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**Resonant Soft X-ray Diffraction as a Probe for Complex Magnetic Structures.** Christian Schuessler-Langeheine. *II. Physikalisches Institut, Universitaet zu Koeln, Zuelpicher Str. 77, 50937 Koeln, Germany.* E-mail: [schuessler@ph2.uni-koeln.de](mailto:schuessler@ph2.uni-koeln.de)

For the study of complex magnetic order in 3d-transition metal systems resonant diffraction of soft x-rays (RSXD) exists as a technique that is complementary to neutron diffraction. RSXD is characterized by a large magnetic scattering cross section and a high spectroscopic sensitivity. This sensitivity allows to do experiments not only selectively for a certain element in the sample but also for a certain oxidation state of a given element. In addition to magnetic order also charge and orbital order can be probed directly using RSXD. A realistic microscopic theory as well as sum rules allow for a quantitative analysis of the resonance spectra. While the rather long photon wavelengths, which is of the order of 10 to 20 Angstroms for 3d resonances, limits the accessible momentum space, many complex materials exhibit magnetic order on fairly long length scales and can be readily studied using RSXD. Examples are stripe phases as they are found in cuprates and nickelates or the complex charge, orbital and spin order pattern found in doped manganites. Also artificial systems like multilayers typically have periodicities in the nm range and can well be studied using RSXD. Interestingly not only static magnetic order but also fluctuating order that would occur in a neutron experiment in the inelastic channel can be probed. With the use of coherent photons an RSXD experiment gains an additional sensitivity to disorder on nm length scales and to changes of this disorder as a function of time or an external field. Coherent RSXD can hence be used to study magnetic domain dynamics as well as phase separation effects in complex materials. The talk will discuss the experimental possibilities of RSXD and will present results from Sr-doped  $\text{La}_2\text{NiO}_4$ ,  $\text{La}_2\text{CuO}_4$ , and  $\text{La}_2\text{CoO}_4$  as well as from ultrathin Ho-metal films.

**Keywords:** soft X-rays; X-ray anomalous scattering; transition-metal oxides

**FA2-MS09-O2**

**The Nature of Magnetic Coupling in the Martensitic and Austenitic Structures in Magnetic Shape-Memory Alloys Studied by Neutron Polarization Analysis.** Mehmet Acet<sup>a</sup>, Seda Aksoy<sup>a</sup>, Eberhard F. Wassermann<sup>a</sup>, Lluis Mañosa<sup>b</sup>, Antoni Planes<sup>b</sup>, Pascale P. Deen<sup>c</sup>. <sup>a</sup>*Experimentalphysik (AG-Farle), Universität Duisburg-Essen, D-47048 Duisburg.* <sup>b</sup>*Facultat de Física, Departament dEstructura i Constituents de la Matèria, Universitat de Barcelona, E-08028 Barcelona.* <sup>c</sup>*Institut Laue-Langevin, 38042 Grenoble.* E-mail: [mehmet.acet@uni-due.de](mailto:mehmet.acet@uni-due.de)

Ni-Mn-X-based Heusler-type alloys (X: group IIIA-VA elements) undergo martensitic transformations from a high

symmetry cubic austenitic state to a modulated orthorhombic martensitic state of lower symmetry. The presence of such a transformation is responsible for the rich variety of phenomena observed in these materials; mainly being the magnetic shape-memory effect, magnetic superelasticity, the magnetocaloric effect, magnetic field induced structural transformations, exchange-bias, and austenite arrest. To understand the cause of these magnetostructural effects, we study the structure and nature of the magnetic coupling below and above the martensitic transition with XYZ neutron polarization analysis experiments. We show that around the transition temperature  $M_s$ , the magnetic interactions are in the form of short-range antiferromagnetic correlations for  $T < M_s$ , whereas they persist as mixed ferromagnetic and antiferromagnetic short-range correlations for  $T > M_s$  as well as beyond the Curie temperature of the austenitic state. We discuss magneto-structural phenomena in the various crystallographic states of these alloys in relation to the observed magnetic coupling.

**Keywords:** magnetic shape memory; polarization analysis; heusler alloys

**FA2-MS09-O3**

**Orbital Contribution to the Magnetic Moment in  $\text{Co}_2\text{SiO}_4$ .** Andrew Sazonov<sup>a,b</sup>, Vladimir Hutanu<sup>a,b</sup>, Martin Meven<sup>b</sup>, Gernot Heger<sup>a</sup>. <sup>a</sup>*Institut fuer Kristallographie, Rheinisch-Westfaelische Technische Hochschule (RWTH) Aachen, D-52066 Aachen, Germany.* <sup>b</sup>*Forschungsneutronenquelle Heinz Maier-Leibnitz (FRM II), Technische Universitaet Muenchen (TUM), D-85747 Garching, Germany.* E-mail: [andrew.sazonov@frm2.tum.de](mailto:andrew.sazonov@frm2.tum.de)

Synthetic  $\text{Co}_2\text{SiO}_4$  has an orthorhombic crystal structure (space group  $Pnma$ , No. 62) and shows magnetic ordering below  $\sim 50$  K. Both single-crystal and powder neutron diffraction were applied to determine precise crystal and magnetic structure parameters. Detailed symmetry analysis of the magnetic structure show that it corresponds to the Shubnikov magnetic group  $Pnma$  which allow the antiferromagnetic configuration ( $G_x, C_y, A_z$ ) for 4a site with inversion symmetry  $\bar{1}$  (Co1 position) and  $(0, C_y, 0)$  for 4c site with mirror symmetry  $m$  (Co2 position). The magnetic moments from the neutron diffraction data were found to be  $3.86 \pm 0.05 \mu_B$  and  $3.37 \pm 0.04 \mu_B$  for Co1 and Co2, respectively. An important orbital contribution to the total magnetic moment of  $\text{Co}^{2+}$  in  $\text{Co}_2\text{SiO}_4$  was predicted by means of magnetic susceptibility and non-polarized neutron diffraction measurements. This prediction was independently proved by means of direct X-ray magnetic circular dichroism and polarized neutron diffraction studies which indicate a spin to orbital magnetic moment ratio  $\mu_L / \mu_S \approx 0.25$ . The results are in agreement with theoretical expectation of the spin-only value  $3 \mu_B$  for the  $\text{Co}^{2+}$  ion in the high spin state ( $S = 3/2, t_{2g}^5 e_g^2$ ). Thus, the excess magnetic moment above  $3 \mu_B$  is caused by the orbital part. Spin-orbit coupling with this partially unquenched orbital moment in  $\text{Co}^{2+}$  is mainly responsible for the magnetocrystalline anisotropy in the cobalt olivine.