Magnetic Refrigeration with Ni_2MnGa-based Heusler Alloys

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Abstract

Since Brown´s experiment in 1976 [1] which demonstrated that magnetic materials can be used for refrigeration at room temperature, magnetic refrigeration has been predicted to replace the conventional compression/expansion technology in a near future. The magnetic refrigeration, based on the magnetocaloric effect (MCE), raised increasing attention when a giant magnetocaloric effect was discovered in $Gd_5Si_2Ge_2$ alloy by Pecharsky and Gschneidner in 1997 [2]. Since then, several other groups have found other magnetic materials claimed to be better magnetic refrigerant materials at room temperature, such as MnFePAs[3] and MnAs [4]. Despite the high magnitude of the magnetocaloric effect, these systems show problems of high cost of materials (Gd) and toxicity (As). Another class of promising magnetic materials for refrigeration are the Heusler Alloys based, such as Ni_2MnX, where X= Ga,In, Sn[5]. Heusler alloys are known to present the magnetic shape memory effect and recently large magnetocaloric effect was reported, as in $Ni_2Mn_{0.75}Cu_{0.25}Ga$ [6]. Here we present a study with the goal of reducing the fabrication costs of this Heusler alloy while maintaining the high magnetocaloric effect, by replacing Ga by Al. To maintain appreciable magnetocaloric effect, the Cu concentration was varied. Our results show that the compound with 10% of Cu and 16% of Al presents a magnetic entropy change of -6.6 J/kg, for a magnetic field change of 5T, with a refrigerant capacity (RC) of 520 J/Kg between 292 and 399 K. These values show that it is possible to fabricate cheaper magnetocaloric materials based on Heusler alloys, in our case with a 30% reduction cost compared to the $Ni_2Mn_{0.75}Cu_{0.25}Ga$.

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