Physicochemical and Atomic Characterization of Silver Powder after Biofield Treatment

Mahendra Kumar Trivedi, Rama Mohan Tallapragada, Alice Branton, Dahryn Trivedi, Gopal Nayak, Omprakash Latiyal, Snehasis Jana

To cite this version:

Mahendra Kumar Trivedi, Rama Mohan Tallapragada, Alice Branton, Dahryn Trivedi, Gopal Nayak, et al.. Physicochemical and Atomic Characterization of Silver Powder after Biofield Treatment. Journal of Bioengineering & Biomedical Science, 2015, 5 (3), pp.1000165. hal-01502108

HAL Id: hal-01502108
https://hal.science/hal-01502108
Submitted on 5 Apr 2017

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Distributed under a Creative Commons Attribution 4.0 International License
Physicochemical and Atomic Characterization of Silver Powder after Biofield Treatment

Mahendra Kumar Trivedi1, Rama Mohan Tallapragada1, Alice Branton1, Dahryn Trivedi1, Gopal Nayak1, Omprakash Latiyal2 and Snehasis Jana2*

1Trivedi Global Inc., 10624 S.Eastern Avenue Suite A-969, Henderson, NV 89052, USA
2Trivedi Science Research Laboratory Pvt. Ltd., Hall-A, Chinar Mega Mall, Chinar Fortune City, Hoshangabad Road, Bhopal-462026, Madhya Pradesh, India

Abstract

Silver is widely utilized as an antimicrobial agent and wound dressing, where its shape, size, surface area, and surface charge play an important role. The aim of present study was to evaluate the impact of biofield treatment on physicochemical and atomic properties of silver powder. The silver powder was divided into two groups, coded as control and treatment. The treatment group received Mr. Trivedi’s biofield treatment. Subsequently, control and treated samples were characterized using particle size analyzer, X-ray diffraction (XRD) and surface area analyser. Particle size data exhibited that particle sizes \( d_{10}, d_{50}, d_{90}, \) and \( d_{99} \) (Size, below which 10, 50, 90, and 99% particle are present, respectively) of treated silver powder were substantially reduced up to 95.8, 89.9, 83.2, and 79.0% on day 84 as compared to control. XRD results showed that lattice parameter, unit cell volume, and atomic weight were reduced, whereas density and nuclear charge per unit volume were found to be increased as compared to control. In addition, the crystallite size was significantly reduced up to 70% after biofield treatment on day 105 as compared to control. Furthermore, the surface area of treated silver powder was substantially enhanced by 49.41% on day 68 as compared to control. These findings suggest that biofield treatment has significantly altered the atomic and physicochemical properties which could make silver more useful in antimicrobial applications.

Keywords: Biofield treatment; Silver; X-ray Diffraction; Particle size; Surface area

Introduction

Silver (Ag), a white, lustrous transition metal, known for its high electrical conductivity, reflectivity, and thermal conductivity. It exists in form of face centred cubic (FCC) crystal structure. Silver is widely used for electrical applications, filler material in conductive polymer, solar photovoltaic panel etc. [1]. Besides this, silver and silver-based compounds have been used in several antimicrobial applications [2]. Guggenbichler et al. reported that silver has most effective antibacterial action and least toxicity to animal cell [3]. Silver ions (Ag+) are microcidal at low concentration, which can be used to treat burns, wounds and ulcers. In addition, silver is also used in various hygiene products including face creams, health supplements, and water filtration cartridges [4]. Silver nanoparticles are gaining tremendous attention due to its capability of modulating the chemical, physical, antimicrobial, and optical properties. Furthermore, it is well established that uniform sized particles, with required shape, physical and chemical properties are of great interest in the formulation of new pharmaceutical products [5]. Besides, silver nanoparticles can be synthesised through various techniques such as sol gel, reverse micelle, intern gas condensation, and sonochemistry, etc, but many of these techniques either use hazardous or expensive chemicals [6]. Moreover, in physical condensation process a tube furnace is used, which occupies a large space and require large amount of thermal power [7]. Whereas, in chemical synthesis approach, the use of strong reducing agent such as borohydride results into smaller particles but it is difficult to control over large particle [8]. Thus, after considering properties and biological applications of silver, authors wanted to investigate an economically safe approach that could be beneficial to modify the physical and structural properties of silver powder.

The law of mass-energy inter-conversion has existed in the literature for more than 300 years for which first idea was given by Hasenohrl, after that Einstein derived the well-known equation \( E=mc^2 \) for light and mass [9,10]. Furthermore, the energy exists in various forms and there are several ways to transfer the energy from one place to another such as electromagnetic waves, electrochemical, electrical and thermal etc. Similarly, the human nervous system consists of neurons, which have the ability to transmit information and energy in the form of electrical signals [11]. Thus, a human has ability to harness the energy from environment/universe and it can transmit into any object (living or non-living) on the Globe. The object always receives the energy and responded into useful way and that is called biofield energy. This process is known as biofield treatment. Mr. Trivedi’s biofield treatment has known to transform the characteristics in various fields such as material science [12,13], microbiology [14-16], biotechnology [17,18], and agriculture [19-21]. In metals and ceramics the biofield treatment has shown the excellent results at physical, thermal, and atomic level [22,23]. In addition to this, the biofield treatment had increased the crystallite size and particle size by two folds and six folds, respectively in carbon allotropes [24]. Based on the outstanding results achieved by biofield treatment on metals and ceramics, an attempt was made to evaluate the effect of biofield treatment on atomic and physicochemical properties of silver powder.

*Corresponding author: Dr. Snehasis Jana, Trivedi Science Research Laboratory Pvt. Ltd., Hall-A, Chinar Mega Mall, Chinar Fortune City, Hoshangabad Road, Bhopal-462026, Madhya Pradesh, India, Tel:+91-755-6660006; E-mail: publication@trivedisrl.com

Received: July 24, 2015; Accepted: September 16, 2015; Published: September 28, 2015


Copyright: © 2015 Trivedi MK, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.
Experimental

Silver powder used in present investigation was procured from MEPCO, India. Silver powder was divided into two parts, referred as control and treated. The treated part was received Mr. Trivedi’s biofield treatment. Control and treated samples were characterized using particle size analyzer, X-ray diffraction (XRD), and surface area analyzer at different time periods.

Particle size analysis

Particle size analyzer, Sympatec HELOS-BF was used to determine the particle size distribution. This system can detect the particle size from 0.1 μm to 875 μm. The data obtained from the instrument was in the form of a chart of cumulative percentage vs. particle size. Particle sizes d10, d50, d90, and d99 (size below which 10%, 50%, 90%, and 99% particles are present, respectively) were computed from particle size distribution curve. Percent change in particle size was calculated using following equations:

\[
\% \text{ change in particle size, } d_{10} = \frac{\left( d_{10} \text{ Treated} - d_{10} \text{ Control} \right)}{d_{10} \text{ Control}} \times 100
\]

Where, \(d_{10}\) Control and \(d_{10}\) Treated are the particle size, \(d_{10}\) of control and treated samples respectively. Similarly, the percent change in particle size \(d_{50}\), \(d_{90}\) and \(d_{99}\) were calculated.

X-ray diffraction analysis

XRD analysis of control and biofield treated silver powder was carried out on Phillips, Holland PW 1710 XRD diffractometer, which had a copper anode with nickel filter. The wavelength of X-ray radiation used was 1.54056 Å. Data obtained from the XRD was in chart form of intensity vs. 2θ°, with a detailed table containing d value (Å), number of peaks, peak width 2θ°, peak count, relative intensity etc. Further, lattice parameter, unit cell volume, and atomic weight were computed using PowderX software. Atomic weight in g/mol was calculated as multiplying the atomic weight by the Avogadro number (6.023 × 10²³). Weight of the unit cell was calculated as, atomic weight multiplied by the number of atoms present in a unit cell. Total nuclear charge was calculated as the number of protons multiplied by charge on a proton (1.6 × 10⁻¹⁹ C). Nuclear charge per unit volume was computed as follow:

\[
\text{Nuclear charge per unit volume} = \frac{\text{Total nuclear charge in an atom}}{\text{Volume of an atom}}
\]

Crystallite size was calculated as follow:

\[
\text{Crystallite size} = \frac{k \lambda}{b \cos \theta}
\]

Where, \(\lambda\) is the wavelength of x-ray (=1.54056 Å) and \(k\) is the equipment constant (=0.94).

Besides, the percent change in the lattice parameter was calculated using following equation:

\[
\% \text{ change in lattice parameter} = \frac{A_{\text{Treated}} - A_{\text{Control}}}{A_{\text{Control}}} \times 100
\]

Where \(A_{\text{Control}}\) and \(A_{\text{Treated}}\) are the lattice parameter of treated and control samples respectively. Similarly, the percent change in all other parameters such as unit cell volume, density, atomic weight, nuclear charge per unit volume, crystallite size were calculated.

Surface area analysis

The surface area was measured by the Surface area analyser, SMART SORB 90 based on Brunauer–Emmett–Teller (BET), which had a detection range of 0.2-1000 m²/g. Percent change in surface area was calculated using following equations:

\[
\% \text{ change in surface area} = \frac{S_{\text{Treated}} - S_{\text{Control}}}{S_{\text{Control}}} \times 100
\]

Where, \(S_{\text{Control}}\) and \(S_{\text{Treated}}\) are the surface area of control and treated samples respectively.

Results and Discussion

Particle size analysis

The particle size analysis results of \(d_{10}\), \(d_{50}\), \(d_{90}\), and \(d_{99}\) of silver powder are presented in Table 1. Data showed that the particle size, \(d_{50}\), i.e. smaller size particles of treated silver sample was increased from 47.04 μm (control) to 48.73 μm on day 10, whereas it was significantly reduced to 1.97, 1.68, and 1.67 μm on day 84, 91, and 109, respectively. It suggest that \(d_{50}\) was substantially decreased by 95.81, 96.43, and 96.45% on day 84, 91, and 109 respectively as compared to control. Average particle size, \(d_{95}\), was significantly reduced from 81.90 μm (control) to 79.43, 8.31, 6.82, and 6.94 μm on day 10, 84, 91, and 109 respectively in treated silver sample. It suggest that \(d_{95}\) of treated silver sample was substantially reduced by 3.02, 89.85, 91.67, and 91.53% on day 84, 91, and 109 respectively as compared to control. In addition, particle size \(d_{99}\) of treated silver sample was reduced from 124.29 μm (control) to 118.71, 20.88, 17.60, and 34.59 μm on day 10, 84, 91, and 109 respectively, which indicated that after biofield treatment, \(d_{99}\) of silver samples were reduced by 4.49, 83.20, 85.84, and 72.17% on day 10, 84, 91, and 109, respectively as compared to control. Furthermore, the particle size \(d_{99}\) was significantly reduced from 173.70 μm (control) to 154.16, 36.55, 34.95, and 61.35 μm on day 10, 84, 91, and 109 respectively in treated silver sample. It indicated that \(d_{99}\) of treated silver sample was substantially reduced by 11.25, 78.96, 79.88, and 64.88% on day 10, 84, 91, and 109 respectively as compared to control. Overall, particle size data revealed that biofield treatment has significantly reduced the silver particle size. Our group previously reported that biofield treatment has significantly reduced the particle size in titanium and antimony powder [12,13]. Silver particles have high density of point defects, dislocations, grain and interphase boundaries. The boundaries are structurally weak points in silver powder, which can easily fracture under high stress conditions. Thus, it is assumed that biofield treatment probably transfer the stress energy to silver particles, which may result into fracturing of particles and reduced particle size. It is reported that antimicrobial action of silver is depend upon its size i.e smaller the size of silver particles, higher is antimicrobial efficacy in human body [25,26]. Further, it is also reported that antimicrobial activity of silver is associated with its ionized form as body fluid ionized the silver (Ag⁺) and make it highly reactive. This ionized silver atom binds to tissue protein and change the structure of bacterial cell wall and nuclear membrane, which further leads to cell distortion and death.

Table 1: Effect of biofield treatment on particle size of silver powder.
The reduction of atomic size may increase nuclear charge per unit volume in treated silver since both are inversely related. Previously, our group reported that biofield treatment had increased the nuclear charge per unit volume in zinc and chromium [12]. Moreover, the increase in nuclear charge per unit volume in silver as compared to control indicates that ionic strength of silver (Ag⁺) probably enhanced after biofield treatment. It is reported that positive charge of silver ions (Ag⁺) plays an important role in antimicrobial activity [29].

Thus, it is assumed that biofield treated silver could exhibit the higher antimicrobial efficacy as compared to control. Besides, the crystallite size of treated silver sample was reduced from 72.89 nm (control) to 21.87, 31.26, 62.48 and 27.35 nm on day 105, 156, 189, 203 respectively. Thus, data suggest that crystallite size in treated silver sample was significantly reduced by 70.0, 57.1, 14.3, and 62.5% on day 105, 156, 189, 203 respectively as compared to control. The existence of internal strain in treated silver is evidenced by change in unit cell volume and lattice parameter (Table 3). These internal strains made dislocations to move on the slip planes and intersecting slip planes built in stress concentrations. Furthermore, the stress concentration increases to such an extent causing the crystal to fracture at the sub boundaries and reduce the crystallite size. Our group previously reported that biofield treatment has significantly reduced the crystallite size in aluminium [30]. Furthermore, it is demonstrated that the rate of dissolution of a drug can be improved by choosing solids which exhibits high solubility due to low crystallinity or high amorphous phase [31]. Torrado et al. reported that solids with smaller crystallite size exhibited faster dissolution rate as compared to solids with higher crystallite size [32]. Thus, it is assumed that biofield treated silver powder may exhibit the higher dissolution rate in body fluid as compared to control, which ultimately can improve the bioavailability of dosage form containing silver.

### Surface area analysis

Surface area of control and treated silver samples are presented in Table 4. Data exhibited that surface area of treated silver sample was increased from 1.70 m²/g (Control) to 2.54 m²/g on day 68 as compared to control. It indicates that surface area was enhanced by 49.41% as compared to control on day 68 after biofield treatment. It is well established that decrease in particle size of any powder enhance its surface area. Thus, the decrease in particle size leads to increase the surface area of treated silver powder after biofield treatment. Our group
Previously reported that biofield treatment has reduced the surface area in silicon and zirconium oxide [33,34]. Noyes-Whitney proposed the relationship between rate of dissolution (R) and surface area (S) of a solid as following [35]:

\[ R = \frac{DS(C_s - C)}{L} \]

Where, D is diffusion constant, C_s and C are the concentration in the bulk dissolution medium and diffusion layer surrounding the solid, respectively, L is diffusion layer thickness. This equation revealed that the rate of dissolution can be modified primarily by altering the surface area of the solids. Thus, the large surface area of treated silver as compared to control indicates a higher dissolution rate of silver particles in surrounding fluid, which possibly improves the bioavailability. Moreover, it is reported that antimicrobial activity of silver is highly depended on its surface area since higher surface area causes large exposure to bacteria [36,37]. Thus, overall study suggest that bioavailability and antimicrobial efficacy of biofield treated silver might enhanced after biofield treatment.

Conclusion

Overall, biofield treatment has substantially altered the atomic and physicochemical properties of silver powder. Particle size data revealed that d_{10}, d_{50}, and d_{90} of treated silver powder were significantly reduced up to 95.8, 89.9, 83.2, and 79.0% on day 84 as compared to control. XRD results showed that unit cell volume and atomic weight was decreased up to 0.75%, whereas density and nuclear charge per unit volume and density decreased up to 0.75% as compared to control silver on day 203. Also, the increase in nuclear charge per unit volume indicates that ionic strength of silver (Ag^+) probably enhanced, which may improve its antimicrobial activity. In addition, crystalline size was reduced up to 70% in treated silver as compared to control on day 105. Moreover, the decrease in particle size, increases the surface area up to 49.41 % in treated silver powder as compared to control on day 68. Thus, reduction in particle size, crystallite size and increase in surface area may increase the dissolution rate and thus bioavailability, which further attributes to antimicrobial efficacy of treated silver as compare to control.

Acknowledgement

 Authors gratefully acknowledge to Dr. Cheng Dong of NLSC, Institute of Physics and Chinese academy of sciences for providing the facilities to use Powder X software for analyzing XRD results.

References


