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ORIGINAL PAPER

Synthesis and characterization of Ag nanoparticles embedded in PVA via UV-photoreduction technique for synthesis of Prussian blue pigment

Ibraheem O. Ali[1,2] · Tarek M. Salama[2] · Mostafa I. Mohamed[3] · M. B. M. Ghazy[2] · Mostafa F. Bakr[2]

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Abstract Silver nanoparticles doped in polyvinyl alcohol (AgNps/PVA) were synthesized via polymer-promoted reductive reaction of $AgNO_3$ and PVA under time-dependent exposure to UV radiation. The AgNps/PVA composites were characterized by X-ray photoelectron spectroscopy (XPS), X-ray diffraction, UV–Vis spectroscopy, and transmission electron microscopy to describe the structure, nuclearity, and distribution of Ag Nps within the PVA matrix. The UV–Vis spectrum of AgNps/PVA exhibited a broad surface plasmon absorption around 425–443 nm which originated from the formation of Ag NPs. Surface analysis by XPS indicated that the Ag NPs were grown solely on the PVA surface at UV exposure time of 2 h (2.0AgNPs/PVA). Increasing the UV exposure time to 4 h will cause the transformation of metallic nanosilver to oxidized nanosilver. UV–Vis absorption spectra were in situ recorded to follow the synthesis of Prussian blue (PB) on 2.0AgNPs/PVA (PB@2.0AgNPs/PVA). The colloidal dispersion of 2.0AgNPs/PVA in an acidic medium containing free Fe(III) ions and potassium hexacyanoferrate(III) revealed an additional band centered at 720 nm due to the intermetal charge-transfer absorbance of the polymeric Fe(II)-C-N-Fe(III) of the PB@2.0AgNPs/PVA nanocomposite. Control experiments were shown to involve a spontaneous electron transfer reaction between 2.0AgNPs/PVA and Fe(III) ions, with a concomitant decomposition of hexacyanoferrate(III) and formation of PB was observed. Moreover, IR gave clear cut evidence for the synthesis of PB@2.0AgNPs/PVA from the appearance of a band for the cyano group at 2090 cm^{-1}.

Keywords Ag nanoparticles · PVA · XRD · XPD · UV radiation · PB synthesis

Introduction

The synthesis and properties of metal nanoparticles (NPs) have received much attention due to their unique optical [1], electrical [2], magnetic [3], and thermal [4] properties. Among various types of metal NPs, many studies have been performed to synthesize Ag NPs because of their high electrical conductivity, stability, and low sintering temperatures [5, 6]. Besides their novel optical properties, Ag NPs show other interesting properties, such as, e.g., antimicrobial qualities in opposition to an array of microorganisms. Ag NPs have been as a result incorporated into products that cover anything from photovoltaics to biological and chemical detectors. A number of synthetic approaches have already been requested for the activity of silver nanoparticles. Examples include wet chemical synthesis [7, 8], hydrothermal [9], ultraviolet irradiation photoreduction [10, 11], and electrochemical deposition [12].

Polymers can serve as minimizing or capping substances and consequently avoid particle progress [10]. Several polymers have already been used as NPs stabilizing media such as polyvinyl alcohol [13], polyacrylic acid [14], polyaryl esters [15], polyacrylonitrile [16], and polyvinyl pyrrolidone [17]. The attributes of the ensuing materials depend upon the particle dimensions distribution, filling up

✉ Ibraheem O. Ali
ibraheem_othman202@yahoo.com

1 Chemistry Department, College of Science and Arts, Al Jouf University, Algrayat, Saudi Arabia

2 Department of Chemistry, Faculty of Science, Al-Azhar University, Nasr City, Cairo 11884, Egypt

3 Forgery and Counterfeiting Researches Department, Forensic Medicine Authority, Ministry of Justice, Tanta, Egypt