Synthesis, processing and characterization of FeMnGa nanoparticles for permanent magnet applications

G. Sempros[1], K. Kanari[1], C. Sarafidis[1], M. Gjoka[2], C. Chrissafis[1], N. Lupu[3], G. Ababei[3], D. Niarchos[2], O. Kalogirou[1]

[1]Dept. of Physics, Aristotle University of Thessaloniki, 54124 Thessaloniki, Greece
[2]Institute of Nanoscience and Nanotechnology, NCSR "Demokritos", Athens, Greece
[3]National Institute of R&D for Technical Physics, 47 Mangeron Blvd., 700050 Iasi, Romania

Abstract:

In recent years, there is a great demand in materials suitable for permanent magnets which led to shortages in the supply of rare earth elements, a basic ingredient of high performance magnets. Research for rare earth free magnetic materials is considered as a viable alternative. Various Heusler alloys are investigated as possible candidates. Among them, the binary compound Mn_XGa has gained interest. A method of improving the magnetic properties of intermetallic compounds is the introduction of a magnetic atom like Fe in replacement of a 3d metal, in our case, by replacing a quantity of Mn with Fe. In this study $Mn_{0.4}Fe_{0.3}Ga_{0.3}$ alloys were prepared in a high purity Ar atmosphere with the arc-melting technique followed by melt-spinning in order to get nanostructured ribbons. The samples were further treated (annealing, mechanical processing) in order to tune the microstructure, mostly to reduce the grain size and obtain single phase particles with optimum magnetic properties. Magnetization measurements were performed by using a Vibrating Sample Magnetometer (VSM), versus temperature and field. The structure of the samples was observed with the X-Ray Diffraction Patterns (XRD). The $L1_2$ structure was observed for the first time, among the other ones $D0_{19}$ and $L2_1$ which are already observed in Mn_3Ga studies. A deeper observation was performed with Scanning Electron Microscopy (SEM) and Thermogravimetric Analysis (TG), in which the stoichiometry and the homogeneity were confirmed. Saturation magnetization of the basic material was measured at 81.4 Am^2/kg while remanence and coercive field were low. The effect of the grain size on the magnetic properties, due to mechanical processing, is presented.

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