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SILVER NANOPARTICLES EXTRACTED FROM PLANTS AND THEIR CHEMICAL SYNTHESIS-A REVIEW

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Abstract:
Development of reliable and eco-accommodating methods for the synthesis of nanoparticles is a vital step in the field of nanotechnology. Silver nanoparticles are important because of their exceptional chemical, physical, and biological properties, and hence applications. In the last decade, numerous efforts were made to develop green methods of synthesis to avoid the hazardous byproducts. This review describes the methods of green synthesis for Ag-NPs and their numerous applications.

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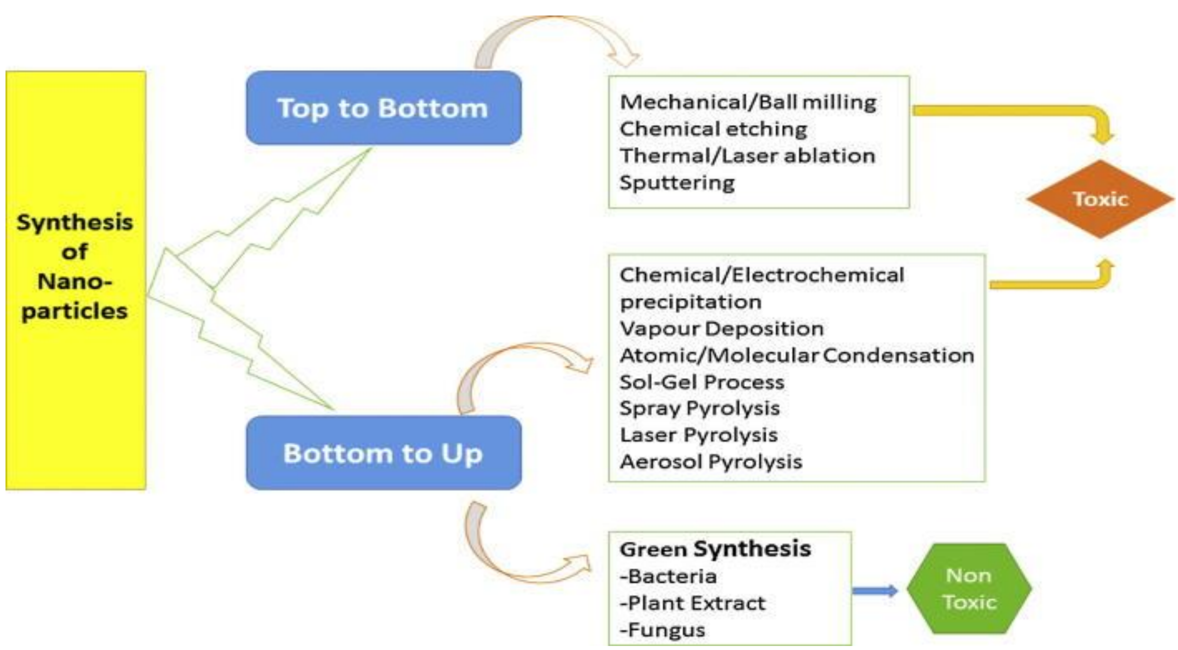
INTRODUCTION:

Within this size range all the properties (chemical, physical and biological) changes in fundamental ways of both individual atoms/molecules and their corresponding bulk. Novel applications of nanoparticles and nanomaterials are growing rapidly on various fronts due to their completely new or enhanced properties based on size, their distribution and morphology. It is swiftly gaining renovation in a large number of fields such as health care, cosmetics, biomedical, food and feed, drug-gene delivery, environment, health, mechanics, optics, chemical industries, electronics, space industries, energy science, catalysis, light emitters, single electron transistors, nonlinear optical devices and photo-electrochemical applications. Tremendous growth in these expanding technologies had opened applied frontiers and novel fundamentals. This includes the production of nanoscale materials afterwards in investigation or utilization of their mysterious physicochemical and optoelectronic properties [1], [2], [3].

The nanoparticles used for all the aforesaid purposes, the metallic nanoparticles considered as the most promising as they contain remarkable antibacterial properties due to their large surface area to volume ratio, which is of interest for researchers due to the growing microbial resistance against metal ions, antibiotics and the development of resistant strains [2]. Among the all noble metal nanoparticles, silver nanoparticle are an arch product from the field of nanotechnology which has gained boundless interests because of their unique properties such as chemical stability, good conductivity, catalytic and most important antibacterial, anti-viral, antifungal in addition to anti-inflammatory activities which can be incorporated into composite fibres, cryogenic superconducting materials, cosmetic products, food industry and electronic components. [4], [5]. For biomedical applications; being added to wound dressings, topical creams, antiseptic sprays and fabrics, silver functions' as an antiseptic and displays a broad biocidal effect against microorganisms through the disruption of their unicellular membrane thus disturbing their enzymatic activities.

The development of biologically-inspired experimental processes for the syntheses of nanoparticles is evolving into an important branch of nanotechnology. Generally there are two approaches which are involved in the syntheses of silver nanoparticles, either from "top to bottom" approach or a "bottom to up" approach (Fig. 1). In bottom to top approach, nanoparticles can be synthesized using chemical and biological methods by self-assemble of atoms to new nuclei which grow into a particle of nano scale as shown in while in top to bottom approach, suitable bulk material break down into fine particles by size reduction with various lithographic techniques e.g. grinding, milling, sputtering and thermal/laser ablation. (Fig. 1).



Among them, there are 313 products utilizing nanosilver (24% of products listed), this has made nanosilver the largest and fastest growing class of NPs in consumer products applications. According to the report of silver nanotechnology commercial inventory published in 2008, the health and fitness markets were found to be the biggest emergence of products utilizing nanosilver (131 records) compared to other categories such as appliances [4], medical applications [5], and electronics and computers (8). The worldwide market incorporating nanotechnology continues to grow on a rapid and consistent basis. With the world annual rate of increase ~25%, the commercial nanotechnology industry value is predicted to increase significantly from $91 billion by 2009 to $1 trillion by 2015 and $3 trillion by 2020 . Despite the historic use of nanosilver in health-related fields, however, the future prospect of silver nanotechnologies applications for other product fields, i.e., for environmental disinfections remains to be unexploited.

In recent years a growing number of outbreaks of infectious diseases have emerged. For an example, in early May 2011, an outbreak of diarrhea disease caused by an unusual serotype of Shiga-toxin–producing *Escherichia coli* (O104 : H4) began in Germany with a large number of cases of diarrhea with 3167 without the hemolytic–uremic syndrome (16 deaths) and 908 with the hemolytic–uremic syndrome (34 deaths) [6]. These infectious diseases have not only occurred in developing countries with low levels of hygiene and sanitation, but have also been recognized in developed countries. Food and waterborne pathogens are the main factors for the outbreak of these diseases, the transmission of these pathogens endangering public health. The outbreak of re-emerging and emerging infectious diseases are a significant burden on global economies and public health [7-11]. Their emergence is thought to be driven largely by socio-economic, environmental and ecological factors. To prevent further spread of the infectious pathogens, disinfection methods should be done properly to eliminate these pathogens from infected environmental areas, and effective treatments should also be carried for patients in hospitals and in the community. Particularly, the noble metal Ag-NPs is drawing increasing attention for potential prevention of bacterial/fungal and viral infections due to their well-documented antimicrobial and disinfectant properties. The generation of stable and efficient Ag-NPs forms offers an advanced perspective in the field of environmental hygiene and sterilization.

Chemical synthesis

Currently, many methods have been reported for the synthesis of Ag-NPs by using chemical, physical, photochemical and biological routes. Each method has advantages and disadvantages with common problems being costs, scalability, particle sizes and size distribution. Among the existing methods, the chemical methods have been mostly used for production of Ag-NPs. Chemical methods provide an easy way to synthesize Ag-NPs in solution. Monodisperse samples of silver nanocubes were synthesized in large quantities by reducing silver nitrate with ethylene glycol in the presence of polyvinylpyrrolidone (PVP) [12-14], the so-called polyol process. In this case, ethylene glycol served as both reductant and solvent. It showed that the presence of PVP and its molar ratio relative to silver nitrate both played important roles in determining the geometric shape and size of the product. It suggested that it is possible to tune the size of silver nanocubes by controlling the experimental conditions.

Spherical Ag-NPs with a controllable size and high monodispersity were synthesized by using the polyol process and a modified precursor injection technique [15-19]. In the precursor injection method, the injection rate and reaction temperature were important factors for producing uniform-sized Ag-NPs with a reduced size. Ag-NPs with a size of 17 ± 2 nm were obtained at an injection rate of 2.5 ml s^{-1} and a reaction temperature of 100 °C. The injection of the precursor solution into a hot solution is an effective means to induce rapid nucleation in a short period of time, ensuring the fabrication of Ag-NPs with a smaller size and a narrower size distribution.

Nearly monodisperse Ag-NPs have been prepared in a simple oleylamine-liquid paraffin system [16-22]. It was shown that the formation process of Ag-NPs could be divided into three stages: growth, incubation and Oatwald ripening stages. In this method, only three chemicals, including silver nitrate, oleylamine and liquid paraffin, are employed throughout the whole process. The higher boiling point of 300 °C of paraffin affords a broader range of reaction temperature and makes it possible to effectively control the size of Ag-NPs by varying the heating temperature alone without changing the solvent. Otherwise, the size of the colloidal Ag-NPs could be regulated not only by changing the heating temperature, or the ripening time, but also by adjusting the ratio of oleylamine to the silver precursor.

Generally, the chemical synthesis process of the Ag-NPs in solution usually employs the following three main components: (i) metal precursors, (ii) reducing agents and (iii) stabilizing/capping agents. The formation of colloidal solutions from the reduction of silver salts involves two stages of nucleation and subsequent growth. It is also revealed that the size and the shape of synthesized Ag-NPs are strongly dependent on these stages. Furthermore, for the synthesis of monodispered Ag-NPs with uniform size distribution, all nuclei are required to form at the same time. In this case, all the nuclei are likely to have the same or similar size, and then they will have the same subsequent growth [23-25]. The initial nucleation and the subsequent growth of initial nuclei can be controlled by adjusting the reaction parameters such as reaction temperature, pH, precursors, reduction agents (i.e. $NaBH_4$, ethylene glycol, glucose) and stabilizing agents (i.e. PVA, PVP, sodium oleate)[26]

CONCLUSION:

Ag-NPs are one of the most attractive nanomaterials for commercialization applications. They have been widely used for antimicrobial, electronic and biomedical products. In this review, we provide a comprehensive understanding of the Ag-NPs from synthesis methods, antimicrobial effects and possible toxicology considerations of Ag-NPs to both humans and ecology. The emphasis is also placed on the disinfectant ability of Ag-NPs nanomaterials with respect to environmental treatments. An overview of some current applications for use of Ag-NPs in disinfectant applications was given and discussed.

REFERENCES:

1.Ju-Nam Y and Lead J R. Sci. Total Environ.2008; 400: 1.
2.De M, Ghosh P S and Rotello V M 2008 Adv. Mater. 20020 4225.
3.Lu A-H, Salabas E L and Ferdi Schüth, Angew. Chem. Int. Ed. Engl. 2007;46: 122.
4.Ghosh Chaudhuri R and Paria S 2012 Chem. Rev. 112 :2373.
5.Sharma V K, Yngard R A and Lin Y 2009 Adv. Colloid Sur. Interface 145:83.
6.Krutyakov Y A, Kudrynskiy A A, Olenin A Y and Lisichkin G V 2008 Russ. Chem. Rev. 77: 233.
7.Monteiro D R et al 2009 Antimicrob. Agents 34: 103.
8.Ahamed M, Alsalhi M S and Siddiqui M K 2010 Clin. Chim. Acta 411: 1841.
9.García-Barrasa J, López-de-luzuriaga J M and Monge M 2011 Cent. Eur. J. Chem. 9 :17.
10.Fabrega J, Luoma S N, Tyler C R, Galloway T S and Lead J R 2011 Environ. Internat. 37: 517.
11.Dallas P, Sharma V K and Zboril R 2011 Adv. Colloid Interface Sci. 166 :119.
12.Rasko D A et al 2011 N. Engl. J. Med. 365 :709.
13.Jones E K etal 2008 Nature 451: 990.
14.Sun Y and Xia Y 2002 Science 298 :2176.
15.Kim D, Jeong S and Moon J 2006 Nanotechnology 17 :4019.
16.Chen M, Feng Y-G, Wang X, Li T-C, Zhang J-Y and Qian D-J 2007 Langmuir 23 :5296.
17.Chen S-F and Zhang H 2012 Adv. Nat. Sci.: Nanosci. Nanotechnol. 3 035006.
18.Dang T M D, Le T T T, Blance E F and Dang M C 2012 Adv. Nat. Sci.: Nanosci. Nanotechnol. 3 035004.
19.Patil R S et al 2012 Adv. Nat. Sci.: Nanosci. Nanotechnol. 3 015013.
20.Lee D K and Kang Y S 2004 ETRI J. 26: 252.
21.Jung J H, Cheol Oh H, Soo Noh H, Ji J H and Soo Kim S 2006 J. Aerosol Sci. 37: 1662.
22.Tien D-C, Tseng K-H, Liao C-Y, Huang J-C and Tsung T-T 2008 J. Alloys Compounds 463 :408
23.Siegel J, Kvítek O, Ulbrich P, Kolská Z, Slepička P and Švorčík V 2012 Mater. Lett. 89 :47.
24.Christy A J and Umadevi M 2012 Adv. Nat. Sci.: Nanosci. Nanotechnol. 3 035013 25.Sakamoto M, Fujistuka M and Majima T 2009 J. Photochem. Photobiol. C 10 :33.
26.Sato-Berrú R, Redón R, Vázquez-Olmos A and Saniger J M 2009 J. Raman Spectrosc. 40: 376.