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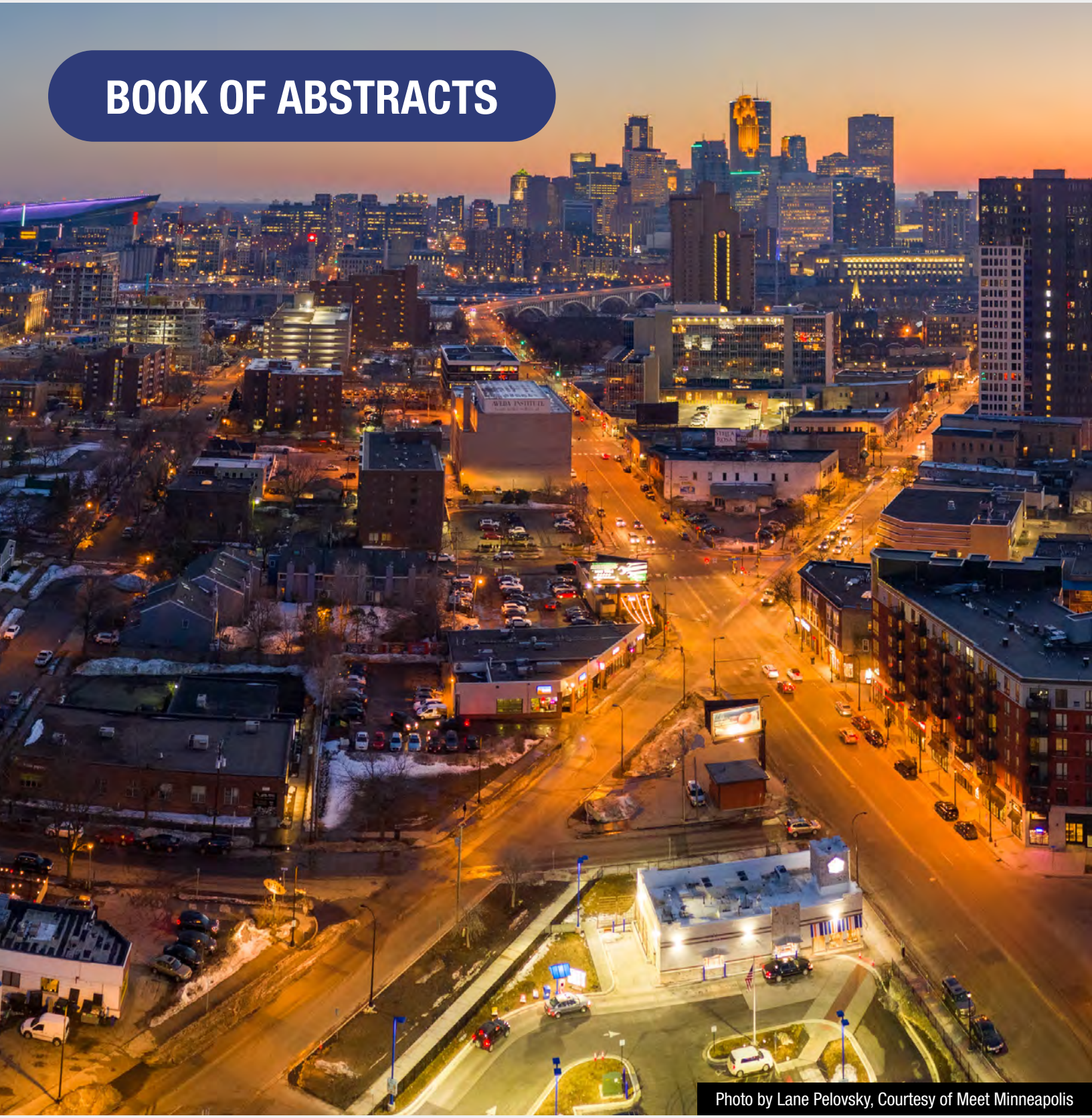
BOOK OF ABSTRACTS



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Session NPB
MAGNETOCALORIC MATERIALS III
(Poster Session)

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NPB-01. The change of atomic environments caused by Co doping in $La(Fe_{1-x}Co_x)_{11.4}Si_{1.6}$ magnetocaloric materials. *B. Wang*[1], H. Zhou[1], F. Hu[1] and B. Shen[1] *1. Institute of Physics, Chinese Academy of Sciences, Beijing, China*

Solid-state refrigeration based on magnetocaloric effect (MCE) has been regarded as an attractive alternative to the conventional gas compression technique. $La(Fe,Si)_{13}$ materials exhibit giant MCE and negative thermal expansion (NTE), which are regarded as one of the most likely materials to be used in room temperature magnetic refrigeration. Our recent study proved that hydrostatic pressure in $La(Fe_{0.92}Co_{0.08})_{11.9}Si_{1.1}$ sharpens the magnetoelastic transition and enlarges the volume change during the transition, through alerting the intra-icosahedron Fe-Fe bonds (B1, B2, B3) rather than the inter-icosahedral bonds (B4, B5) in the $NaZn_{13}$-type structure, thus MCE and barocaloric effect get enhanced. However, Co doping in $La(Fe_{1-x}Co_x)_{11.4}Si_{1.6}$ induces the decrease of MCE, where the intrinsic mechanism remains unknown. In order to clarify the essence from atom level, we studied the doping-dependent variation of Fe-Fe bonds by Co in $La(Fe_{1-x}Co_x)_{11.4}Si_{1.6}$ (x=0, 0.06) by variable temperature XRD and Retveld refinements. Unlike hydrostatic pressure, due to Co doping, the five Fe-Fe bonds have different elongations in the temperature range 150~300K covering phase transition (Fig.2). This demonstrates the increase in exchange distance and enhancement of the exchange interaction, which is consistent with a large increase in the Curie temperature (Fig.1a). Compared to $LaFe_{11.4}Si_{1.6}$ with negative volume change ΔV/V (-1.30%) during FM-PM transition, $La(Fe_{0.94}Co_{0.06})_{11.4}Si_{1.6}$ shows a decreased ΔV/V (-0.96%) by 26.2% in magnitude and the phase transition becomes slower (Fig.1b). Similar study on doping at La sites is under way. Examining the variation of atom local environments can provide insight for understanding the intrinsic origin of magnetocaloric properties, which is helpful for optimizing magnetocaloric materials.

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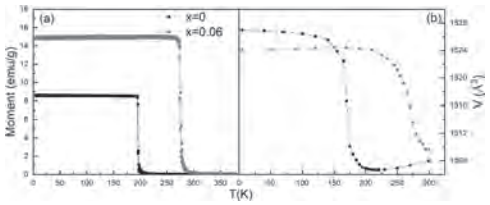


Fig.1 (a) M-T curves under 0.01T and (b) lattice volume as a function of temperature for $La(Fe_{1-x}Co_x)_{11.4}Si_{1.6}$.

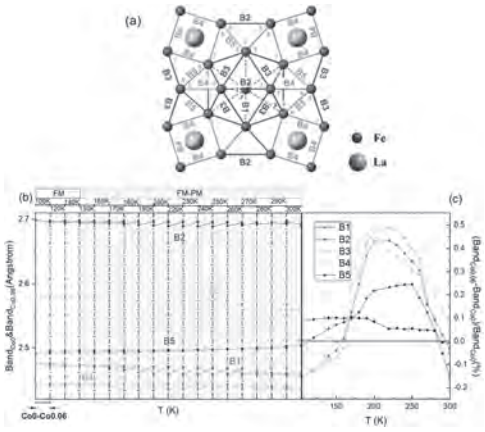


Fig. 2 (a) Schematic view of Fe-Fe bonds in $LaFe_{13}$ with $NaZn_{13}$-type structure, (b) the compared Fe-Fe bonds for $La(Fe_{1-x}Co_x)_{11.4}Si_{1.6}$ with and without 6 at.% Co doping at different temperatures covering phase transition temperature, (c) the change ratio of Fe-Fe bonds caused by 6 at.% Co doping.

NPB-02. The effect of acid treatment on the magnetic and magnetocaloric properties of Al-rich $Al_{0.85+x}Si_{0.15}Fe_2B_2$. *K.M. Stillwell*[1], B. Birch[1], N. Kramer[3], B. Reese[1], A. Pathak[2] and M. Khan[1] *1. Physics, Miami University, Oxford, OH, United States; 2. Ames National Laboratory, Ames, IA, United States; 3. SUNY Buffalo State College, Buffalo, NY, United States*

Owing to the relative abundance of its constituent elements and large MCE observed near room temperature, the $AlFe_2B_2$ system has attracted much attention recently [1]. As an alternative to current rare earth materials, $AlFe_2B_2$ promises the realization of cleaner, energy efficient refrigeration technologies based on phenomena associated with MCE [2]. Additionally, excess Al is believed to generate phase impurities which can change the observed MCE properties of this system [3]. By dissolving certain impurities in acid, a significant enhancement of the MCE properties of this system have been observed [4]. Considering this behavior, we have studied the effect of acid treatment on the magnetic, magnetocaloric, and transport properties of $Al_{0.85+x}Si_{0.15}Fe_2B_2$ (x = 0.2, 0.4). The goal was to explore the possibility of enhancing the MCE properties of the materials by adding excess aluminum and subjecting them to acid treatment after annealing. The samples were prepared by arc melting followed by drop-casting. The drop-casted samples were annealed followed by acid treatment. The alloys were characterized by x-ray diffraction, scanning electron microscopy, dc magnetization, and electrical resistivity measurements. The second order ferromagnetic phase transitions were observed near room temperature (~298 K – 315 K) and peak magnetic entropy changes (-ΔSM) of more than 4 J/kg K were observed for a field change of 5 T. The details of phase purity, microstructure, magnetic, and transport properties of the acid treated and the drop casted annealed materials will be presented.

[1] A. Loudaini, M. Aggour, L. Bahmad, O. Mounkachi, Magnetic properties, magnetocaloric effect and cooling performance of AlFe2B2 compound: Ab initio, Monte Carlo and numerical modeling study, Materials Science and Engineering: B, 264 (2021). [2] Xiaoyan Tan, Ping Chai, Corey M.

Thompson, Michael Shatruk, Magnetocaloric Effect in AlFe2B2: Toward Magnetic Refrigerants from Earth-Abundant Elements, Journal of the American Chemical Society, 135 Iss. 25 9553-9557 (2013). [3] Tahir Ali, M. N. Khan, E. Ahmed, Asad Ali, Phase analysis of AlFe2B2 by synchrotron X-ray diffraction, magnetic and Mossbauer studies, Progress in Natural Science: Materials International, 27 251-256 (2017). [4] J.W. Lee, M.S. Song, B.K. Cho, Chunghee Nam, Magnetic properties of pure AlFe2B2 formed through annealing followed by acid-treatment, Curr Appl Phys., 19 933-937 (2019).

NPB-03. Magnetocaloric properties of Co-doped $Mn_{0.5}Fe_{0.5}Ni_{1-x}Co_xSi_{0.94}Al_{0.06}$ intermetallic alloys. *S. Bhattacharjee*[1], N. Kramer[2], M. Khan[1] and A. Pathak[2] *1. Physics, Miami University, Oxford, OH, United States; 2. Physics, State University of New York, Buffalo, NY, United States*

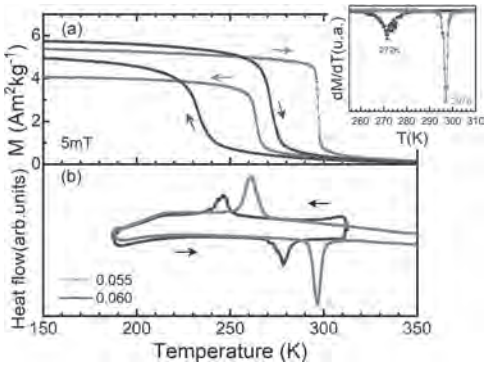
Magnetic refrigeration is an environmentally friendly cooling technology, which is believed to be significantly more efficient than the currently employed gas-compression-based cooling technologies. The commercialization of this technology is crucially dependent on the discovery of materials that exhibit large magnetocaloric effects and can be easily fabricated using cheap, non-toxic, and readily available elements. The intermetallic $Mn_{1-x}Fe_{x-\delta}Ni_{\delta}Si_{1-y}Al_y$ compounds are known to exhibit large magnetocaloric effects at the relatively low magnetic field (H = 2T or lower) and tunable phase transition [1, 2]. These materials have gained much interest in recent years due to the fact that the constituent elements are cheap and readily available. However, selected drawbacks including large thermal hysteresis and mechanical instability make these materials unsuitable for application. More research efforts are required to eliminate these drawbacks so that the application potential for these materials can be realized. Therefore, we have synthesized the substitution of Ni with Co in $Mn_{0.5}Fe_{0.5}Ni_{1-x}Co_xSi_{0.94}Al_{0.06}$ ($0.025 \le x \le 0.075$) alloys by arc melting followed by a rapidly quenched vacuum suction casting technique and study the magnetic and magnetocaloric properties of the system, which has not been reported yet. X-ray diffraction and scanning electron microscopy (SEM) data indicated that the samples exhibited a single-phase. Peak magnetic entropy changes of ($-\Delta S_M$) of as-cast alloy with x =0.025 is found to be 12 and 31 J kg-1K-1 for ΔH = 2 and 5 T, respectively around 225 K. The observed large MCEs are due to the first order magneto-structural phase transition exhibited by the materials from low-temperature ferromagnetic orthorhombic phase to high-temperature paramagnetic hexagonal phase. In this presentation, we present details of phase purity, microstructure, and magnetic properties of as-prepared and heat-treated alloys with $0.025 \le x \le 0.075$

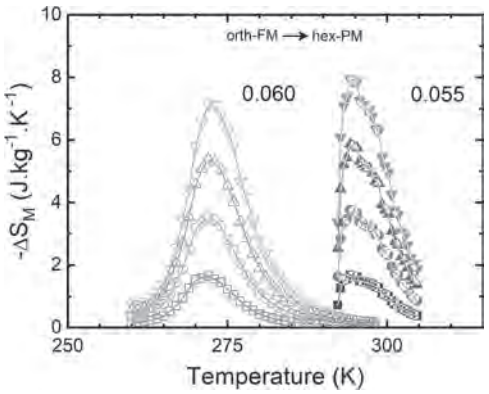
[1] A. Biswas, A.K. Pathak, N.A. Zarkevich, X. Liu, Y. Mudryk, V. Balema, D.D. Johnson, and V.K. Pecharsky, Acta Mater. 180, 341 (2019). [2] M Khan, RC Das, J Casey, BL Reese, B Akintunde, AK Pathak, AIP Advances 12, 035227 (2022).

NPB-04. Magnetostructural transition and magnetocaloric effect in thermally annealed $Mn_{0.5}Fe_{0.5}NiSi_{1-x}Al_x$ melt-spun ribbons (x= 0.055 and 0.060). *M.d. Arreguin Hernandez*[2,1], A. Dzubinska[2], M. Reiffers[3], J. Sanchez[1,4], C.F. Sanchez Valdés[5] and R. Varga[2] *1. Materiales, Instituto Potosino de Investigacion Cientifica y Tecnologica, San Luis Potosi, Mexico; 2. CPM-TIP, UPJS, Kosice, Slovakia; 3. Faculty of Humanities and Natural Sciences, University of Presov, Presov, Slovakia; 4. Departamento de Fisica, Universidad de Oviedo, Oviedo, Spain; 5. Div. Multidisciplinaria, UACJ, Ciudad Juarez, Mexico*

The giant magnetocaloric (MC) effect measured in $Mn_{0.5}Fe_{0.5}NiSi_{1-x}Al_x$ alloys (0.05 £ x £ 0.07) for a low magnetic field change ($|\Delta S_M|^{max}$ ~16-24 $Jkg^{-1}K^{-1}$ at 2 T) [1], and the fact that they are based on cheap and abundant elements motivated the interest on their study. The effect is linked to their first-order martensitic-like magnetostructural transformation (MST) from a high-temperature hexagonal Ni_2In-type paramagnetic (PM) phase to a low-temperature orthorhombic TiNiSi-type ferromagnetic (FM) phase which is tunable over wide temperature range by changing the Al content [1,2]. As melt spinning is a rapid solidification technique able to produce alloy ribbon samples with a high chemical homogeneity and may result very appropriate to fabricate these five-elements alloys, we produced $Mn_{0.5}Fe_{0.5}NiSi_{1-x}Al_x$ melt-spun ribbons with x=0.055 and 0.060 that were thermally annealed at 1123 K for 4 h; their MST and MC characteristics were studied. RT XRD pattens show that samples are nearly single phase with a major Ni_2In-type phase coexisting with a minor amount of the TiNiSi-type one. DSC, $M(T)^{5mT}$ and $M(T)^{2T}$ curves, shown in Fig. 1, denote the occurrence of the MST with a large thermal hysteresis (~ 32 K), the substantial effect of Al-content on the tuning of the MST temperature without a significant change in the magnetization change across the MST which led to similar $\frac{1}{2}DS_M(T)\frac{1}{2}^{max}$ values (as Fig. 2 shows). The results are discussed and compared with previous data reported in literature for bulk alloys.

[1] A. Biswas et al., Acta Mater. 180, 341–348 (2019). [2] C.L. Zhang et al., Appl. Phys. Lett. 105, 242403 (2014).



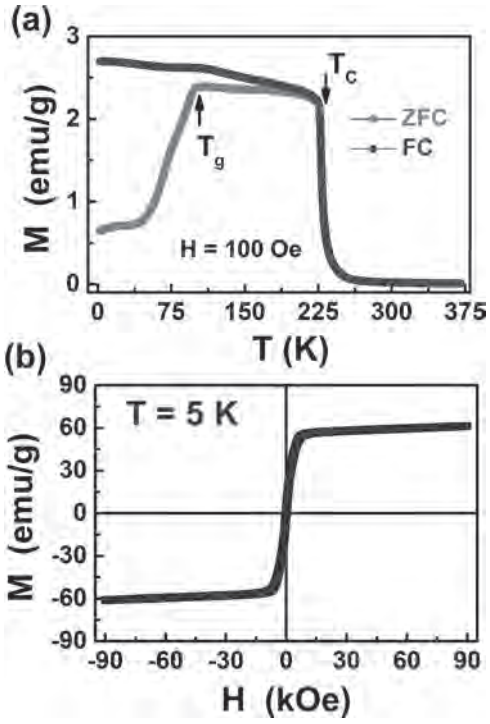


NPB-05. Magnetocaloric properties and exchange bias in arc melted Mn_5Sn_3 alloy. *L. Bachhraj*[1], P. Babu[2] and G. Basheed[1] *1. CSIR-National Physical Laboratory, New Delhi, India; 2. UGC-DAE Consortium for Scientific Research, Mumbai Centre, BARC Campus, Mumbai, India*

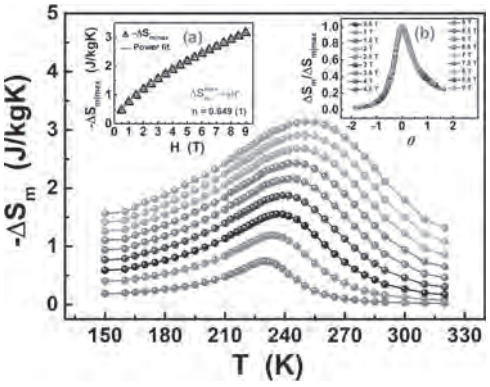
Magnetic refrigeration (MR), exploiting the adiabatic demagnetization phenomena, is preferable over conventional cooling technology due to its high efficiency with environment friendly method [1-3]. Owing to this, the earth-abundant Mn-based alloys, i.e. Mn_5Sn_3, crystallizes in Ni_2In type hexagonal structure (space group $P6_3/mmc$), occupies two non-equivalently sites with opposite spin alignment: Mn_I at 2a site with a moment of 0.8 μ_B and Mn_{II} at 2(d) site with a moment of 3.8 μ_B and Sn atom occupies 2c site. The temperature and field-dependent dc magnetization measurements have been carried out to study the MCE and exchange bias in Mn_5Sn_3 alloy. The M (T) curve at 100 Oe shows ordering temperature at T_c ~ 227 K and spin glass (SG) transition at T_g ~ 110 K [Fig. 1a]. The origin of SG is due to geometrical frustration, that comes from vacancy and disordering present at Mn_{2d} site. Furthermore, the M (H) hysteresis loop at 5 K reveals the typical soft ferromagnetic behaviour, saturation magnetisation (M_S) of 62 emu/g [Fig.1(b)], where MH loop slightly shifted towards a negative field direction,

indicating the presence of exchange bias phenomena with exchange bias field (H_{EB}) 5.67 mT at 50 K. Apart from this, Isothermal magnetic entropy change ($\Delta S_M(T)$) is (calculated Using Maxwell equation) 2.16 J/Kg-K at 5 T [Fig. 2], also $\Delta S_M(T)$ evolve with applied magnetic field as - $\Delta S_M(T) = aH^n$, where n is local exponent, power law fit gives n = 0.649 (1) [Inset of Fig 2(a)]. From Inset fig. 2(b), It is quite apparent that all the normalized entropy curves with various ΔH values collapse into a single curve, confirming second-order magnetic phase transition. The relative cooling power (RCP) value is obtained as 242 J/kg for a field change of 5 T which is significantly larger than the earlier reported Mn_5Sn_3 study [4]. Hence, with negligible thermal/magnetic hysteresis and reasonable RCP, the Mn_5Sn_3 is prominent candidate for MR devices.

1. V. Franco, J. Bluez, J. Ipus, J. Law, L. Moreno - Ramz, A. Conde, Prog. Mater. Sci. 93, (2018) 112–232. 2. V. K. Pecharsky, K. A. Gschneidner Jr, J. Magn. Magn. Mater. 200 (1), (1999) 44–56. 3. V. Franco, J. Blazquez, B. Ingale, A. Conde, Annu. Rev. Mater. Res. 42, (2012) 305–342. 4. Jian Huang, Jie Xiang, Ce Zhi, Xuezhen Wang, Xueling Hou, Adv. Mat. Res. 299-300 (2011) 520-524.



(a) MT curve of Mn_5Sn_3 alloy under 100 Oe applied magnetic field, (b) MH loop measured at 5 K upto 9 T.



The temperature dependence of $-\Delta S_m$ in the field range of 1 T – 9 T (ΔH = 1 T), Inset (a): Power-law behaviour of $-\Delta S_{m|max,}$ (b): Normalized $-\Delta S_m$ as a function of the rescaled temperature (θ)

NPB-06. Large reversible magnetocaloric effects in $Pr_{2-x}Nd_xIn$.

A. Biswas[1], R.K. Chouhan[1], A. Thayer[1,2], *Y. Mudryk*[1], O. Dolotko[1] and V. Pecharsky[1,2] *1. Ames National Laboratory, Ames, IA, United States; 2. Department of Materials Science and Engineering, Iowa State University, Ames, IA, United States*

Over the last few decades, interest in discovery of materials that exhibit large magnetocaloric effects below room temperature and can support energy-efficient magnetocaloric liquefaction of various gases is on the rise. Here we report a series of rare-earth based $Pr_{2-x}Nd_xIn$ compounds, where Curie temperatures are tunable by adjusting x_{Nd} between 57 and 110 K. Every member of the family exhibits a sharp magnetic transition between the paramagnetic and ferromagnetic states. These transitions give rise to magnetic field-induced entropy changes comparable to or larger than those reported in any other known material in the same temperature range, making $Pr_{2-x}Nd_x$ In compounds suitable for liquefaction of technologically important gases including oxygen, nitrogen, and natural gas. The magnetic transitions in these intermetallics do not show any detectable thermomagnetic hysteresis which is advantageous from the application point of view. While the transition temperature increases with x_{Nd}, the maximum entropy change is slightly reduced from 15 J/ Kg K at 57 K when x_{Nd} = 0 to 13 J/Kg K at 110 K when x_{Nd} = 2, all quoted values are for the magnetic field changing between 0 and 2 T. Notably, the thermodynamic nature of phase transitions for the end-members of the series is different. In case of Pr_2In, the transition is first-order magnetoelastic, as evidenced by symmetry-invariant discontinuous changes in cell volume occurring in concert with the ferromagnetic ordering/disordering transitions.[1,2] Conversely, the phase transition in Nd_2In is rather unconventional, being intermediate between a typical first-order and a typical second-order kind. Density functional theory calculations, providing insights into the electronic structure of the end members and expounding differences in their physical behaviors, will be also discussed. Acknowledgement: This work was performed at Ames National Laboratory (AMES) and was supported by the Division of Materials Science and Engineering of the Office of Basic Energy Sciences of the U.S. Department of Energy (DOE). AMES is operated for the U.S DOE by Iowa State University under Contract No. DE-AC02-07CH11358.

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NPB-07. Effect of X-Ray Irradiation on Magnetocaloric Material, $(MnNiSi)_{1-x}Fe_2Ge_x$.

J.J. Nunez[1], V. Sharma[1], J. Rojas[1], R. Barua[1] and R.L. Hadimani[1,2] *1. Mechanical & Nuclear Engineering, Virginia Commonwealth University, Richmond, VA, United States; 2. Psychiatry, Harvard University, Boston, MA, United States*

Magnetic refrigeration based on magnetocaloric effect at room temperature is generally considered a potential substitution for classical vapor compression systems due to its high efficiency and environmental friendliness. $(MnNiSi)_{1-x}(Fe_2Ge)_x$ materials are attractive multicaloric materials that change their magnetic properties with the application of magnetic field, pressure, and temperature [1],[2]. The effects of electron and proton irradiation techniques in magnetocaloric materials have been reported in peer-reviewed articles therefore, this study investigated the effects of X-ray irradiation on $(MnNiSi)_{1-x}(Fe_2Ge)_x$. Polycrystalline $(MnNiSi)_{1-x}(Fe_2Ge)_x$ samples were prepared by arc-melting the constituent elements of purity better than 99.9% in an ultrahigh argon atmosphere to ensure sample homogeneity[2]. The procedure utilized X-RAD 225XL Precision X-Ray. The study evidences an observable effect in the $(MnNiSi)_{1-x}Fe_2Ge_x$, x = 0.34 composition when exposed to an absorbed X-ray dosage of ~120Gy/min for 5 hours. A Quantum Design PPMS was used to measure the magnetization (M) of the $(MnNiSi)_{1-x}(Fe_2Ge)_x$ with applied magnetic fields from -3T to 3T. Fig.1(a) shows the M-T data from 200K to 350K with T_c ~ 292K before treatment and 286K after treatment (cooling curve). There was also a significant change in the magnetization ~47.4% from 2.72 emu/g to 4.01 emu/g at an applied magnetic field=100Oe. Fig.1(b) presents the M-H (magnetization vs.

magnetic field) loops from 300K to 345K as it exhibited irradiation-induced hysteresis in comparison to the pristine sample. Fig.2(a) exhibits an observable change of 10Oe in the magnetic coercivity at 200K after treatment. Fig.2(b) presents the hysteresis graphs for the samples at 200K and shows a saturation magnetization decrease but yielded an increase in magnetization from H=0Oe-4500Oe for the treated sample. These presented results would provide base guidelines for factors affecting the performance of magnetocaloric materials in extreme environments.

[1] Zhang, C. L., et al. "Magnetostructural Transition and Magnetocaloric Effect in MnNiSi-Fe_2Ge System." *Applied Physics Letters*, vol. 107, no. 21, 2015, p. 212403., https://doi.org/10.1063/1.4936610. [2] D. Clifford, V. Sharma, K. Deepak, R. V. Ramanujan, and R. Barua, "Multicaloric Effects in (MnNiSi)1−x(Fe_2Ge) x Alloys," in *IEEE Transactions on Magnetics*, vol. 57, no. 2, pp. 1-5, Feb. 2021, Art no. 2500405, doi: 10.1109/TMAG.2020.3025002.

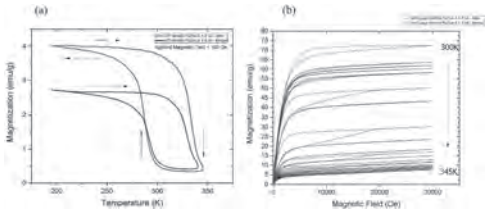

Fig.1 (a)MT Data from temperature range 200K-350K at 100Oe. (b)MH Loops 300K–345K exhibiting irradiation-induced hysteresis.

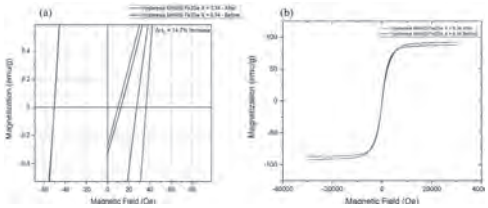

Fig.2 (a) Coercivity Data at 200K with an increase of 14.7% after treatment. (b) Hysteresis data from -3T to 3T at 200K.

NPB-08. Near-room temperature magnetocaloric effect in $Mn_{4.9}Cu_{0.1}Ge_3$ compound. *S. Sakthivel*[1], A. Kumar[1], U. Remya[1], S. Athul[1], A. Dzubinska[2], M. Reiffers[3] and R. Nagalakshmi[1] *1. Intermetallics and NLO Laboratory, Physics, National Institute of Technology Tiruchirappalli, Tiruchirappalli, India; 2. Center for Progressive Materials-Technology and Innovation Park, University Pavol Jozef Šafárik, Kosice, Slovakia; 3. Faculty of Humanities and Natural Sciences, Presov University, Presov, Slovakia*

Magnetic refrigeration based on magnetocaloric effect is an effective technology to curb greehouse gas emission. It is crucial to choose a viable magentocaloric material with reversible room temperature magnetocaloric effect. Mn_5Ge_3 based compounds are the perfect fit to this class. They are rare-earth free and exhibits a magnetic entropy change () of 9.3 J/kg K and relative cooling power () of 400 J/kg in = 5 T around 296 K[1]. Here, the magnetic interaction between and among the Mn atoms in *4d* and *6g* sites dictates the magnetocaloric effect which can be manipulated *via* tuning the Mn-Mn distance[2]. A best method to do so is doping and in this work, a non-magnetic element Cu is doped in place of Mn as a new attempt. $Mn_{4.9}Cu_{0.1}Ge_3$ polycrystalline compound, synthesized by arc melting method, has crystallized in Mn_5Si_3-type D8 hexagonal crystal structre (*SG: P6₃/mcm*). The thermomagnetic measurements reveal a paramagnetic to ferromagnetic transition at 288.7 K, and shifts to higher value as the applied magnetic field is increased (*Fig. 1*). Arrott plot constructed from field-dependent magnetization demonstrates second order nature of the magnetic transition. In a magnetic filed change of 5 T, $Mn_{4.9}Cu_{0.1}Ge_3$ compound shows = 6.03 J/kg K and RCP = 360.7 J/kg at 292 K (*Fig. 2*). The wide temperature working span has deemed its RCP closer to the parent compound and also it is comparable with other compounds in this class. The near-room temperature, second order magnetocaloric effect are valuable properties for a magnetic refrigerant and this makes $Mn_{4.9}Cu_{0.1}Ge_3$ compound a remarkable magnetocaloric material.

Acknowledgement: *This work is the implementation of following projects and awards: DST-INSPIRE award (No. DST/INSPIRE/03/2018/000691), University Science Park TECHNICOM for Innovation Applications Supported by Knowledge Technology, ITMS: 26220220182, VEGA 1/0404/21 and VEGA 1/0705/20.*

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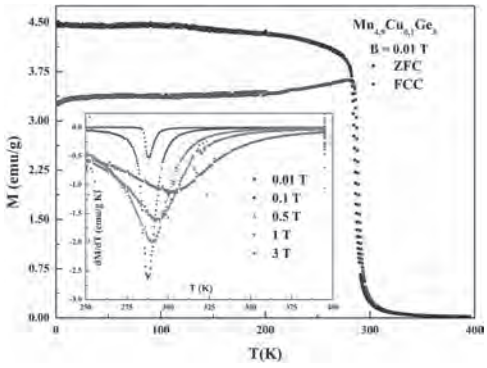
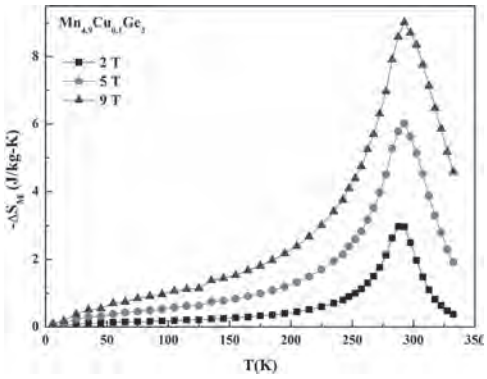


Temperature dependent zero field cooled and field cooled curves in B = 0.01 T. Inset: *dM/dT* vs *T* graph demonstrating shift in transition temperature in various magnetic fields



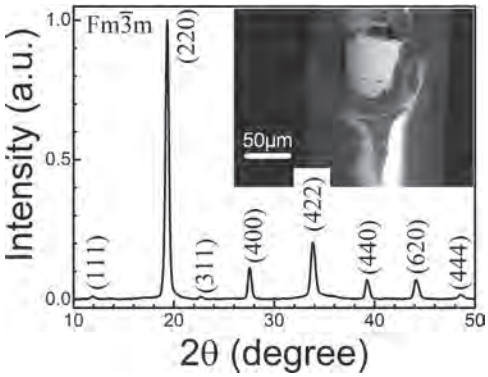
Magnetocaloric effect in $Mn_{4.9}Cu_{0.1}Ge_3$ compound

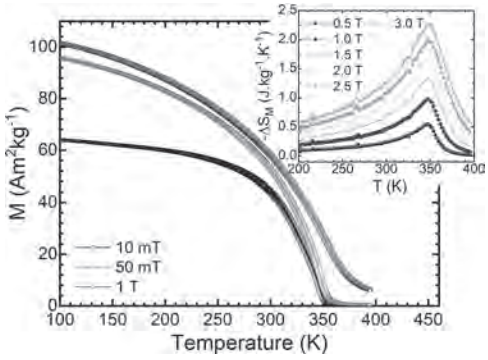
NPB-09. Structural, magnetic and magnetocaloric characterization of Ni_2MnSn microwires prepared by Taylor-Ulitovsky technique. *M.d. Arreguin Hernandez*[1,2], M. Varga[1,3], M. Hennel[1,3], T. Ryba[4], J. Sanchez[2,5] and R. Varga[3,4] *1. Inst. Phys., Fac. Sci., UPJS, Kosice, Slovakia; 2. Materiales, IPICYT, San Luis Potosí, Mexico; 3. CPM-TIP, UPJS, Kosice, Slovakia; 4. RVmagnetic, Kosice, Slovakia; 5. Departamento de Fisica, Universidad de Oviedo, Oviedo, Spain*

In this work, we addressed the fabrication of Ni_2MnSn glass-coated microwires (mws) by using the Taylor-Ulitovky technique, as well as their structural, magnetic and magnetocaloric (MC) characterization. Apart from the physical characteristics of the material itself, wire-shaped MC materials bring additional features of interest from the viewpoint of refrigeration applications such as an easier magnetization saturation along wire length, and a large surface-to-volume ratio [1]. The former may lead to reach a given MC effect value at a lower magnetic field change $m_0\Delta H$, whereas the latter allows a high heat-transfer rate with the exchange fluid. Microwires were prepared from a bulk arc-melted ingot of nominal composition Ni_2MnSn

produced from highly pure elements (≥ 99.9 %). Their average metallic core diameter was 86 μm (as the inset of Fig. 1(a) shows). Their characteristic XRD pattern, shown in Fig. 1(a), was indexed based on a single-phase austenite with the $L2_1$ structure (space group Fm-3m; a= 5.98 Å). The foreground graph in Fig. 1(b) shows that the $M(T)$ curves measured upon heating and cooling cycles under magnetic fields m_0H of 10 mT, 50 mT, and 1 T almost overlap; austenite shows a Curie temperature of 350 K. The thermal dependencies of the magnetic entropy change $-\Delta S_M(T)$ for different $m_0\Delta H$ values are shown at the inset of the figure; the curves are broad reaching a $|\Delta S_M|^{max}$ value of 2.3 $Jkg^{-1}K^{-1}$ at 3.0 T. The results are compared with those previously reported for bulk and melt-spun ribbons of the same composition [2,3].

[1] J. Alam et al., J. Magn. Magn. Mater. 513, 167074 (2020). [2] M. Nazmunnahar et al., J. Magn. Magn. Mater. 386, 98–101 (2015). [3] T. Krenke et al., Phys. Rev. B 72, 014412 (2005).





NPB-10. Investigation Of Structural And Magnetic Properties Of Nanocrystalline $Pr_{0.57}Bi_{0.1}Ca_{0.33}MnO_3$. *G. Singh*[1], A. Gaur[1] and R.N. Mahato[1] *1. School Of Physical Sciences, JNU, New Delhi, India*

Perovskite manganite oxide shows that various future technologies (eg. spintronics, magnetic sensors, infrared detectors, magnetic storage media, colossal magneto-resistance application, thermo-electric applications, and magnetic refrigerants) are greatly relying on these materials [1]. Double exchange (DE) interaction and super-exchange (SE) interaction play a vital role in the above-given properties [2]. We have investigated the structural and magnetic properties of nanocrystalline powder $Pr_{0.57}Bi_{0.1}Ca_{0.33}MnO_3$ (PBCMO) synthesized by the sol-gel technique. PBCMO is very interesting shows various magnetic transition as compare to $La_{0.57}Bi_{0.1}Ca_{0.33}MnO_3$ which shows only one magnetic transition [3]. The Rietveld analysis of the X-ray diffraction (XRD) pattern reveals that the compound crystallizes in a single orthorhombic phase with the Pbnm space group. The Crystallite size was calculated using the Scherrer formula and it is found to be ~27 nm. Scanning electron microscope (SEM) images confirm the homogeneity of the sample and the average particle size from SEM image using particle size distribution with Lorentz fit was found to be 110 nm. This has revealed that each particle consists of several crystallites. Temperature dependence Magnetization measurements under the external magnetic field of 500 Oe, in Fig.1, have shown that the sample exhibits magnetic transition at temperature ~ 44 K from ferromagnetic (FM) to paramagnetic (PM) phase with increasing temperature. Moreover, we have observed three small bumps near temperatures 75 K, 158 K, and 222 K that may suggest us simultaneous occurrence of the FM phase and antiferromagnetic phase [4]. Field-dependent magnetization for nanocrystalline PBCMO has exhibited ferromagnetism (FM) at low temperature (5 K) and the linear hysteresis loop corresponds to the paramagnetic region at room temperature as shown in Fig.2.

1) Dipak Mazumdar, Kalipada Das and I. Das, J. Appli. Phys. 127, 093902-1 (2020) 2) A. Pal, A. Rao and D. Kekuda, Journal of Magnetism and Magnetic Materials. 512. 167011. 10.1016/j.jmmm.2020.167011. 3) Arpit Gaur, Meenakshi, Vipin Nagpal and Priyanka Bisht, Solid State Communications. 340. 114504. 10.1016/j.ssc.2021.114504. 4) J.R. Sun, J. Gao and Y. Fei, PHYSICAL REVIEW B 67, 144414 (2003)

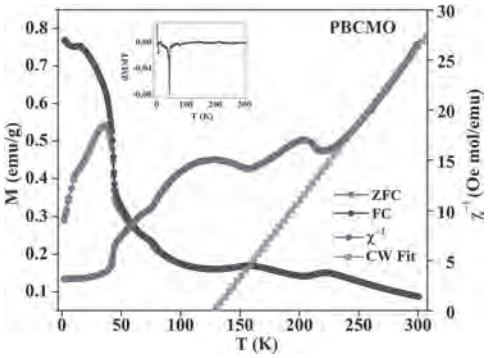


Fig.1 Temperature dependence of FC and ZFC magnetizations for nanocrystalline $Pr_{0.57}Bi_{0.1}Ca_{0.33}MnO_3$ sample at applied field of 500 Oe. Inset shows the derivative of M (T) curve (dM/dT versus T plot).

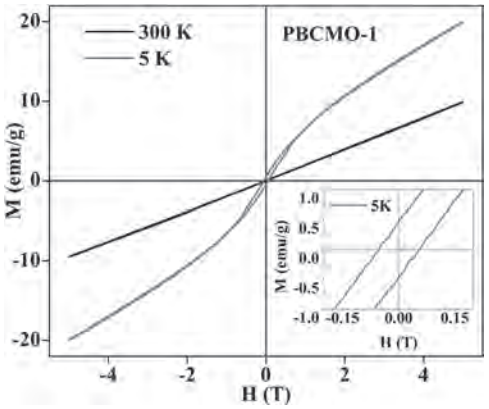


Fig.2 Magnetisation (M) versus applied magnetic field (H) plot at 5 K and 300 K temperature. Inset shows the magnified view of M versus H plot at 5 K.

NPB-11. Withdrawn

NPB-12. Magnetocaloric properties in $Pr_{1-x}Sr_xMnO_3$(x=0.48 and 0.52): Study using Landau and Maxwell Model. A.K. Saw[1], J.J. Nunez[2], *R.L. Hadimani*[2] and V. Dayal[1] *1. Department of Physics, Maharaja Institute of Technology Mysore, Mandya, India; 2. Department of Mechanical and Nuclear Engineering, Virginia Commonwealth University, Richmond, VA, United States*

The magnetocaloric effect (MCE) is a common phenomenon in magnetic materials, and the essence of which is a thermal effect caused by the change of magnetic moment order under an adiabatic condition. A wide range of materials showing the first-order (FO)/second-order (SO) magnetic phase

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*Best student presentation award finalist

*Best student presentation award finalist