

Structural investigation of FeS₂ nanoparticles synthesized by high-energy mechanical milling process

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Iron sulfides are currently recognized as advanced inorganic materials with non-conventional applications, such as high-energy density batteries, precursors for the synthesis of superconductors, diagnostic materials, materials for photoelectrolysis, solar energy materials and chalcogenide glasses [1,2]. In addition, iron sulphide has been suggested to play a crucial role in life origin [3,4]. Therefore, iron sulphide nanoparticles may have a significant potential for applications in many areas.

²Nanoparticles of sulfides have been synthesized recently by different chemical routes with the aim to prepare materials with controlled particle morphology and size distribution [5]. The routes of synthesis described in most of the papers have applied the solvothermal synthesis with the intervention of microwave, sonochemical and autoclave techniques.

On the other hand, the technique of mechanical milling has recently emerged as a versatile technique for producing materials far from equilibrium in this process, powder particles are subjected to severe mechanical deformation during collisions with balls and vial and are repeatedly deformed, cold welded and fractured. Solid-state reactions can be generated in powder blends and, similarly, chemical reactions between powders and the grinding atmosphere can be induced. Owing to this unique novel milling behavior, mechanical milling allows materials scientists to circumvent material limitations and manufacture alloys that are difficult or impossible to produce by conventional melting and casting techniques. For instance, researchers have used MA to successfully synthesize equilibrium and/or non-equilibrium phases in many alloy systems including amorphous materials, quasicrystals, nanocrystalline materials, rare earth magnets, and intermetallics. Mechanochemical process has been successfully employed to the synthesis of different nanopowder materials including sulfide [5,6].

In the current work, we investigated the preparation of iron sulfide powders starting from elemental Fe and S mixtures. During the milling process, the induced mechanical energy may give rise to mechanochemical reactions of Fe and S [13,14].

Aim of the present study is to investigate the microstructural, structural and magnetic properties changes of the mechanically alloyed FeSe₂ powder mixture during the milling process. The structural evolution during the mechanochemical reaction process taking place in the pyrite samples were monitored by X-ray diffraction (XRD), scanning electron microscopy (SEM) and Fe Mössbauer spectroscopy.

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