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X-Ray Diffraction, Microstructure, and Mössbauer Studies of Nanostructured Materials Obtained by High-Energy Ball Milling

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Abstract : High-energy ball milling is a solid-state powder processing technique that allows synthesizing a variety of equilibrium and non-equilibrium alloy phases starting from elemental powders. The advantage of this process technology is that the powder can be produced in large quantities and the processing parameters can be easily controlled, thus it is a suitable method for commercial applications. It can also be used to produce amorphous and nanocrystalline materials in commercially relevant amounts and is also amenable to the production of a variety of alloy compositions. Mechanical alloying (high-energy ball milling) provides an inter-dispersion of elements through a repeated cold welding and fracture of free powder particles; the grain size decreases to nano metric scale and the element mix together. Progressively, the concentration gradients disappear and eventually the elements are mixed at the atomic scale. The end products depend on many parameters such as the milling conditions and the thermodynamic properties of the milled system. Here, the mechanical alloying technique has been used to prepare nano crystalline Fe_50 and Fe_64 wt.% Ni alloys from powder mixtures. Scanning electron microscopy (SEM) with energy-dispersive, X-ray analyses and Mössbauer spectroscopy were used to study the mixing at nanometric scale. The Mössbauer Spectroscopy confirmed the ferromagnetic ordering and was use to calculate the distribution of hyperfin field. The Mössbauer spectrum for both alloys shows the existence of a ferromagnetic phase attributed to γ-Fe-Ni solid solution.

Keywords : nanocrystalline, mechanical alloying, X-ray diffraction, Mössbauer spectroscopy, phase transformations
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