Neutron Diffraction Study of Magnetic Ordering in Ce(Mn<sub>x</sub>Fe<sub>1-x</sub>)<sub>2</sub>Ge<sub>2</sub>, Vadim Sikolenko<sup>a</sup>, Ekaterina Pomjakushina<sup>b</sup>, Antonio Cervellino<sup>c</sup>, Anatoly Senyshyn<sup>d</sup>.<sup>a</sup>ETH Zurich and Paul Scherrer Institute. <sup>b</sup>Paul Scherrer Institute. <sup>c</sup>Technical Universität Munich. E-mail: vadim.sikolenko@psi.ch

Crystal and magnetic structure of Ce(Mn<sub>x</sub>Fe<sub>1-x</sub>)Ge<sub>2</sub> with x = 0, 0.6, 0.8 have been studied by neutron powder diffraction. All these ternary compounds crystalize in the body-centered tetragonal ThCr<sub>2</sub>Si<sub>2</sub>-type structure (I4/mmm). But magnetic properties are different. They can be considered as an interaction of two magnetic sublattices: Ce-subsystem and Mn subsystem, but in case of CeMn<sub>2</sub>Ge ions of Ce are nonmagnetic. On the other side, intralayer Mn-Mn exchange interaction is the strongest and this fact leads to ferromagnetic coupling of the Mn moments along c-axis. But the interlayer Mn-Mn exchange is very sensitive to the lattice parameters which leads to ferromagnetic or antiferromagnetic ordering of the Mn sublattice. When Mn is replaced by another 3d element Fe the Curie or Neel temperatures decrease and a new magnetic phases appear with increasing amount of transition metal. We have observed the magnetic contribution for nuclear reflexes (hkl) with h+k = 2n, which could be corresponds to ferromagnetic components on the Mn sublattice. Pure CeMnGe<sub>2</sub> indicates appearance of the satellites (101) and (101). With the substitution Mn by Fe these satellites disappear. This fact means that magnetic structure is canted for the pure compound and ferromagnetic for the substituted samples. Crystal structure is similar for all samples (I4/mmm tetragonal lattice) but with the increasing of Fe substitution level initial volume decreases as well as Mn-Mn distances and magnetic contribution to the nuclear peaks.

Keywords: neutron powder diffraction; magnetism; intermetallic structures

Magnetic Structure of ZnFe<sub>2</sub>O<sub>4</sub>, Aleksandar Krešenović<sup>a</sup>, Predrag Vulić<sup>b</sup>, Bratislav Antić<sup>c</sup>, Emil S. Božin<sup>b</sup>, Jovan Blanusa<sup>b</sup>.<sup>a</sup>INSA “Vinca”, Serbia. <sup>b</sup>FMG, University of Belgrade, Serbia. <sup>c</sup>Columbia University, New York, USA. E-mail: akremen@EUNet.rs

ZnFe<sub>2</sub>O<sub>4</sub> spinel with pyrochlore sublattice of corner-sharing Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal ZnFe<sub>2</sub>O<sub>4</sub> spinel, colinear and Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal ZnFe<sub>2</sub>O<sub>4</sub> spinel, colinear and Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal ZnFe<sub>2</sub>O<sub>4</sub> spinel, colinear and Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal ZnFe<sub>2</sub>O<sub>4</sub> spinel, colinear and Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal ZnFe<sub>2</sub>O<sub>4</sub> spinel, colinear and Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal ZnFe<sub>2</sub>O<sub>4</sub> spinel, colinear and Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal ZnFe<sub>2</sub>O<sub>4</sub> spinel, colinear and Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal ZnFe<sub>2</sub>O<sub>4</sub> spinel, colinear and Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal ZnFe<sub>2</sub>O<sub>4</sub> spinel, colinear and Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal ZnFe<sub>2</sub>O<sub>4</sub> spinel, colinear and Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal ZnFe<sub>2</sub>O<sub>4</sub> spinel, colinear and Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal ZnFe<sub>2</sub>O<sub>4</sub> spinel, colinear and Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal ZnFe<sub>2</sub>O<sub>4</sub> spinel, colinear and Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal ZnFe<sub>2</sub>O<sub>4</sub> spinel, colinear and Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal ZnFe<sub>2</sub>O<sub>4</sub> spinel, colinear and Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal ZnFe<sub>2</sub>O<sub>4</sub> spinel, colinear and Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal ZnFe<sub>2</sub>O<sub>4</sub> spinel, colinear and Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal ZnFe<sub>2</sub>O<sub>4</sub> spinel, colinear and Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal ZnFe<sub>2</sub>O<sub>4</sub> spinel, colinear and Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal ZnFe<sub>2</sub>O<sub>4</sub> spinel, colinear and Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal ZnFe<sub>2</sub>O<sub>4</sub> spinel, colinear and Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal ZnFe<sub>2</sub>O<sub>4</sub> spinel, colinear and Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal ZnFe<sub>2</sub>O<sub>4</sub> spinel, colinear and Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal ZnFe<sub>2</sub>O<sub>4</sub> spinel, colinear and Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal ZnFe<sub>2</sub>O<sub>4</sub> spinel, colinear and Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal ZnFe<sub>2</sub>O<sub>4</sub> spinel, colinear and Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal ZnFe<sub>2</sub>O<sub>4</sub> spinel, colinear and Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal ZnFe<sub>2</sub>O<sub>4</sub> spinel, colinear and Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal ZnFe<sub>2</sub>O<sub>4</sub> spinel, colinear and Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal ZnFe<sub>2</sub>O<sub>4</sub> spinel, colinear and Fe-tetrahedra belongs to a group of frustrated magnetic materia...
Enhanced Orbital Magnetic Moment of An Highly Ordered Epitaxial FePt Thin Film Grown from Multilayers by Ion Assisted Sputtering Deposition.

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FePt alloy in a $L1_0$ ordered structure is one of the best materials for the future high density perpendicular recording hard disk drive due to its high magnetocrystalline anisotropy energy and perpendicular magnetic anisotropy (PMA) property. The ordered FePt thin film was obtained by annealing the as deposited Fe/Pt multilayers grown by low energy ion assisted sputtering on the MgO(001) substrate. An epitaxial highly ordered (parameter 0.95) $L1_0$ FePt film was obtained. X-ray magnetic circular dichroism (MCD) on Fe L-edges was used to measure the orbital and spin magnetic moments of the thin film. The out-of-plane MCD signals increase with increasing annealing temperatures. The out-of-plane orbital-to-spin ratio is found to be proportional to the order parameter. The enhancement of orbital to spin magnetic moment is more than 100%. This enhancement may be due to a strong interfacial hybridization between Fe and Pt layers at interfaces and consequently, results in a strong PMA effect.

Keywords: magnetic thin film; X-ray diffraction; epitaxial layers

X-ray Scattering Study of the Phase Transition in Nd$_{1/2}$Sr$_{1/2}$MnO$_3$.

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The colossal magnetoresistance (CMR) conjugating with the lattice distortions in manganese oxides shows the very reach and fascinating physical phenomena, such as charge, orbital and spin ordering, and has motivated extensive studies. Experiments have revealed a rich phase diagram with a variety of different structures as a function of stoichiometry, temperature, and applied magnetic field [1]. For instance, in the case of Nd$_{1/2}$Sr$_{1/2}$MnO$_3$ [2], the compound undergoes a transition from a paramagnetic insulator to a ferromagnetic metal for $x < 0.48$, and from a paramagnetic insulator to a $C$-type antiferromagnetic insulator for $x > 0.63$. For a hole concentration of $0.48 < x < 0.52$, Nd$_{1-x}$Sr$_x$MnO$_3$ first undergoes a transition to the ferromagnetic metallic state at about 250 K, and then becomes an $A$-type antiferromagnetic metal at about 200 K. Upon further cooling, it becomes a $CE$-type antiferromagnet at about 160 K, at which it has been reported to coexist with the $A$-type antiferromagnetic state at low temperatures. The $CE$-type antiferromagnetic state displays both charge and orbital ordering. The $CE$-type charge and orbital ordering are characterized by the alternate ordering of the Mn$^{3+}$ and Mn$^{4+}$ ions and by the ordering of $d(3x^2-r^2)$ and $d(3y^2-r^2)$ orbitals on the Mn$^{3+}$ sites. The unusual magnetic and electronic properties in these materials result from interaction between charge, spin, orbital and lattice degrees of freedom, which are strongly coupled to each other.

We take Nd$_{1/2}$Sr$_{1/2}$MnO$_3$ [2] as an example to demonstrate the observation of a sequential phase transition using high resolution x-ray scattering [3]. By measuring the peak profile of Bragg reflections, upon cooling, we observed an increase in the width of the Bragg reflections around the Curie temperature (252 K) corresponding to the transition from a paramagnetic to a ferromagnetic state. Below approximately 200 K, dramatic changes in the width and integrated intensity were observed. Changes continued until the formation of charge ordering with $q = (1/2, 0, 0)$ at $T_{CO} = 152$ K. This charge ordering was observed to be the first order transition and display a large hysteresis width of 10 K. This second transition can be understood to be caused by the formation of different magnetic domains as that observed by neutron powder diffraction [3].

References


Keywords: magnetism; mesoporous; neutrons

FA2-MS09 Combination of Synchrotron and Neutrons in Magnetic Materials


Keywords: X-ray scattering; phase transition; charge ordering

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Keywords: magnetic thin film; X-ray diffraction; epitaxial layers

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X-ray Scattering Study of the Phase Transition in Nd$_{1/2}$Sr$_{1/2}$MnO$_3$.

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The colossal magnetoresistance (CMR) conjugating with the lattice distortions in manganese oxides shows the very reach and fascinating physical phenomena, such as charge, orbital and spin ordering, and has motivated extensive studies. Experiments have revealed a rich phase diagram with a variety of different structures as a function of stoichiometry, temperature, and applied magnetic field [1]. For instance, in the case of Nd$_{1/2}$Sr$_{1/2}$MnO$_3$ [2], the compound undergoes a transition from a paramagnetic insulator to a ferromagnetic metal for $x < 0.48$, and from a paramagnetic insulator to a $C$-type antiferromagnetic insulator for $x > 0.63$. For a hole concentration of $0.48 < x < 0.52$, Nd$_{1-x}$Sr$_x$MnO$_3$ first undergoes a transition to the ferromagnetic metallic state at about 250 K, and then becomes an $A$-type antiferromagnetic metal at about 200 K. Upon further cooling, it becomes a $CE$-type antiferromagnet at about 160 K, at which it has been reported to coexist with the $A$-type antiferromagnetic state at low temperatures. The $CE$-type antiferromagnetic state displays both charge and orbital ordering. The $CE$-type charge and orbital ordering are characterized by the alternate ordering of the Mn$^{3+}$ and Mn$^{4+}$ ions and by the ordering of $d(3x^2-r^2)$ and $d(3y^2-r^2)$ orbitals on the Mn$^{3+}$ sites. The unusual magnetic and electronic properties in these materials result from interaction between charge, spin, orbital and lattice degrees of freedom, which are strongly coupled to each other.

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