Structural Studies of the Fe/ La_2O_3 nanocomposite obtained by mechanochemical milling.

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Abstract

Rare-earth oxides as Y_2O_3 and La_2O_3 evenly dispersed in Fe matrix constitute ODS alloys with potential applications in nuclear power plants .Dispersion of the above oxides can be obtained from various synthetic routes. However, kinetics , particle size and morphology are difficult to control. Mechanochemical activation of rare earth oxide precursors with either Fe_2O_3 (hematite) or Fe_3O_4 (magnetite) was also used since diffusive processes are accelerated under ambient conditions. In the induced chemical reaction, $AFeO_3$ oxides (A is a rare earth element) can also be produced. This last orthoferrite phase is also interesting for its wide magnetic applications.

In this work, Fe/ La_2O_3 composite powder has been fabricated by high energy ball milling. Powder mixtures were milled during different times 0, 5, 10h in a planetary ball mill where hardened steel vials were rotated at about 400 rpm under argon atmosphere and a ball to powder weight ratio of 16:1 . And phase evolution of the milled powder mixtures were analyzed during the mechanical treatment by X-ray diffraction, differential thermal analysis and scanning microscopy.

Results showed that for the Fe/10%wt. La_2O_3 composite, starting powders are Fe, La_2O_3 and $La(OH)_3$. The last one is due to the highly hygroscopic of La_2O_3, that convert to $La(OH)_3$ when exposed to air. Also, the best refinement of X-ray diffraction pattern shows that La_2O_3, is composed of two structures cubic and hexagonal. After 5h of milling, the formation of the perovskite $LaFeO_3$ is observed with the presence of nanocrystalline Fe and La_2O_3 phases. Increasing the milling time transforms the oxide phase into an amorphous structure and the iron phase into a disordered phase with a grain size less than 20 nm. Above 10 h of milling, the orthoferrite $LaFeO_3$ disappears . Thermal analysis showed the presence of two endothermic peaks of $La(OH)_3$ at 350 and 500°C . Increasing the milling time to 10 h , the formation of a wide exothermic peak is observed due mainly to $LaFeO_3$.