Materials Today: Proceedings xxx (xxxx) xxx

Contents lists available at ScienceDirect

Materials Today: Proceedings

journal homepage: www.elsevier.com/locate/matpr

Formation and characterization of Oleylamine stabilized Ceria nanoparticles

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ARTICLE INFO

Article history:
Available online xxxx

Keywords:
Ceria
PXRD
TEM
Nanoparticles
Oleylamine
Crystallite size

ABSTRACT

Nanostructures are seeking eminent pose in technological advancement due to their size and surface properties and enhanced performance over their bulk counterparts. One of the most well-known and exciting developments among them is observed in metal oxide nanoparticles. Metal oxides have unique characteristics that make them the most pied class of materials and the properties they exhibit cover almost all facets of solid-state physics and material science. Herein, we report the synthesis of Oleylamine capped ceria nanoparticles prepared via chemical precipitation method, the idiosyncratic behaviour of amines attached to the Ce^{3+} ions is observed. To validate the interaction of material with the photon, absorption spectra and photoluminescence studies are undertaken; the analysed band gap is around 4.445 eV. The photoluminescence measurement shows that the CeO_2 nanoparticles are fluorescent in nature. The powder x-ray diffraction (PXRD) result indicates the formation of high purity ceria nanoparticles in fluorite cubic structure in amorphous phase. The crystallite size is found to be 3.00 nm calculated by Debye Scherrer's equation. Overall the combined results serve to indicate that aminolysis reactions are proficient at computing the play of surface amines. Prepared Ceria nanoparticles are used in many applications like hydrogen evolution, photo-degradation and sensing applications.

Selection and peer-review under responsibility of the scientific committee of the Recent Advancements in Materials Science and Nanotechnology.

1. Introduction

Nanotechnology has shown an epoch-making growth and is a pioneering realm of applications in various types of fields; revolutionized pharmaceutical, industrial, agricultural, environmental and material sciences domain. At this scale, materials have unique physical, chemical, optical, electronic, mechanical and quantum properties due to increase in the surface volume ratio compared to the molecular scale behavior. This makes them to stand in front as a significant raw material in various applications like communications [1], energy storage [2], sensing [3], data storage [4], optics [5], transmission [6], environmental protection [7], biology [8,9] and medicine [9]. Till now, nanomaterials, including metal oxides, ferrites [10,11], quantum dots [12,13], Metal halide perovskites [14,15] and so on are developed. Among them, metal oxides have solitary structure, fascinating and show remarkable redox and catalytic properties, high surface area and good mechanical stability. Many of the different metal oxides are reported and discussed, in particular there is a global demand for Rare earth metal oxides and are portentously increasing in turn with their mushrooming in high end technology, environmental and remunerative areas. Within the 17 nearly indistinguishable lustrous silvery soft heavy white metals, Cerium is most abundant rare metal with an atomic number of 58; it shows wide band gap of 3.19 eV along with high excitation energy. It exhibits catalytic properties due to screening of 5p and 4d electrons in the 4f orbital. Cerium di oxide (Ceria) in its oxide form is more stable. In various industrial sectors, Ceria is significant as it used as a raw material in extensive applications such as auto-exhaust catalyst [16], low temperature water gas shift reaction [17], oxygen sensors [18], oxygen permeation membrane systems [19], fuel cells [20], glass polishing materials [21], electrochromic thin film application [22] and so on. Tausif Ahmad et al. investigated the photocatalytic degradation properties of eco-friendly synthesized CeO_2 nanoparticles using Elaeis guineensis leaves as reducing and stabilizing agent. They reported the

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https://doi.org/10.1016/j.matpr.2022.06.306
2214-7853/
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