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Conversion of cellulosic waste materials into nanostructured ceramics and nanocomposites

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ABSTRACT

Cellulosic waste materials which include sawdust, wastepaper, corncob and sugarcane bagasse were converted into nanostructured ceramics and nanocomposites by submersion in silica colloidal suspension (sol) and subsequently by calcination of the cellulosic/SiO_2 nanocomposites under controlled conditions. Depending on the calcination conditions used, nanostructured SiO_2 ceramics and carbon/SiO_2 nanocomposites were obtained. The morphology of resulting nanostructured ceramics and nanocomposites obtained from four types of cellulosic waste materials were characterized by Scanning Electron Microscopy (SEM), Fourier transformed infrared spectroscopy (FTIR), and CHN elemental analyzer. The effect of cellulosic materials on the properties of nanostructured ceramics and nanocomposites formed were investigated. Copyright © 2011 VBRI press.

Keywords: Cellulosic materials; nanostructured; ceramics; nanocomposites.

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Introduction

In recent years, the preparation of nanostructured ceramics from biological materials has continued to generate significant interest. Appropriate biological materials have been used as both precursors and templates for the synthesis of hierarchical inorganic materials such as oxides and carbides. Biological materials such as woods possess natural composite structures of high mechanical strength, low density, high stiffness, elasticity and damage tolerances and are therefore suitable to be used as unique nanostructured templates [**1**]. Some recently published studies have reported the preparation of nanostructured ceramics such as TiO_2-, Al_2O_3- and ZrO_2- ceramics from the wood-based materials *via* the sol-gel process with metal-alkoxides [**2**]. Padel and Padhi used the natural cellulose fibers such as sisal and jute for infiltration with $AlCl_3$ or $TiCl_4$ and subsequent transformation into Al_2O_3 or TiO_2 fibers by annealing in air [**3, 4**]. Ota *et al*. produced nanostructured TiO_2 ceramics by infiltration of wood with titanium tetra-isopropoxide followed by heat treatment in air [**5**]. Contrary to the traditional ceramic processing technique normally being used for preparing ceramic materials of simple structures, the mineralization of cellulosic materials provides a feasible approach for preparing ceramic materials of complex shapes and microstructures from low cost precursor materials [**6**].

The present study focused on converting cellulosic waste materials such as sawdust, wastepaper, corncob and sugarcanes bagasse into nanostructured ceramics and nanocomposite materials by impregnating them with silica sol and the subsequent calcinations process under controlled conditions. Such nanostructured ceramics and nanocomposite materials could be utilized for various potential technological applications such as catalyst support, automotive component, armour and light-weight porous ceramics for the aerospace and ground based applications [**7**]. The economical feasibility and significance of utilizing cellulosic waste materials as renewable and inexpensive sources of carbon and precursor materials are clearly evidenced [**8**]. Furthermore, these

