Thermal Plasma Processing of Spherical ZnO Nano Powders

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Abstract. Nano Zinc oxide (ZnO) is gaining more importance and its demand is keep increasing in recent decades because of its potential applications in energy, optoelectronic and sensor fields. To address this issue, the bulk synthesis of nano ZnO is demonstrated in the present article by the thermal plasma processing. Nano sized ZnO spherical particles of size 3 – 25 nm evidenced by transmission electron microscopy (TEM) have been synthesized from micron size zinc metal powder precursor. Surface chemical composition and presence of oxygen vacancies are analyzed by XPS and reported for future application.

INTRODUCTION

Zinc oxide is a direct band gap semiconductor of wide band gap (~3.37 eV) and larger excitation energy of 60 meV [1]. In nano dimension ZnO exhibits good electrical, electronic, electrochemical, and photo catalytic properties. These inherent properties makes ZnO as a useful material to design field emission displays, supercapacitors, solar cells, gas sensors, nano-photonic devices, gas sensors, piezoelectric transducers, varistors, phosphors, and transparent conducting films [2 – 4]. ZnO has been reported as an alternate photocatalyst for TiO_2 to treat wastewater contaminated with organic and inorganic pollutants due to low cost and non- toxicity [5]. These potential applications of nano structured ZnO demanded materials scientists to synthesize nano ZnO by variety of methods including precipitation, facile synthesis, spray-pyrolysis, hydrothermal, sol-gel, thermal evaporation and mechanochemical synthesis [6 – 13].

The present work reports the synthesis of nano ZnO particles by thermal plasma processing and its structural, morphological and X-ray photoelectron microscopic characterization. Thermal plasma processing takes the advantage of the high temperature and high enthalpy of the thermal plasma jet to effect 'in-flight' chemical reactions in the presence of reactive gas to synthesize nano-sized powders of advanced ceramics [14].The high quench rate, which is characteristic of the process, favors homogeneous nucleation resulting in nano-sized particles. The major advantages of the reactive plasma processing includes versatility, short processing time, large throughput, adaptability to process thin films and coatings.

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