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Review Article

A brief review on green synthesis and characterisation of CeO_2 nanoparticles (CeO_2 NPS)

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ABSTRACT

Since last few years, significant efforts have been done by researchers for the synthesis of nanoparticles and their applications in different fields such as sensing, energy storage, environmental remediation, cosmetics, communications and so many others. Green synthesis of nanoparticles using plant derived materials has been attracted for high efficiency, low cost, eco-friendly and simplicity. The biologically synthesised metal and metal oxide nanoparticles are presently known for their great importance in biological, physical, chemical, pharmaceutical and engineering sciences and cerium oxide nanoparticles (CeO_2-NPS) one of them. In this review, we have discussed the different green strategies for synthesis of CeO_2-NPS and their advantages, characterisation techniques, importance of CeO_2-NPS and current studies. CeO_2-NPS have many applications such as catalytic applications, in solid oxide fuel cells, photo-catalysis, and environmental remediation, medicinal and therapeutical.

Key words: *Nanoparticles, Green synthesis, CeO_2-NPS, Characterisations, Applications of CeO_2-NPS*

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INTRODUCTION

Nanotechnology has played an important role in physical, chemical, biological and other fields of science. It is the practices of materials under nano scale (1-100 nm) and an opportunity for research in concerned fields [1,2].The green or biological synthesis of metal and metal oxide nanoparticles by using any plant derived material has been attracted since last half decade [3]. The common green synthesised metal and metal oxide nanoparticles are silver (Ag), gold (Au), platinum (Pt), calcium oxide (CaO), magnesium oxide (MgO), titanium oxide (TiO_2), zinc oxide (ZnO), manganese oxide (MnO_2), copper oxide (CuO), zirconium oxide (ZrO_2) and cerium oxide (CeO_2). These nanoparticles are used as antimicrobial agents, polymer sciences, engineering, pharmaceuticals, toxicology etc because of their excellent physical and chemical properties [3-10]. The green synthesis has been used in the synthesis of such nanoparticles characterised by high efficiency, simple, low cost and eco-friendly [1-3]. Cerium oxide nanoparticles (CeO_2-NPS) are generally used in corrosion protection, chemical and mechanical polishing, fuel catalysis, solar cells and antimicrobials [11-13]. CeO_2-NPS existed in two different forms, CeO_2 (Ce^{4+}) and Ce_2O_3 (Ce^{3+}); presently CeO_2-NPS have been used as multi-enzymes such as oxidase, superoxide oxidase and catalase. Therefore, CeO_2-NPS can be used in bio-analysis, drug delivery and different biomedicines due to sudden exchange of oxidation state between Ce^{3+} and Ce^{4+}[14].

GREEN SYNTHESIS & CHARACTERIZATION OF CeO_2-NPS

CeO_2-NPS can efficiently be synthesised by using the extract of any part of the plants. The different parts of the plant such as leaves, stem or root washed and cut into small pieces and then boiled with distilled water for a specific time. After that, the content is filtered and filtrate is used as plant extract. Now, a requisite amount of extract is treated with the solution of salts containing cerium for a specific time at a fixed shake. Then add alkali base in this content and again shake till all the CeO_2-NPS comes out in the form of precipitate. This CeO_2-NPS precipitate is completely dried and calcined [8-10] . After a successful synthesis of CeO_2-NPS, the common characterisation methods are necessary to explore the physical and chemical properties of CeO_2-NPS[1-5, 17,18].

Table-1: Characterization techniques for CeO_2-NPS

UV-Visible	Formation of CeO_2-NPS in the solution at particular wavelength is confirmed by UV-Visible spectroscopy [1-5].
FTIR	Fourier transform infra red (FTIR) is basically used for the identification of bonds in the biologically synthesised CeO_2-NPS [14].
XRD	X-ray diffraction (XRD) technique is used to determine crystalline, semi –crystalline or amorphous nature CeO_2-NPS [14-17].
FESEM	Field emission scanning electron microscopy (FESEM) is well known for the morphological characters of CeO_2-NPS and others [18-20].
EDX	Energy dispersive X-ray spectroscopy is generally used for elemental analysis of nanoparticles[18-20].
DLS	Dynamic light scattering (DLS) is well known for the size distribution of the smallest particles [21].
TEM	Transmission electron microscopy (TEM) is used to analyse CeO_2-NPS in nanoscale and it also helps in topography, composition and crystallography [11-18].
AFM	Atomic force microscopy (AFM) is very helpful in aggregation and dispersion of nanoparticles w.r.t. the size, shape and structure [21].

CURRENT STUDIES

Charbgooand other co-workers[15] have reported the use of CeO_2-NPS as therapeutic agents in biological and medical sciences. They explored the biocompatible CeO_2-NPS in neurodegenerative therapy and multiple applications in nano-biotechnology.Duttaa et al. [16]has considered the green synthesis of CeO_2-NPS by using cerium nitrate and leaves extract of *Aloe vera*. They focussed on the anti-oxidant potential of CeO_2-NPS in present and future. Annu et al. [17] have reported the biological synthesis of CeO_2-NPS by using the plant extracts and their applications in biomedicine and photo-catalysis. Due to small size and advance properties, CeO_2-NPS can be used in sensors, solid oxide fuel cells, cosmetics, biotransformation and bio-imaging.Naz et al. [18]investigated the use of CeO_2-NPS in almost all areas of research due to their distinctive properties. The green synthesised CeO_2-NPS have been characterised by using electron microscopy, XRD, and TGA. The plant originated CeO_2-NPS have been regarded as a safe and biocompatible material to be used in drug delivery.Thakur [19]has worked on the green synthesis of CeO_2-NPS and utilisations in antibacterial activities against gram negative bacteria. CeO_2-NPS has identified as a potential antibacterial against gram negative bacteria. CeO_2-NPS has also been used in the drug and gene delivery in vitro and in vivo models. CeO_2-NPS also possessed excellent potential in tissue engineering.Zhang et al. [20] reported the use of CeO_2-NPS as antibacterial agents against *E. coli* and *S. aureus*. They have been explained the antibacterial effect of CeO_2-NPS on the basis of reversible conversion between two valence states of Ce(III)/Ce (IV).

CONCLUSIONS

In this mini review, we have discussed very adequately and briefly the green synthesis, characterisations and some important applications of CeO_2-NPS. In the current study section, we have discussed some very important applications and green synthetic approaches of CeO_2-NPS. This paper will be very helpful for the new researchers because of short and very adequate study of CeO_2-NPS.

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