SYNTHESIS OF NICKEL OXIDE NANOPARTICLES

*Faranak Asgari and Negar Kordzangene

Department of Chemistry, College of Chemistry, Ahvaz Branch,
Islamic Azad University, Ahvaz, Iran

*Author for Correspondence

ABSTRACT
Nickel oxide (NiO) nano powder was obtained during a chemical method. Nickel hydroxide precursor, prepared by addition of sodium hydroxide (NaOH) to nickel nitrate Ni(NO₃)₂ solution and vigorously stirring until the pH becomes 7.2 and after drying in oven nano powder NiO was achieved. Transient and scanning electron microscopy showed that the synthesized nano powder NiO had dimensions about 20 nm. The X-ray diffraction pattern revealed that the produced well-crystallized and high purity nickel oxide nanostructure.

Keywords: Nickel Oxide, X-ray Diffraction, Nano Powder

INTRODUCTION
Nickel oxide (NiO) is a p-type oxide semiconductor with a wide band gap (3.6–4.0 eV) and ~1.8 eV conduction band energy (Kunz, 1981) which has been considered as promising materials for optical, electronic and catalytic applications (Luyo et al., 2009). NiO nanoparticles also may have many applications such as in the manufacture of super paramagnetic materials, p-type transparent conducting films, gas sensors, catalyst, alkaline batteries cathode, dye-sensitized solar cells, and solid oxide fuel cells anode (Needham et al., 2006). Various methods such as sol–gel, hydrothermal synthesis, electrochemical methods, metal evaporation and spray pyrolysis, have been used and developed to produce nonopowder materials (Ghosh et al., 2006). Recently, the sonochemical methods have been acknowledged as a promising route for preparation of a variety of materials with nanometer dimensions, including metallic and ceramic nanoparticles (Wu et al., 2007). Ultrasonic waves consist compression and rarefaction cycles (Mahyar et al., 2009). Cavitation is the origin of sonochemical effects and takes place in rarefaction cycles where negative acoustic pressure is enough to pull water molecules from each other to create tiny microbubbles (Hamed et al., 2007). On the other hand in compression cycle of wave, acoustic pressure is positive. Finally microbubbles collapse violently during compression cycles and act as a localized microreactor which produces instantaneous temperatures of several thousand degrees (>5000 °C) and pressure in excess of several hundred atmospheres (Neppolian et al., 2008). Thus, such extreme temperatures and pressures within a small reactor can induce many changes in the morphology nanoparticles during preparation (Fu et al., 2009). The actual mechanism of cavitation is still incompletely understood, and in different cases almost certainly involves shock waves, imploding liquid jets, and the high temperatures and pressures associated with bubble collapse. In this work, nickel hydroxide was prepared chemically and by post heat treatment converted to nickel oxide nanoparticles. Also morphological and structural characterizations were carried out on NiO nanoparticles.

Characterization
Transition emission microscopy (TEM), X-Ray diffraction (XRD) and Scanning emission microscopy (SEM) measurements were performed at room temperature.

RESULTS AND DISCUSSION
Figure 1.a shows X-ray diffraction pattern of powder before calcinations procedure. After chemical treatment and drying of powder in the oven, green powder was obtained. This green powder identified as Nickel hydroxide by XRD. This is a typical Ni(OH)₂. All the diffraction peaks can be indexed to the diffraction data of the Ni(OH)₂.6H₂O. All peaks are broad; in general, the broadening of XRD diffraction peaks may result from small grain sizes or structural micro-distortions in crystal. Under the present experimental conditions, the extremely small particle like structure results in a significant broadening of
some diffraction peaks in Ni(OH)$_2$ XRD patterns. Also, these “saw-tooth” reflections are typical of turbostratic phases which are ordered in two dimensions, but whose layers are orientationally disordered. XRD result Figure 1.b confirms formation of black nickel oxide after calcinations treatment. Other components are not detected in final powders. In nickel oxide this is accompanied by a color change, with the stoichiometrically correct NiO being green and the non-stoichiometric NiO being black. Because of suppression of grain growth, minimum heat treatment temperature was chosen. Therefore, the oven dried cake was heated at 400ºC for 3h to form nanoparticle NiO. Figures 1.a & b illustrate, Ni(OH)$_2$ with poor crystallinity and NiO nano powder with high crystallinity were obtained.

Results show chemical treatment decrease the crystalline size of synthesized powders. Micrograph which showed in Figure 2 depicted aggregated spherical particles with diameter about 20 to 50 nm. They might form due to an interparticle magnetic intractio TEM investigations. Figure 3 exhibit the NiO nanoparticles with an average particle size of 20 nm Morphology of powders is qubic particles due to NaCl structure of NiO. These particles formed morphologies observed in SEM images. Figure 2 Scanning emission microscopy of nickel oxide nano.

**Conclusion**

Pure high crystallinity nickel oxide nano average crystallite size of about 20 nm was synthesized by a novel chemical approach. Morphology of resulted powder is qubic particles due to NaCl structure of NiO. Nickel oxide which is produced in this method is non-stoichiometry and this non is accompanied by a color change from green to black.
REFERENCES


