Nowadays, human-caused climate change is an amplifier element of human impacts on global ecosystems. To withstand global warming the governments are joining efforts by agreements and energy strategies that allow a significant reduction of greenhouse gas emissions. In this context, caloric materials (magneto- or elasto-caloric) as part of the next generation energy saving devices open new possibilities to achieve a noticeable effect on energy consumption. However, the main working material in today’s room-temperature magnetic refrigerator prototypes is the rare earth metal Gd and its based alloys, as well as, the quenched FeRh alloy that has the highest magnetocaloric effect (MCE) value. These alloys belong to critical raw materials (CRM). They are too expensive for practical applications. We would like to present our recent progress on the study of the MCE and elastoecaloric effect in metamagnetic shape memory alloys without CRM. The conventional and inverse MCE in these alloys has been described by the Landau-type theory [1], where the ferro- and antiferromagnetic exchange interactions in a system of the two magnetic sublattices were considered. MCE and IMCE in the thin ribbons of prototype Ni50Mn35In15 alloy were measured by the adiabatic method at 1.9 T to be equal to ΔTad = -1.1K, in the vicinity of the martensitic transformation (MT) temperature of 300K for IMCE, and ΔTad =2.3K for MCE at the Curie temperature, TC = 309 K [2]. The MCE properties of the bulk Ni50Mn34In16(Ga) alloy, exhibiting narrow hysteresis of MT, about 5 K, have been studied as well. This alloy demonstrates a stable cyclic IMCE with ΔTad = 0.75 K under 1.9 T at 263 K during more than 1000 times. Finally, we have studied the magnetocaloric response of Mn50Ni35In15 melt-spun ribbons prepared with the different solidification rates by changing the linear speed of the copper wheel, from 10 to 50 m/s, during melt spinning process. The ribbons produced at low wheel speed (10, 20, and 30m/s) exhibit a L21 structure associated with higher magnetic entropy change (ΔSM up to 18.6 J/kgK for μ0ΔH = 5 T) compared with the B2-ordered single phase ribbons (ΔSM = 11.3 J/kgK for μ0ΔH = 5 T) obtained at higher cooling rates (40 and 50 m/s) [3].

References

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