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Hend Ezzat Salama, Mohamed Samir Abdel Aziz, Gamal Riad Saad

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Thermal properties, crystallization and antimicrobial activity of chitosan biguanidine grafted poly(3-hydroxybutyrate) containing silver nanoparticles

Hend Ezzat Salama*, Mohamed Samir Abdel Aziz, Gamal Riad Saad

Chemistry Department, Faculty of Science, Cairo University, Giza, Egypt, P.O.12613

Abstract

Green synthesis of novel nanocomposites series based on chitosan biguanidine grafted poly(3-hydroxybutyrate) copolymer (ChG-g-PHB) and silver nanoparticles (AgNPs) was successfully done via insitu reduction of $AgNO_3$ in the copolymer matrix. Transmission electron microscopy verified the homogeneous dispersion of spherical shape of the AgNPs with an average particle size 12.3 to 19.2 nm. X-ray diffraction pattern revealed face centered cubic structure of AgNPs. The thermal stability was improved upon increasing the AgNPs content up to 2.0%, then declined upon loading with 3.0%. Coats-Redfern model showed that the sample with 2.0% AgNPs has the highest activation energy of the thermal degradation with values of 264 and 270 kJ mol^{-1} for the 1^{st} and 2^{nd} degradation steps, respectively. Differential scanning calorimetry indicated that AgNPs acts as a nucleating agent for the nonisothermal melt crystallization of PHB component. Avrami equation described well the crystallization of PHB segments, with average Avrami exponent of 3.10 and 3.36 for ChG-g-PHB and its 2.0% nanocomposite, respectively. Regardless of the content of AgNPs, the antimicrobial activity of the nanocomposites is better than the neat copolymer. The sample loaded with 3.0% AgNPs showed the best antimicrobial activity with MIC value range of 0.98-1.95 μg mL^{-1}.

Keywords: Chitosan biguanidine; poly(3-hydroxybutyrate); silver nanoparticles.

*Corresponding author

Email:hend_ezzat2010@yahoo.com

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