layered hydroxides, with their adapted performance and excellent physio-chemical properties, offer wide applications in numerous fields, as water treatment, anticorrosion agent, like a catalyst, flame retardants, sensors and electrodes in addition to its usage in drug delivery systems [3–6]. They are made up of nanolayers with unlimited two-dimensional layers with a thickness in the nanoscale and contribute to large-scale applications in different fields. These host layered materials can be characterized as layered double hydroxides (LDH) and layered hydroxide salts (LH) [7,8].

Layered nanocomposites represent a specific class of multipurpose materials that has obtained numerous considerations in recent years. The specialized structure of nanocomposites develops a synergistic influence among the organic and nonorganic parts, creating compounds with dissimilar physical or chemical properties compared with the isolated components. Theses nanocomposites allow the progress of innovative applications in industry in addition to representing an inventive alternative to the research for new materials. The potential usage of layered nanocomposites encompasses photovoltaic devices, intelligent membranes, biochemical and chemical detectors, new catalysts, separation devices, smart microelectronic devices in addition to some materials merging ceramics and polymers, etc. [9–12].

MWCNTs gained more attention worldwide in the last decades due to their superior chemical stability, excellent electrical conductors, strength, stiffness, unique structural, high thermal conductivities in addition to their full range of potential applications in nanoelectronics, optics, sensors and nanocomposites [13,14]. Moreover, they can be reacted and treated using carbon-rich chemistry as its composition consists of a pure carbon polymer. Therefore, it may allow for many innovative applications in materials, electronic engineering, chemical processing, and energy management due to the possibility of its structural modification

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