Reducing the Crystallite Size of Spherulites in PEO-Based Polymer Nanocomposites Mediated by Carbon Nanodots and Ag Nanoparticles

Ranjdar M. Abdullah 1, Shujahadeen B. Aziz 1,2,*  , Soran M. Mamand 1, Aso Q. Hassan 3, Sarkawt A. Hussein 1 and M.F.Z. Kadir 4

1 Hameeds Advanced Polymeric Materials Research Lab., Department of Physics, College of Science, University of Sulaimani, Qlyasan Street, Sulaimani 46001, Kurdistan Regional Government, Iraq; ranjdar.abdullah@univsul.edu.iq (R.M.A.); soran.mamand@univsul.edu.iq (S.M.M.); sarkawt.hussen@univsul.edu.iq (S.A.H.)
2 Komar Research Center (KRC), Komar University of Science and Technology, Sulaimani 46001, Kurdistan Regional Government, Iraq
3 Department of Chemistry, College of Science, University of Sulaimani, Qlyasan Street, Sulaimani 46001, Kurdistan Regional Government, Iraq; asoqadir2012@yahoo.com
4 Centre for Foundation Studies in Science, University of Malaya, Kuala Lumpur 50603, Malaysia; mfzkadir@um.edu.my
* Correspondence: shujahadeenaziz@gmail.com

Received: 6 May 2019; Accepted: 4 June 2019; Published: 9 June 2019

Abstract: The PEO-based polymer nanocomposites were prepared by solution cast method. Green approaches were used for synthesis of carbon nano dots (CNDs) and silver nanoparticles (Ag NPs). It was found that the crystallite size of spherulites of PEO was greatly scarified upon incorporation of CNDs and Ag NPs. In the present work, in opposition to other studies, broadening of surface plasmon resonance (SPR) peak of metallic Ag NPs in PEO-based polymer composites was observed rather than peak tuning. Various techniques, such as powder X-ray diffraction (XRD), SEM, UV–Vis spectroscopy, and photoluminescence (PL), were used to characterize the structural, morphological, and optical properties of the samples. Increase of amorphous phase for the PEO doped with CND particles was shown from the results of XRD analyses. Upon the addition of suspended Ag NPs to the PEO:CND composites, significant change of XRD peak position was seen. A field-emission scanning electron microscope (FESEM) was used to investigate the surface morphology of the samples. In the SEM, a significant change in the crystalline structure was seen. The size of PEO spherulites in the PEO nanocomposite samples became smaller and the percentage of amorphous portion became larger, owing to the distribution of CNDs and Ag NPs. The UV–Vis absorption spectra of the PEO-based polymer were found to improve and shift to higher wavelengths upon incorporation of CNDs and Ag NPs into the PEO matrix. The SPR peak broadening in the UV–Vis spectra was observed in the PEO:CNDs composites due to the Ag NPs. The absorption edge value of PEO was found to shift toward lower photon energy as the CNDs and Ag NPs are introduced. The photoluminescence (PL) spectra were also observed for the PEO:CNDs and PEO:CNDs:Ag samples and found to be more intense in the PEO:CNDs system than in the PEO:CNDs:Ag system. Lastly, the optical band gap of the samples was further studied in detail using of Tauc’s model and optical dielectric loss parameter. The types of electron transition were specified.

Keywords: PEO nanocomposite; carbon nano dots; plasmonic silver nanoparticles; XRD study; morphology; optical properties