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Synthesis and properties of nano ZnO using polysaccharides as chelating agents: Effects of various parameters on surface modification of polysaccharides

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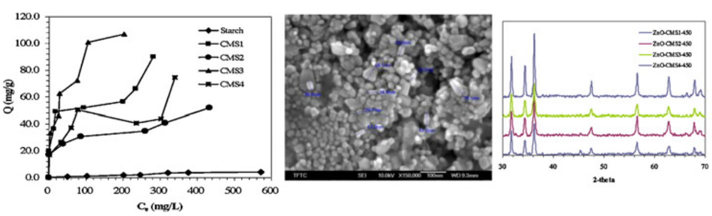
HIGHLIGHTS

- ► Polysaccharides (sodium alginate and corn starch) as chelating and structure directing agents.
- ► Elaborate studies on effect of different parameters on surface modification.
- ► Freundlich isotherms of Zn^{2+} and ZnO from Zn-polysaccharides organic polymers.

GRAPHICAL ABSTRACT



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ABSTRACT

Using polysaccharides (corn starch and sodium alginate) as both chelating and structure directing agents nano zinc oxides (ZnO) with moderate surface area and high pore volume were prepared. FT-IR and TGA analyses revealed that modified polysaccharides are more stable than that of unmodified one. Surface modification of starch was controlled by sodium chloracetate concentration and reaction temperature. Freundlich adsorption isotherms as preliminary studies confirmed that modified starch showed enhanced interaction with zinc ions. The interaction of zinc salt with polysaccharides produced zinc-polysaccharides polymers, which finally cleaved upon calcination to produce nano ZnO. Preparation of nano ZnO using native (unmodified) starch was unsuccessful. Experimental results indicated that 450 °C is the optimum calcination temperature to produce effective nano ZnO. Surface and optical properties of ZnO were carried out. SEM and TEM of ZnO indicated that uniform particle and shape distributions were obtained at low calcination temperature (450 °C).

1. Introduction

Zinc oxide ZnO is a promising optoelectronic and electronic functional material and has been recognized as one of the most interesting materials due to wide direct band gap energy and large exciton binding energy [1]. ZnO is also a green material that is bio-safe, biocompatible and biodegradable, and as a versatile material it has been widely used in various fields such as medical and environmental science [2,3], catalysts [4,5], microsensors [6], photoelectrochemical cells [7], piezoelectric transducers and actuators [8]. These properties are generally governed by structure, orientation and morphology of ZnO. Therefore, controlling of these features is one of the most challenging tasks in ZnO preparation [9]. So far, a variety of methods [10] has been developed to synthesize nano ZnO including vapor phase growth, vapor–liquid–solid processes, soft chemical methods, electrophoretic deposition, sol–gel process and homogeneous precipitation. In these preparation techniques, by-products being formed via different reaction pathways can presumably control the formation and morphology of the resulting inorganic material in various ways. Since the electrical and optical properties of nanomaterials, depend on both the particle shape and the particle size, the preparation method must also ensure the control over the morphology and the growth [11]. However, the use of metal–organic supramolecular compounds [12] as precursors for the preparation of nano ZnO has not yet been thoroughly investigated [13–15] and also the use of a simple, cost-effective method, starting from commercially available, low-price chemicals, is important for the facile production of ZnO.

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