PREPARATION OF MAGNETIC NANOPARTICLES WITH SURFACTANT ASSISTED HIGH ENERGY BALL MILLING TECHNIQUE

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The nanocomposite magnets consisting of a coarse mixture of a hard magnetic phase with high coercivity and a soft magnetic phase with high saturation magnetization, have started being studied since already the late 80s. Since today, the need for the preparation of such nanocomposite magnets with improved properties (high coercivity and saturation magnetization, and increased energy product) is continuously increasing, we are seeking ways in which materials with high coercivity (including rare earths) can improve their properties in the nanoscale and by coupling with softer materials, to give high quality and low cost magnets. However Bottom Up methods used for the preparation of nanocomposite magnets, have shown limited success.

The technique "Surfactant Assisted High Energy Ball Milling (HEBM)" has called the attention of researchers, as a technical composition to control the size, shape and magnetic properties of the produced nanoparticles from intermetallic rare earths. Simultaneously it is a simple and inexpensive method for reducing the grain size of nanocrystalline powders.

The purpose of this study was to prepare nanoparticles of Sm_2Fe_{17}, through the HEBM technique, as well as the study of the effect of milling time, both in the structural (composition, shape and grain size) and in the magnetic nature of the sample (coercivity, saturation magnetization).

The milling of powder of 50 μm in an organic solution of oleic acid / oleylamine has led into grains of the order of 0.5 μm (500 nm) after 22 hours, showing somewhat improved properties compared to the initial powder. It has not been possible to obtain smaller grains so that exchange forces between the hard Sm_2Fe_{17} and soft Fe can occur resulting into dramatically improved magnetic properties, as further milling has led to a change in the composition of the mixture (decomposition of intermetallic compound Sm_2Fe_{17} and appearance of secondary phases), gasification of surfactant and has caused the formation of agglomerates (clustering). The very high milling times (98 hours) have led to amorphization of the sample, with simultaneous deterioration of magnetic properties.