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# Chemical Synthesis and Structural/Analytical Characterization of CuNi-$Al_2O_3$ Nanocomposites.

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It is well established that nanostructured materials show advanced mechanical and transport properties [1]. These materials, however, can be further enhanced through the inclusion of nanoparticles in the structure of a particular matrix, thereby forming nanocomposites [2]. Under this perspective, CuNi alloys, which are highly ductile material, can have its hardness considerably improved with the incorporation of $Al_2O_3$ nanoparticles [3]. Different methods for producing nanocomposites in laboratory scale have been studied from a variety of physical and chemical methods. The present study is centered on a chemical route process aiming at obtaining metallic nanoparticles of homogeneous composition in which a fully homogeneous dispersion of a nano scale ceramic phase ($Al_2O_3$) has been incorporated.
The synthesis procedure can be divided into two steps. First, thermal decomposition of a nitrate solution containing, $Ni(NO_3)_2$, $Cu(NO_3)_2$ and $Al(NO_3)_3$ in an adequate proportion of them. The second step is the preferential hydrogen reduction (copper and nickel) of the oxides mixture obtained in the first step. Based on the nitrates mixture composition the Ni, Cu and $Al_2O_3$ contents can be pre-established. The obtained nanocomposite powder was analyzed by XRD for phase identification of the product powder. SEM-EDS analysis was employed as a first step for an overall appreciation of the microstructure; extend of particles agglomeration and also for obtaining elemental chemical mappings. TEM techniques have been extensible used under diffraction a phase contrast modes, using a LaB6 Jeol 2010 and a FEG Jeol instruments, both operating under 200 kV accelerating potential.

A detailed study of particle morphology and size distribution of the synthesized powder shows it is primarily constituted of spheroidal-like particles with diameters in the 5 to 60 nm range, some exhibiting faceting, Figure 1. TEM/STEM analytical techniques, including EDS elemental mapping , shows that the entire synthesis procedure has been successful since it has produced metallic nanoparticles with homogeneous composition in Ni and Cu with a fine dispersion of smaller $Al_2O_3$ nanoparticles, with an average 10nm in size. A typical example is displayed in Figure 2, a bright field /dark field pair of a composite nanoparticle with an inner structure suggesting a core/shell assembly, a unique structural feature which is consisted of an inner core containing $Al_2O_3$ and an external shell of CuNi. Figure 3. Shows the EDS spectrum acquired from the edge of the particle shown in Fig 2. Finally, micro hardness measurements carried out on consolidates bulk pellets of CuNi/-$Al_2O_3$ nanocomposites confirmed the expectations that mass addition of $Al_2O_3$, even about 1%, can result in a much higher hardness as compared with binary CuNi alloy, 250 Hv and 147 Hv respectively [4].

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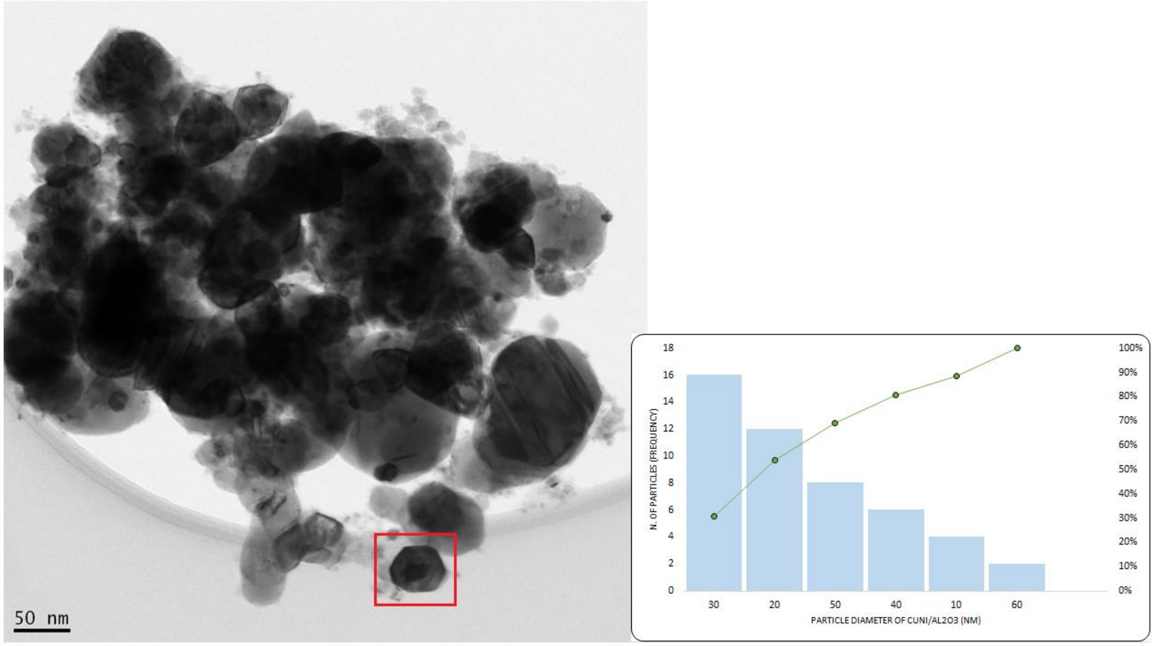

**Figure 1.** a) Bright field TEM of CuNi-$Al_2O_3$ nanoparticles agglomerate;b) Histogram of composite nanoparticles size distribution

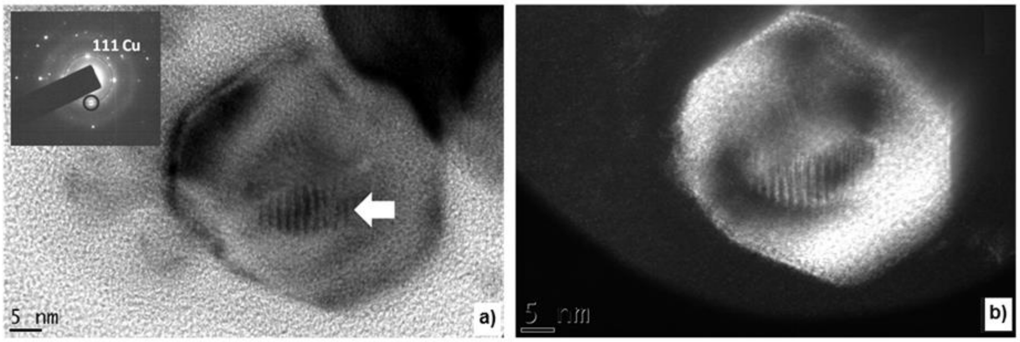

**Figure 2.** TEM images of nanoparticle boxed in Fig.1: a) Bright field b) Centered Dark Field.

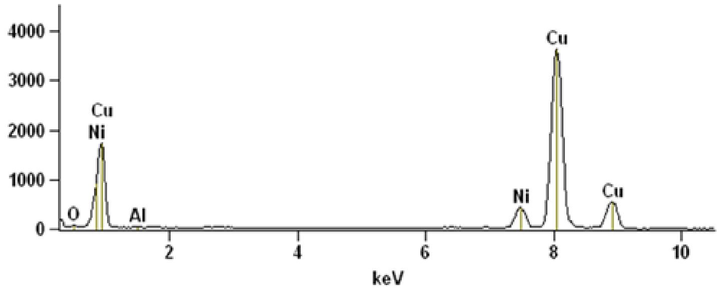

**Figure 3.** EDS spectrum from the edge of shell nanoparticle shown in the Fig2.

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