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MgO/Copolymers and Terpolymers Core-Shell Nanocomposites

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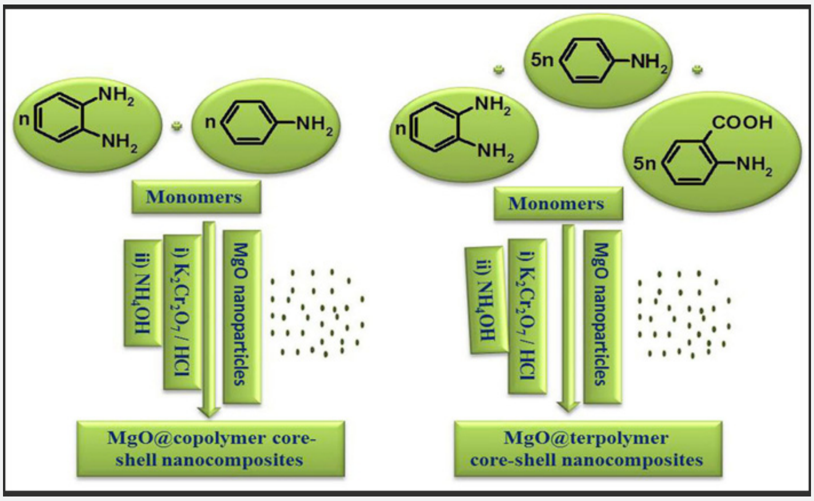
Abstract

The tremendous demand for novel materials, concepts, applications, and technologies remains an ongoing challenge. The remarkable advancements in technology, along with modern science, have facilitated a highly productive search for new substances that can engender positive outcomes across diverse domains. In line with our previous efforts to synthesize and investigate binary nanocomposites, new binary nanocomposites were synthesized, combining MgO nanoparticles with a copolymer as well as MgO nanoparticles with a terpolymer. These binary composites exhibit prerequisite characteristics in terms of the purification of water from toxic organic dyes while also demonstrating high efficacy in achieving this goal. Accordingly, the market is provided with potential binary nanocomposites that are synthesized via an exquisite protocol with the use of diverse and ultramodern characterization techniques for their characterization (Graphical Abstract).



Graphical Abstract

Introduction

The tremendous demand for high-performance materials has led researchers to focus on producing products with improved properties while minimizing changes in equipment, process, and input costs. Polymer/nano-metal oxide nanocomposites have gained increasing interest over the last few decades because of their more suitable mechanical, chemical, and physical characteristics in comparison to conventional polymers. They offer a low-cost alternative for commercial use in the automotive industries as well as packaging. The addition of nano-metal oxide to polymer materials aims at enhancing their characteristics to generate polymers/nano-metal oxide composites with specific properties appropriate for particular appliances.

Nanometal oxides have outstanding characteristics which include biocompatibility, non-toxicity, high chemical and thermal stability, and excessive surface reaction activity [1-3]. Magnesium oxide was chosen as MgO has several applications in commercial chemistry as a catalyst assist, optoelectronic material filler, and air pollutant gas scrubber [4]. Additionally, MgO exhibits effective antibacterial efficacy in aqueous settings because of the oxide anions formation on its surface [5] (Graphical Abstract).

Discussion

Various new composites have been reported, including terpolymer/kaolinite [6, 7], copolymer/kaolinite [8-10], terpolymer/bentonite [11-14], copolymer/bentonite [15-19], and copolymer/pyrogenic silica [20] composites alongside new polymers [21-29]. Core-shell polymers (CSPs) are one type of binary composite that has attracted enormous research interest, in technological applications and fundamental science. CSPs consist of two types: core particles surrounded by shell particles, in which that combination produces exceptional characteristics not developed by using individual constituents. The resulting system may combine properties from both the core and shell, imparting new functionality to CSPs. In continuation with previous work, novel core-shell nanocomposites (CSNCs) have been established based on Fe_2O_3 [30,31], TiO_2 [32-35], and Al_2O_3 [36,37] nanoparticles synthesized using in situ oxidative chemical polymerization techniques. Recently, MgO@copolymer and MgO@terpolymer nanocomposites were also published as new binary nanocomposites based on magnsium oxide, namely, MgO/copoly (aniline and o-phenylenediamine) CSNCs and MgO/ terpoly(anthranilic acid, aniline, and o-phenylenediamine) CSNCs that showed desirable property for purifying water from organic dyes [38,39].

Conclusion

A remarkable synthetic protocol applying in situ oxidative polymerization as an economical approach for synthesizing new core-shell nanocomposite containing nano MgO has been successfully established. Adaptable loads using several weights of nano MgO were utilized. In the FTIR spectra of CSNCs, FTIR spectra of MgO, pristine copolymer, and terpolymer were distinguished. The linkage between MgO and copoly (aniline and o-phenylenediamine) or terpoly (anthranilic acid, aniline, and o-phenylenediamine) was identified within the FTIR bands. The spectral characteristics upon combination of MgO within the copolymeric and terpolymeric sequences have indicated the successful synthesis of CSNCs from nano MgO with the original copolymer or terpolymer. Thermal investigations revealed that nano-MgO is incorporated into the copolymeric and terpolymetric nanocomposites. Additionally, the newly fabricated CSNCs had a core-shell structure as a sphere-shape with sizes ranging from 15 nm up to 66 nm. Dynamic light scattering (DLS) results indicate that the binary MgO@copolymer CSNCs have a narrow PDI and incipient instability being either good or best systems, meanwhile the binary MgO@terpolymer CSNCs have a narrow PDI and moderate stability being good system. Under sunlight irradiation, MB dye degradation was substantiated, which proved the photocatalytic efficacy of CSNCs against MB. Reasonable interpretations for the photocatalytic efficacy results of CSNCs have been justified. This approach presents a simplistic, beneficial, and cost-effective technique to generate novel, promising CSNCs featuring diverse functionality. More research could pave the way for exploring novel binary nanocomposites.

Prime Novelty Statement

In line with our previous efforts to synthesize and investigate binary nanocomposites, new binary nanocomposites were synthesized, combining MgO nanoparticles with a copolymer as well as MgO nanoparticles with a terpolymer. These binary composites exhibit prerequisite characteristics in terms of the purification of water from toxic organic dyes while also demonstrating high efficacy in achieving this goal. Accordingly, the market is provided with potential binary nanocomposites that are synthesized via an exquisite protocol with the use of diverse and ultramodern characterization techniques for their characterization.

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