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Biopolymer Assisted Green Synthesis of Ag Nanoparticle for Photocatalytic Activity

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Abstract

Green synthesis of nanoparticles is an essential need for the sustainable and acceptable environment. The biosynthesis of nanoparticles has been proposed as a cost-effective and environmentally friendly alternative to chemical and physical methods. Plant-mediated synthesis of nanoparticles is a green chemistry approach that connects nanotechnology with plants. Silver nanoparticle (Ag NPs), one of the noble metal nanoparticles, has attracted extensive attention in the past decades due to its wide application. We have provided an overview of various methods used by eminent researchers for the green synthesis of Ag NPs assisted biopolymers and their photocatalytic activity towards any kinds of toxic pollutants.

Introduction

Nano is a prefix meaning "extremely small." When quantifiable, it translates to one-billionth, as in the nanosecond. Nano comes from the Greek word "nanos" meaning "dwarf." Nanoparticles show unique chemical, physical and biological applications because of its high surface to volume ratio. With the increasing awareness of environmental protection, people are inclined to develop the eco-friendly approach for the synthesis of nanoparticles. Three main steps in the preparation of nanoparticles that should be evaluated from a green chemistry perspective are the choice of the solvent medium, environmentally extracted reducing agent, and nontoxic material for the stabilization of the nanoparticles. Currently, many natural polymers like chitosan, soluble starch, polypeptide, heparin, and hyaluronan have been involved in the green preparation of nanoparticles as reducing and stabilizing agent [1,2]. Among the various nanoparticles emphasis is on the green synthesis of Ag NPs, because it exhibits strong cytotoxicity toward a broad range of microorganisms and are widely used as an antibacterial agent, causing long lasting protection against bacteria [3-5]. Extraction of toxic dyes from wastewater embraces the organic-inorganic ion exchange, electro dialysis, photocatalytic degradation, and chemical precipitation [6-9]. Among the above stated, photocatalytic degradation stands the most efficient method due to is ease in functionality and cost effective [10-11]. In recent years, silver nanoparticles have received adequate interest owing to their wide range of application in the field of catalysis, adsorption, bio-sensing and biotechnology [12-14].

Discussion

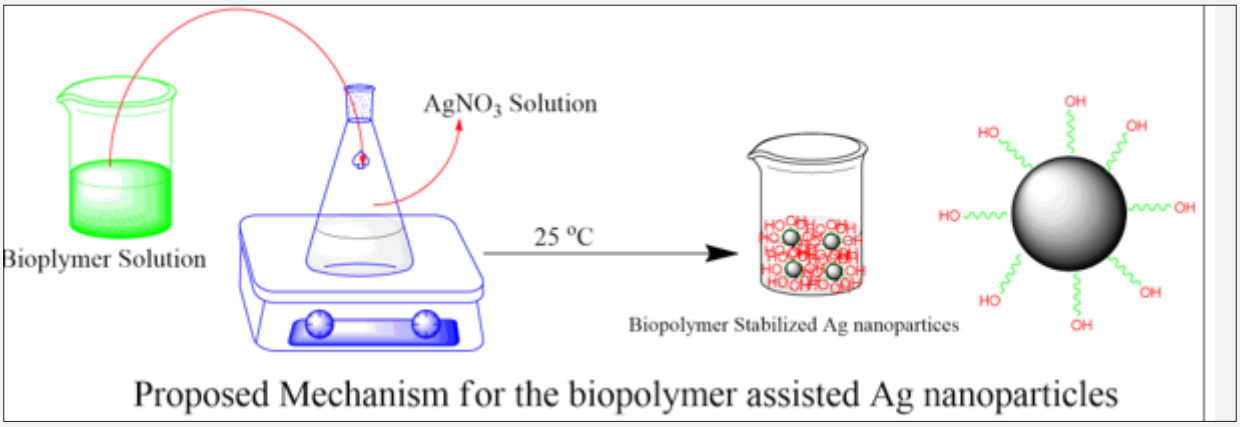

Figure 1.

Ag NPs have been synthesised by various researchers by using biopolymers. Some of the key studies have been reported here. For synthesis of silver nanoparticles, Xanthan gum (XG) was dissolved in ultrapure water under constant stirring for dissolution of XG to achieve solution and $AgNO_3$ was added in the obtained solutions [1]. Another study reported microwave-assisted method of synthesizing silver nanoparticles was developed using sodium alginate as stabilizer and reducer. During the heating process, the colour of the reaction mixture changed slowly from colourless to light brown due to reduction of Ag+ to AgO [2]. Another study revealed the synthesis of silver nanoparticles, agar powder were dissolved in deionized water under constant stirring condition to obtain the solution of different concentration with the slowly addition of Ag NPs, incubated for some hours in the dark condition at constant stirring, maintained slightly acidic. The agar polysaccharide was extracted from red alga [3]. Another study was reported using guar gum (GG) as a green reducing agent for the production of highly stable silver nanoparticles (Ag NPs) within this biopolymer and subsequent crosslinking with borax to form crosslinked Ag@GG beads [4]. Another study showed Chitosan-based silver nanoparticles were synthesized by reducing silver nitrate salts with biodegradable chitosan [5] (Figure 1).

Concerning the photo activity of $Ag0/Ag_2O$ deposited on TiO_2, it has been proposed that the photoexcitation of Ag_2O rather than AgO acts as active sites responsible for the enhanced photocatalytic activity, whereas AgO might contribute to the stability [15,16]. In this work, noble metal silver was introduced to g-C_3N_4 photocatalyst with different weight ratios for the first time. The effect of Ag loading amount on the optical absorption, photoluminescence property and photocatalytic performance were investigated in detail. The photocatalytic mechanism of Ag/g-C_3N_4 photocatalyst was proposed based on photocatalytic results and PL spectra, and the enhanced photo-activity came from the promotion of charge separation efficiency caused by the synergy between Ag and g-C_3N_4 [17].

Conclusion

With the advancement in technology of green synthesis of nanoparticles. Ag NPs are becoming synthesised due their intensive antimicrobial applications. They are being prepared with natural extract or by using biopolymers which are cost effective, environment friendly and simple alternative. The Ag nanoparticles prepared by different kind of biopolymers showed an enhanced photocatalytic activity towards toxic organic water pollutant as compared to net Ag nanoparticles. This increment in property is due to improved stability and surface functional density of the material.

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