Accepted Manuscript

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PII: S0925-8388(16)32918-8

DOI: 10.1016/j.jallcom.2016.09.164

Reference: JALCOM 38998

To appear in: *Journal of Alloys and Compounds*

Received Date: 25 April 2016

Revised Date: 22 July 2016

Accepted Date: 16 September 2016

Please cite this article as: R. Halder, S. Bandyopadhyay, Synthesis and optical properties of anion deficient nano MgO, *Journal of Alloys and Compounds* (2016), doi: 10.1016/j.jallcom.2016.09.164.

Synthesis and optical properties of anion deficient nano MgO

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Abstract:

Nanocrystalline MgO powder was synthesized via modified organic gel combustion route using Urea-Formaldehyde for the first time as fuel. The formation reaction is explained through DTA-TGA. The phase formation (Rietveld refined XRD, FTIR) and the inherent powder characteristics were analyzed in terms of particle characteristics (FESEM, HRTEM, NIR-absorption), light absorption behaviour (UV-Vis spectroscopy) and photoluminescence properties (PL- spectroscopy). The general occurrence in the form of large porous nano spheres constituted by very fine crystallites of the order of 4-25 nm with enlarged cell parameters of pure MgO were obtained. Enhanced reactivity of the produced powder is expected to originate out of the exposed polarised surfaces of these fine grains with capability to provide high energy binding sites. The non equilibrium condition prevalent under extreme speedy kinetics of the formation reaction introduced quantum subsystems in the lattice. Photoconversion between different optical centres greatly influenced the luminescence properties yielding a broad emission spectrum. The spectrum is intense because of high concentration of anion deficiency with an obvious blue shift due to lower concentration of H^- traps in it. Promotion of electron in the introduced quantum subsystems under excitation provided intraband energy transfer between optical centres below the conduction band that lowered down the band gap value to 4.45 eV. Spark plasma sintering was employed for powder densification. The ultimate product constituted by nano grains of size corresponding to 200-500 nm exhibits ~ 80% transmittance in IR region.

Key words: nano-MgO, urea-formaldehyde gel, microscopy, band gap, luminiscence, IR- transparency.

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1. Introduction:

Periclase or magnesia (MgO), a natural mineral and an important component of the earth's mantle has the rocksalt- fcc crystal structure that is stable up to a fairly high pressure of 227 GPa [1]. All its physical and chemical properties depend on crystallite size and surface to volume ratio while their crystal defects that influences electronic structure, determines their metallic, semi-conducting and insulating character. In technological applications, bulk MgO is used traditionally as refractory in the steel making and refining processes, etc [2]. The nanocrystalline magnesium oxide in comparison to its larger sized complement has been shown to possess unique functional and optical characteristics those might display various physico chemical properties and find versatile applications. Nano sized Magnesium oxide is used for its high catalytic activity [3] due to the presence of active sites or oxygen vacancies on surfaces and edges which have the potentiality of charge transfer between substrate and adsorbate. Because of the capability to adsorb molecules by bond breaking process combined with high surface to volume ratio of the nano crystalline variety, it is useful as destructive adsorbents in the hazardous waste water treatment [4]. The additional characteristics are bacteriocidal effects that show antibacterial activity against food borne pathogen [5] and hence produce bacteria- free variety of the filtrate. For a similar reason of vacancy concentration which induces polarity in surfaces, the material