MATERIALS SCIENCE & ENGINEERING
TEXAS A&M UNIVERSITY

MSEN 681 SEMINAR SERIES

4:10 PM • MARCH 18 • RDMC 202

Dr. Daniel Salazar-Jaramillo

Senior Researcher

BCMaterials, *Basque center for materials, applications & nanostructures*

Caloric effects in metamagnetic shape memory alloys: A critical raw materials free alternative

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 elastocaloric 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 $Ni_{50}Mn_{35}In_{15}$ alloy were measured by the adiabatic method at 1.9 T to be equal to ΔT_{ad} = -1.1K, in the vicinity of the martensitic transformation (MT) temperature of 300K for IMCE, and ΔT_{ad} =2.3K for MCE at the Curie temperature, T_C = 309 K [2]. The MCE properties of the bulk $Ni_{50}Mn_{34}In_{16}$(Ga) alloy, exhibiting narrow hysteresis of MT, about 5 K, have been studied as well. This alloy demonstrates a stable cyclic IMCE with ΔT_{ad} = 0.75 K under 1.9 T at 263 K during more than 1000 times. Finally, we have studied the magnetocaloric response of $Mn_{50}Ni_{35}In_{15}$ 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 $L2_1$ structure associated with higher magnetic entropy change (ΔS_M up to 18.6 J/kgK for $\mu_0\Delta H$ = 5 T) compared with the B2-ordered single phase ribbons (ΔS_M = 11.3 J/kgK for $\mu_0\Delta H$ = 5 T) obtained at higher cooling rates (40 and 50 m/s) [3].

References

[1] V.A. L'vov, A. Kosogor, J.M. Barandiaran, and V.A. Chernenko, "Theoretical description of magnetocaloric effect in the shape memory alloy exhibiting metamagnetic behavior", J.Appl.Phys.119 (2016) 013902.

[2] P. Álvarez-Alonso, C. O. Aguilar-Ortiz, J. P. Camarillo, D. Salazar, H. Flores-Zuniga, V. A. Chernenko, "Adiabatic magnetocaloric effect in Ni50Mn35In15 ribbons", Appl.Phys.Lett. 109 (2016) 212402

[3] C.O. Aguilar-Ortiz, J. P. Camarillo-García, J. Vergara, P. Álvarez-Alonso, D. Salazar, V.A. Chernenko, H. Flores-Zúñiga, Effect of solidification rate on martensitic transformation behavior and adiabatic magnetocaloric effect of Ni50Mn35In15 ribbons. JALCOM, 748 (2018) 464-472.

Dr. Daniel Salazar-Jaramillo (PhD in Physics and Mathematics) is an electronic engineer from the Universidad del Quindío (2007) who received the doctor degree in physics and mathematics from the Universidad de Castilla-La Mancha in 2012. He started his research on nanostructured and granular magnetic materials, transition metal oxides, magnetic properties and electrical transport in nanocrystalline oxides, magnetic, structural and thermal properties in strongly correlated electron systems during his PhD. Since late 2013 he is joined to the BCMaterials in a postdoctoral position and currently he is a Senior Researcher and his work is focused on the study of the magnetocaloric effect and their physical features on single crystals of magnetic shape memory alloys and on the coercivity enhancement of nanostructured rare-earth(RE)-free hard magnets by grain boundary engineering. Dr. Salazar has published more than 25 SCI papers and 2 book chapters. He has contributed to over 40 international conferences, given six invited talks in international conferences. He has participated in 7 publicly funded projects and one privately funded project, being PI or co-PI of two European Projects (H2020). He has organized three international symposiums/workshops. Member of Board of two Scientific Advisory Committees. Currently, he is the Secretary of the Magnetic Materials Committee of the Metals, Minerals and Materials Society, in USA.