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Effects of Zn Content on the Magnetic and Magnetocaloric Properties of Ni-Zn Ferrites

N. Chau[1], N.K. Thuan[1], D.L. Minh[2], N.H. Hai[1], N.H. Luong*[1]
[1]Center for Materials Science, Hanoi University of Science, Vietnam National University, Hanoi, 334 Nguyen Trai, Thanh Xuan, Hanoi, Vietnam
[2]Department of Solid State Physics, Hanoi University of Science, Vietnam National University, Hanoi, 334 Nguyen Trai, Thanh Xuan, Hanoi, Vietnam
*Corresponding author: luongnh@vnu.edu.vn, Phone: +84 4 558 2216, Fax: +84 4 858 9496

Among spinel ferrites, Cd and Zn ferrites always are normal ferrites with Cd and Zn ions locating only in tetrahedral sites. This study presents effects of Zn on the magnetic and magnetocaloric properties of the mixed spinel ferrites $Ni_{1-x}Zn_xFe_2O_4$ (x = 0.60, 0.65, 0.70, 0.75). The presence of Zn affects lattice parameters, saturation magnetization M_s, Curie temperature T_c, and magnetic entropy change ΔS_m. At highest Zn content, the Curie temperature reduces to the temperature lower than room temperature and magnetic structure of spins in the octahedral sublattice should be canted. The maximum magnetic entropy change occurs in a large temperature range from low temperature to hundreds of Celcius degrees.

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Research for Magnetocaloric Effect on $Gd_{1-x}Dy_x$ Alloys

Xueling Hou*, Xu Hui, Jiansen Ni, Dingkang xiong Junfeng Kong, Li Shitao, Zhang An, Bangxin Zhou
Institute of Materials, Shanghai University, Shanghai 20007, P R China
*Corresponding author: xlhou@staff.shu.edu.cn, Phone: +86-021-56333870, Fax: +86 -021-56333870

The use of magnetocaloric refrigerant technology in near room temperature applications will offer considerable environmental benefits by eliminating ozone depletion, greenhouse, or hazardous gas compared with the gas-compression refrigeration. Because of all above advantages, it has been drawn attention in the recent decade. However, one of the major obstacles for the large scale use of that technology is that the required high purity of the elements to produce excellent compounds as working materials involves high costs, as commercial elements to compounds will decrease the intensity of the magnetocaloric effect (MCE). As a result,it will be important to produce excellent alloys or compounds with the high MCE as working body in low cost commercial element and low cost process in further use of that technology.

In this paper, the $Gd_{1-x}Dy_x$ alloys were made by low cost commercial elements with purity up to 99.50% for Gd and 99.50% for Dy, (X=0, 0.13, 0.20, 0.27, 0.34, 0.40) by arc melting stoichiometric proportions on a water-cooled copper crucible under high pure argon atmosphere and annealed at 1273 K for 5 h and followed by quenching to room temperature. The influences of Dy content on the MEC of $Gd_{1-x}Dy_x$ alloys were investigated by direct measurement of the adiabatic temperature change ΔT of samples.

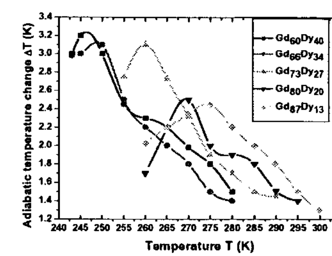

Fig. 1. The adiabatic temperature change ΔT of $Gd_{1-x}Dy_x$.

Experiment results were shown in Fig. 1. It is clearly seen that TC decreased linearly with the increase of Dy substitution Gd in of $Gd_{1-x}Dy_x$ alloys. This is a common phenomenon found in heavy rare earth alloys or compounds where the magnetic ordering temperature (Tc) is proportion to G (G is the average de Gennes factor for rare earth) [1]. The result [2] makes it possible that $Gd_{1-x}Dy_x$ alloys to have a more low value of the Tc. The adiabatic temperature change ΔT increase with the amount if Dy introduced in Gd. The enhancement of ΔT may result from the changes of atom magnetic moment by the addition of Dy atoms. When alloys were formed replacement $Gd_{1-x}Dy_x$ solid solution. The magnetic moment of $Gd_{1-x}Dy_x$ alloys will increases with content of Dy increasing. So the ΔT will decrease with content of Dy increasing.

As a result, whenx was changed from 0 to 40 at% in of $Gd_{1-x}Dy_x$ alloys, the adiabatic temperature change ΔT increases from 1.6K to 3.2K, the Curie temperature decreased from 288K to 245.5K. as x= 27at%, the adiabatic temperature change ΔT of $Gy_{73}Dy_{27}$ is 3.1K, it is almost same as that of high pure(99.99%) Gd and is clearly superior to impure Gd (99.50%). The Curie temperature Tc of Gy73Dy27 alloy is 260K, it is minor to high pure Gd and impure Gd. But this alloy made of low cost commercial elements has a better MCE and are promising candidates for working materials for room temperature magnetic refrigeration.

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