Magnetic Properties and Magnetocaloric effect in $La_{1-x}Nd_xFe_{10.5}Si_{2.5}$ (x = 0.2, 0.4, 0.6) Alloys

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In this report, we present a detailed studies on the magnetic properties and MCE of $La_{1-x}Nd_xFe_{10.5}Si_{2.5}$ (x= 0.2, 0.4, 0.6) alloys. The samples were prepared from pure (99.9%) La, Nd, Fe and Si metals by an arc-melting method in a high purity argon atmosphere. And then, the products were sealed in a fused-silica jacket under vacuum and annealed at 1323 K for two weeks. According to the powder X-ray diffraction patterns, the crystal structure of an as-cast sample displayed the elemental Fe-type structure, but after the annealing process, they were transformed into the $NaZn_{13}$-type structure.

Magnetic measurements versus temperature (T = 70-300 K) and magnetic field (H = 0-3T) were performed on a vibrating sample magnetometer (VSM). The $M(T)$ curves for samples, all the samples exhibiting a ferromagnetic-paramagnetic (FM-PM) phase transition at Curie temperature T_C = 252, 250, and 246 K for x = 0.2, 0.4, and 0.6, respectively. This FM-PM phase transition can be seen more clearly if H/M is plotted versus M^2 [1]. The nonlinear parts in the low field region at temperatures below and above T_C are driven toward two opposite directions, revealing the FM-PM phase separation. A negative slope corresponding to a first-order phase transition according to Banerjeer's criteria [2] has been observed in H/M versus M^2 curves. Based on isothermal magnetization data, $M(H, T)$, we have calculated $\Delta S_M(T)$ data for samples under an applied magnetic field change H = 3 T. As a function of temperature, the $\Delta S_M(T)$ curves show a maximum (denote as $|\Delta S_{Mmax}|$) at around their T_C. With H = 3 T, the values of $|\Delta S_{Mmax}|$ are found to be 3.8, 3.6, and 3.4 $J \times kg^{-1} \cdot K^{-1}$ for x = 0.2, 0.4, 0.6 samples, respectively. The nature of magnetic properties and MCE in the $La_{1-x}Nd_xFe_{10.5}Si_{2.5}$ alloys will be discussed thoroughly by mean of the effect of Ce-doping concentration.

References

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