Optik 127 (2016) 10378–10388

Contents lists available at ScienceDirect

Optik

journal homepage: www.elsevier.de/ijleo

Green synthesis of biocompatible silver nanoparticles mediated by Osmanthus fragrans extract in aqueous solution

Chunfa Dong[a,b,*], Xianglin Zhang[a,**], Hao Cai[a], Chuanliang Cao[a]

[a] State Key Lab of Materials Processing and Die & Mould Technology, School of Materials Science and Engineering, Huazhong University of Science and Technology, Wuhan 430074, PR China

[b] School of Mechanical and Electrical Engineering, Hubei Polytechnic Unviersity, Huangshi 435003, PR China

ARTICLE INFO

Article history:
Received 17 June 2016
Accepted 23 August 2016

Keywords:
Silver nanoparticles
X-ray techniques
Electron microscopy
Osmanthus fragrans

ABSTRACT

A practical, convenient and green method for the synthesis of highly stable and small sized silver nanoparticles with narrow distribution from 2 nm to 30 nm is reported. Silver nitrate was used as silver precursor, and Osmanthus fragrans extract was acted as capping agent as well as reducing agent. The formation of silver nanoparticles was observed by the change of color from colorless to yellow. The as-prepared silver nanoparticles were characterized by scanning electron microscope (SEM), transmission electron microscopy (TEM), high resolution transmission electron microscopic (HRTEM), UV–vis spectroscopy (UV-vis), X-ray diffraction (XRD) and Fourier transform infra-red spectroscopic (FT-IR). The formation of silver nanoparticles was confirmed by its characteristic surface plasmon absorption peak at 400–450 nm in UV–vis spectra. The TEM and SEM images showed that the as-synthesized silver fine spherical particles are distributed uniformly with a narrow distribution from 2 nm to 30 nm. The HRTEM and XRD results demonstrated that the obtained metallic nanoparticles were single crystalline silver nanoparticles. FT-IR data revealed that the silver nanoparticles are coated with Osmanthus fragrans extract. The effects of the silver nitrate and Osmanthus fragrans extract concentrations on the particle size were investigated. The green synthesis method is simple and may be extended to preparation of other noble metal nanoparticles.

1. Introduction

Recently, nanostructured materials, particularly metal nanoparticles have drawn a great deal of attention due to their remarkable optical, physical and chemical properties, which largely differ from their bulk ones [1–5]. Metal nanoparticles are more chemically reactive than their bulk solid counterparts and they are widely used as sensor materials in electronic devices. As a consequence, fabrication and preparation of metal nanoparticles have become increasingly popular in recent years [6,7]. Among the metal nanoparticles, silver nanoparticles have got much recognition, because they have a number of superior properties and are widely applied in various fields, such as medicine, photo catalysis, lithography, electronics, surface-enhanced resonance Raman scattering, optical biosensors, etc [8–11]. These properties, as well as the corresponding

* Corresponding author at: State Key Lab of Materials Processing and Die & Mould Technology, School of Materials Science and Engineering, Huazhong University of Science and Technology, Wuhan 430074, PR China.
** Corresponding author.
E-mail addresses: dongchunfa@126.com (C. Dong), hust_zxl@mail.hust.edu.cn (X. Zhang).

http://dx.doi.org/10.1016/j.ijleo.2016.08.055
0030-4026/

applications, are mainly dependent on the sizes, sizes distribution, shapes and stabilities of silver nanoparticles in aqueous solution. Hence, the precise controllable synthesis of silver nanoparticles allows not only to investigate unusual properties of nanoparticles but also to adjust their physical properties and chemical properties as desired. Many strategies, including chemical and physical methods, have been developed for the fabrication of silver nanoparticles with different sizes and morphologies, such as radiation chemical reduction, ultrasonic irradiation, microwave-assisted synthesis, electrochemical reduction, photo reduction, thermal decomposition in organic solvents, chemical reduction and so on [12–19]. Among these methods, the most popular method for the preparation of silver nanoparticles is chemical reduction of silver ions to metallic silver in the presence of capping agents [20]. In addition, the most commonly used capping agents are surfactants and polymers [19,21].

However, most of the capping agents and the reducing agents used in the chemical methods involve in toxicity and other hazards and may inflict continuous risks on the environment [22]. Furthermore, the use of environmental toxicity or biological hazards may limit the application of silver nanoparticles. In order to minimize the effects of hazardous chemicals on the environment as well as maximize safety and efficiency, researchers are showing an upsurge of interest in exploring new protocols to prepare silver nanoparticles using green technology [22]. In these researches, natural polymers, such as carboxymethyl cellulose [23], hydroxypropyl cellulose [24], microcrystalline cellulose [25], ethyl cellulose [25], acetyl cellulose [25], starch [26], chitosan [27] and hydroxy propyl methyl cellulose [19], were used as capping and reducing agents for the preparation of silver nanoparticles. According to Raveendran theories [26], the utilization of natural polymers as capping and reducing agents, makes the synthesis processes are completely green and free from hazardous and pollutants, enabling these green methods to be reliable and viable. Besides the natural polymers, studies pertaining to the green synthesis of silver nanoparticles using extract which obtained from plants, as stabilizing and reducing agents, have also been reported in recent years. Ashokkumar et al., prepared silver nanoparticles using Gloriosa superba L. leaf extract as capping agent as well as reducing agent [28]. Raja's group prepared silver nanoparticles from Prosopis juliflora leaf extract [29]. Ghoreishi et al., have synthesized silver and gold nanoparticles using Rosa damascene extract as reducing agent and capping agent [30]. Das et al., mentioned a method for fabrication of silver nanoparticles using Sesbania grandiflora leaf extract as both reducing and capping agent [31]. Dubey et al., reported the synthesis of silver and gold nanoparticles using Rosa rugosa leaf extract [32]. Bindhu et al., used Hibiscus cannabinus leaf extract for the synthesis of silver nanoparticles [33]. Wang et al., reported the extracellular synthesis of gold nanoparticles using Barbated Skullcup herb [34]. Philip et al., used Anacardium occidentale leaf to synthesize silver and gold nanoparticles [14]. The same group use marcotyloma uniflorum, hibiscus rosa sinensis, edible mushroom extract, mangifera indica leaf, honey, tulsi leaf, murraya koenigii leaf and saraca indica flower to synthesize silver or gold nanoparticles [9,35–39].

Among the natural polymers and nature plants, Osmanthus fragrans, belonging to dungarunga family, has great economic and medicinal value. Osmanthus fragrans occurs naturally in China and widely used as an ornamental plant. It is one of the ten traditional flowers in China. Furthermore, Osmanthus fragrans have long been valued for their medicinal, aromatherapy, culinary and cosmetic properties. Osmanthus fragrans flowers have also been used as tea and herbal medicine in China.

The main aim of this work is to prepare small, single crystal and highly stable monodispersed silver nanoparticles with controllable size and size distribution via a facile and totally green method by using cheap and renewable materials. In this work, we reported a completely green and simple one step process to synthesize silver nanoparticles by mixing silver nitrate solution and Osmanthus fragrans flowers extract. Silver nanoparticles can be synthesized with lower amounts of flowers extract and without any additional chemicals and/or physical steps. Here, silver nitrate is used as silver precursor, and Osmanthus fragrans flowers extract was used as stabilizing agent as well as reducing agent. The effect of flowers extract and the concentrations of silver precursor were evaluated to optimize the preparation protocol fabricating silver nanoparticles. By varying the reaction time, we monitored the temporal evolution of the optical of the silver nanoparticles. The as-synthesized silver nanoparticles were small with a narrow distribution from 2 nm to 30 nm. This synthetic process is a viable and reliable method for synthesis of small and highly monodispersed, biocompatible and stable colloidal silver nanoparticles, hence may find applications in industrial and medical. In addition, the use of cheap and nontoxic starting materials, atmospheric pressure, and the moderate reaction temperature, are other advantages of this procedure. To the best of our knowledge, it is the first time to use Osmanthus fragrans flowers extract for the synthesis of metal nanoparticles.

2. Experimental methods

2.1. Materials

Silver nitrate, used in the experiment was obtained from Sinopharm Chemical Reagent Co. Ltd. The water used in the experiment was doubly distilled water. Fresh flowers of Osmanthus fragrans were collected in Huazhong University of Science and Technology, Wuhan, China. All glasswares have been washed with fresh chloroazotic acid and distilled water and then dried in oven before use. All chemicals and solvents were of analytical grade and were used as received without further purification.