Heat-treatment Effect in $Mn_{0.997}Fe_{0.003}As$ for Magnetic Refrigeration Application

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The structure and the magnetocaloric effect of single-phased $Mn_{0.997}Fe_{0.003}As$ were studied with X-ray diffraction and vibrating sample magnetometry. In the $Mn_{0.997}Fe_{0.003}As$ sample, the first-order ferromagnetic-to-paramagnetic transition was observed near the Curie temperature (T_C), namely at 308 K for the quenched sample and at 313 K for the slowly-cooled sample. This magnetic transition was accompanied by a structural transition from a hexagonal (NiAs-type) to an orthorhombic (MnP-type) structure. We also observed that after the heat treatment, the sample showed a large change in the magnetocaloric effect depending on the cooling conditions. From the isothermal M-H curves, the changes in the magnetic entropy ($-\Delta S_M$) were determined at temperatures between 280 and 320 K for different magnetic fields. For the sintered samples under slow cooling and water quenching, the maximum magnetic entropy changes at a magnetic field of 1.5 T were 19.6 and 32.2 J/kg K, respectively. Such a significant difference between the maximum entropy changes is due to the degree of the structure distortion, which depends on the heat treatment.

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