and transforms to an anti-ferromagnetically ordered state (θ_P = -18.6(2) K) below 33 K. The magnetic spin structure can be described with k = (0, 0, 0) in space group *Pbca'* and it is similar to the one of the *C*2/*c* phase except that it is non-collinear in nature, i.e. there are components of the magnetic moment along all three crystallographic axes. Small magneto-elastic coupling is observed in the orthorhombic phase. More details are reported in [5].

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Keywords: pyroxene, neutron diffraction, magnetism

FA5-MS41-P04

Magnetostructural and magnetocaloric properties of $Ni_{50-x}Cu_xMn_{36}Sn_{14}$ by magnetic measurements and neutron diffraction experiments. Ilker Dincer[a], Yalcin Elerman[a], Ercüment Yüzüak[a], Markus Hölzel[b], Anatoliy Senyshyn[b], Eyüp Duman[a], Thorsten Krenke[c],
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Compared with conventional refrigeration, magnetic refrigeration technology has many advantages, such as the absence of harmful gas, less noise, low cost and high efficiency. Since the discovery of martensitic transformation with both phases magnetically ordered in Heusler alloys Ni-Mn-Z (Z: Ga, In, Sn and Sb) increasing attention has been paid to study the change in magnetic and electrical properties associated to the first-order reversible magnetostructural transition that originates valuable functional properties such as magnetic superelasticity, large inverse magnetocaloric effect, and large magnetoresistance change [1 and the references therein]. The reversibility and irreversibility of the magnetostructural transition is very important for magnetic actuator materials such as magnetic shape memory alloys. The austenite phase induced by the magnetic field is able to transform back to the initial martensite phase when the magnetic field is removed. A complete recovery of the initial martensite state may bring about magnetoelasticity (two-way magnetic shape memory effect), while the irreversible magnetostructural transition would result in magnetoplasticity (one-way magnetic shape memory effect).
We showed that the effects of the irreversibility of the magnetostructural transitions on magnetocaloric effect in the (Ni-Cu)-Mn-Sn compounds was very important by magnetic and resistance measurements under magnetic field [1]. The magnetic entropy change of the $Ni_{50-x}Cu_xMn_{36}Sn_{14}$ (x=2 and 4) compounds are estimated by using Maxwell equation and the M(H) curves obtained from noncontinuous heating method. These compounds show the magnetostructural phase transition from cubic to orthorhombic structure with decreasing temperature at around 218 and 168 K, respectively. To see better the type of the magnetostructural transition, we perform the neutron diffraction experiments for these compounds at the different temperatures and under different magnetic fields. According to the neutron diffraction experiment near A_S (A_S: Austenite start temperature), the Martensite phase of these compounds transforms to Austenite phase with increasing the magnetic field from 0 to 5 T, while these compounds remains in the Austenite phase with decreasing the magnetic field to zero Tesla. This is the evidence of the irreversible magnetostructural transition occurred in these compounds. Because of that, the determination of the magnetic entropy change in alloys which show the irreversible magnetostructural transition has carefully been studied [2].

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Keywords: Neutron diffractions, Magnetostructural transition, Magnetocaloric effect

FA5-MS41-P05

Structural, magnetic and magnetocaloric effect in the off-stoichimetric $Gd_5Ge_{2.05-x}Si_{1.95-x}Mn_{2x}$ alloys Yalcin Elerman, Ercüment Yüzüak, Ilker Dincer
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Magnetic refrigeration based on MCE of solid-state working substances have attracted tremendous attention in recent years due to its energy efficient and environment friendly properties as compared with the gas compression refrigeration technology that is used currently. Practical applications of the MCE, therefore, have the potential to reduce the global energy consumption and eliminate or minimize the use of ozone-depleting alloys, greenhouse gases, and precarious. After the discovery of the giant magnetocaloric effect in the $Gd_5Si_2Ge_2$ alloy, there has been much interest in the $Gd_5(Si_xGe_{1-x})_4$ family alloys [1]. As seen in earlier studies, the stoichiometric $Gd_5Si_2Ge_2$ with doping alloys have not won with the appropriate of magnetocaloric features. For this reason, we attempt to improve the magnetocaloric properties of the off-stoichiometric $Gd_5Ge_{2.05}Si_{1.95}$ alloy by replacing non-magnetic Ge/Si atoms by a small amount of magnetic Mn atom. We have investigated the structural, magnetic and magnetocaloric properties of the $Gd_5Ge_{2.05-x}Si_{1.95-x}Mn_{2x}$ (2x=0.02, 0.06) alloys using scanning electron microscopy, x-ray powder diffraction, DSC and magnetic measurements. According to DSC and magnetic measurements, the both alloys exhibit a structural phase transition (the first order phase transition) around room temperature. The Curie temperatures of these alloys are around 295 K. We determine the magnetic entropy changes near the transition temperatures using Maxwell relation and magnetization data. The maximum values of isothermal magnetic entropy change of the $Gd_5Ge_{2.05-x}Si_{1.95-x}Mn_{2x}$ alloy with 2x = 0.02 that occurred is found to be -12.1 $J.kg^{-1}.K^{-1}$ and -19.8 $J.kg^{-1}.K^{-1}$ around 268 K in an applied field of 2 T and 5 T, respectively. The magnetic entropy changes are also estimated from DSC analysis for each alloy. The values of the magnetic entropy change of the $Gd_5Si_{2.05-x}Ge_{1.95-x}Mn_{2x}$ (2x=

0.02 and 0.06) alloys are found -16.5 $J.kg^{-1}.K^{-1}$ and -14.2 $J.kg^{-1}.K^{-1}$ from the DSC analysis at around the structural transition temperatures, respectively. Since the values of the relative cooling power and the isothermal magnetic entropy change of the x=0.02 alloy is bigger than of the $Gd_5Ge_{2.05}Si_{1.95}$ alloy, this alloy should be good candidate for room temperature magnetic cooling technology [2].

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Keywords: Structural phase transition, Magnetic materials, Magnetic entropy change

FA5-MS41-P06

Opechowski-Guccione-like symbols of magnetic space groups. Hans Grimmer, *Laboratory for Developments and Methods, Research with Neutrons and Muons, Paul Scherrer Institut, Villigen, Switzerland*
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For the magnetic space group types with black and white lattice two sets of symbols have been proposed: the BNS symbols [1] and the OG symbols [2]. Whereas generators of the group can be read off the BNS symbol, the International Tables for X-Ray Crystallography (1952) must be consulted to interpret the OG symbols in the cases where the black and white lattice is centred. We shall define OG-like symbols in the case of centred lattices in such a way that generators of the group can be deduced directly from the symbol [3]. The definition generalizes a proposal of Bertaut [4] for crystal class *mmm* to every crystal class.

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Keywords: magnetic space groups, Opechowski-Guccione symbols, Belov-Neronova-Smirnova symbols

FA5-MS41-P07

Temperature dependent Neutron Diffraction Studies on Iron Pnictide Single Crystals Martin Meven[a], Yixi Su[b], Y. Xiao[c], [a]*FRM II, Technische Universität München, Germany,* [b]*JCNS, IFF, Forschungszentrum Jülich, Outstation at FRM II, Garching, Germany,* [c]*IFF, Forschungszentrum Juelich, Germany*
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The single crystal diffractometer (SCD) HEiDi at the hot source of the research neutron source Heinz Maier-Leibnitz (FRM II) was developed as a co-operation of the RWTH Aachen and the TU München [1]. The short neutron wavelengths (0,4 Å $\leq \lambda <$ 1,2Å) of the instrument allow detailed studies of nuclear structures and the magnetic order of compounds with similar or highly absorbing elements.
Thus, HEiDi is an ideal tool for studies on the recently discovered superconducting iron pnictides. In spite of the different chemical composition there are significant similarities between the iron pnictides and the high-T_c cuprates discovered in 1986. In both cases the layered structures undergo a crystallographic phase transition from a tetragonal room/high temperature phase to an orthorhombic low temperature phase. In addition, doping with suitable elements influences the appearance and disappearance of magnetic and superconducting phases significantly.
Detailed studies of undoped single crystals of $BaFe_2As_2$ and $EuFe_2As_2$ were performed on the SCD HEiDi to improve the understanding of the superconducting A-122 compounds. Due to the combination of platelike sample shapes, the complexity of the orthorhombic phase (reflection splitting due to appearance of domains and twinning) and the high absorption of the Eu sample made the precise data collections as well as the accurate interpretation of the results quite challenging but gave a deep insight to the phase transitions and magnetic order at low temperatures [2, 3] of these compounds.

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Keywords: Instrumentation, Magnetism, Phase transition

FA5-MS41-P10

Structural Aspect of Stabilization of Magnetic Particles in Solution: SAXS Study Eleonora Shtykova[a], Petr Konarev[b], Lyudmila Bronstein[c], Dmitri Svergun[b], [a]*Institute of Crystallography, Russian Academy of Sciences, Moscow, Russia,* [b]*EMBL Hamburg Outstation, Germany,* [c]*Indiana University, Department of Chemistry, USA*
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A problem of stabilization of iron oxide magnetic nanoparticles (NPs) in solution is of special importance due to their possible application in life science, medicine, and particularly in anti-cancer therapy. Precondition for such applications is water solubility, which can be achieved by introducing a biocompatible shell on the hydrophobic NP surface. These coatings must fulfill certain requirements, and, first of all, they must prevent the aggregation of nanoparticles in solution. Functional properties of the protective shells depend strongly on their thickness, density, chemical composition and structure. Moreover, the practical use of the ferromagnetic liquids is determined by the metal particle shapes, size and size distributions. Therefore, all these characteristics of the specimens should be comprehensively characterized. In this work we report structure and properties of iron oxide NPs synthesized by decomposition of iron oleates and encapsulated by different methods. We analyze also the process of micellization of differently grafted PMAcOD in water solution, and the ability of the various coatings to encapsulate the NPs. The detailed structural investigation of the specimens was performed using small angle X-ray scattering (SAXS) and a complex of modern tools of SAXS data interpretation and modeling.
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