Giant magnetocaloric effect at room temperature and low-field change in $Fe_{78-x}Cr_xSi_4Nb_5B_{12}Cu_1$ amorphous alloys

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Abstract: This article presents our results for the low-field giant magnetocaloric effect (GMCE) around room temperature in a system of Fe-rich amorphous alloys $Fe_{78-x}Cr_xSi_4Nb_5B_{12}Cu_1$ (x = 0 -8). The structural examination indicated that the as-cast alloys were fully amorphous. Thermal transition analysis performed on a differential scanning calorimetry apparatus showed that both the crystallization temperature and the crystallization activation energy of the mentioned amorphous alloys increased with increasing Cr content. Beside the structural stabilizing enhancement, Cr substitution also improved the anti-corrosion of studied alloys. There is a very sharp ferromagnetic-paramagnetic phase transition at at Curie temperature, which is related to high homogeneity of the alloys. Curie temperature, T_c, linearly decreased from 450 K to 297 K with increasing Cr content from x = 0 to x = 8 due to ferromagnetic dilution. The temperature dependence of the magnetic entropy change, $|??S_m|$, was studied in magnetic field variations of 13.5 kOe, 10.0 kOe and 5.0 kOe. The results showed that the maximal values of $|??S_m|$ occurred near T_c and reduced with increasing Cr content. Namely, for x = 0, $|??S_m|_{max}$ is 11.2 J/kg.K and this value slightly reduces to 8.16 J/kg.K for x = 8. Especially, a giant magnetocaloric effect of 4.1 J/kg.K for x = 8 at 295 K was obtained in a quite low field change of 5.0 kOe. This material is very promising for magnetic refrigerant applications compared with recent typical magnetocaloric materials.

Author Keywords: Amorphous alloys; Magnetic entropy change; Magnetocaloric effect

Year: 2008
Source title: Journal of the Korean Physical Society
Volume: 53
Issue: 2
Page : 763-765
Cited by: 3
Link: Scorpus Link
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ISSN: 3744884
Language of Original Document: English
Abbreviated Source Title: Journal of the Korean Physical Society
Document Type: Article
Source: Scopus
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