FA2-MS09-P01

Neutron Diffraction Study of Magnetic Ordering in $Ce(Mn_{1-x}Fex)_2Ge_2$. Vadim Sikolenko[a], Ekaterina Pomjakushina[b], Antonio Cervellino[b], Anatoly Senyshyn[c]. *[a]ETH Zurich and Paul Scherrer Institute. [b]Paul Scherrer Institute. [c]Technical Universitt Munich.*
E-mail: vadim.sikolenko@psi.ch

Crystal and magnetic structure of $Ce(Mn_{1-x}Fe_x)_2Ge_2$ with x = 0, 0.6, 0.8 have been studies by neutron powder diffraction. All these ternanry compounds crystallize in the body-centered tetragonal $ThCr_2Si_2$-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 $CeMn_2Ge$ 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 $CeMn_2Ge_2$ 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 init cell volume decreases as well as Mn-Mn distances and magnetic contribution to the nuclear peaks.

Keywords: neutron powder diffraction; magnetism; intermetallic structures

FA2-MS09-P02

Magnetic Structure of $ZnFe_2O_4$. Aleksandar Kremenovic[a,b], Predrag Vulic[b], Bratislav Antic[a], Emil S. Božin[c], Jovan Blanusa[a]. *[a]INS "Vinca", Serbia. [b]FMG, University of Belgrade, Serbia. [c]Columbia University, New York, USA.*
E-mail: akremen@EUnet.rs

$ZnFe_2O_4$ spinel with pyrochlore sublattice of corner-sharing Fe-tetrahedra belongs to a group of frustrated magnetic materials [1]. For a normal $ZnFe_2O_4$ spinel, colinear and non colinear magnetic spin arrangements are indicated, which could be equally compatible with neutron diffraction powder intensities observed at 5 K. It is well established that the material orders at 10 K temperature into a ground state which can be described by an ordering vector $\boldsymbol{k}$ = (0 0 1/2), into a magnetic structure involving 32 spins [2]. Results of refinement of the non colinear magnetic structure model, described by König et al. [2], on the basis of TOF neutron data collected at 5K at SEPD instrument at IPNS at Argonne national Laboratory will be presented.

Work at Columbia was supported by the Office of Science, U.S. Department of Energy, under contract no. DE-AC02-98CH10886.

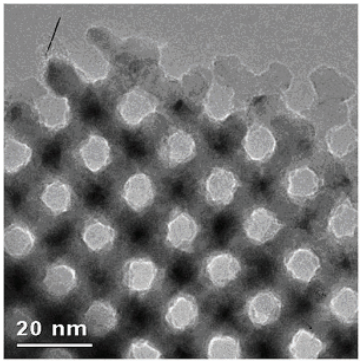
[1] Greedan, J.E., *J. Mater. Chem.*, **2001**, 11, 37. [2] König, U., Bertaut, E.F., Gros, Y., Mitrikov, M., Chol, *G. Sol. Stat. Commun*., **1970**, 8, 759.

Keywords: magnetic structure; time-of-flight diffraction; ferrite

FA2-MS09-P03

Mesoporous 3-*d* Transition Metal Oxides: Magnetic and Crystallographic Studies. Adrian H. Hill[a,b]. *[a]School of Chemistry, The University of Edinburgh, UK. [b]European Synchrotron Radiation Facility, France.*
E-mail: adrian.hill@esrf.fr

The magnetic properties of the first row transition metal oxides are wide and varied and have been studied extensively since the 1930's. Observations that the magnetic properties of these material types change with the dimension of the sample have stimulated many theoretical and experimental studies of the systems involved. As sample sizes decrease towards the nanoscale long range crystallographic order is no longer possible. However, the application of mesoporous silica samples as hard exo-templates to direct the formation of mesoporous metal oxides has provided a new opportunity to explore the influence of scale of crystallographic order further. These types of samples have pore systems running through the material on the mesoscale (diameter between 2-50 nm) with pore walls truly in the nanoscale region (7-9 nm thick) whilst crystallographically ordered over large scale distances (see figure showing mesoporous Cr_2O_3).
The work presented here shows magnetic and crystallographic studies of a variety of the first row transition metal oxides in three dimensional mesoporous forms predominantly using SQUID magnetometry and neutron powder diffraction.
Particular attention is focussed upon a sample of mesoporous hematite, α-Fe_2O_3 which shows suppression of a well defined first-order magnetic phase transition (the Morin transition).[1] This suppression has been studied extensively with neutron powder diffraction and preliminary inelastic neutron spectroscopic measurements. Comparisons with hematite nanoparticles which also show the suppression of the Morin transition can be drawn.[2]



[1] Hill, A. H. *et al*., *Chem. Mater.*, 20, 4891, **2008**. [2] Klausen, S. N. *et al*., *Phys. Rev.* B, 70, 214411, **2004**.

Keywords: magnetism; mesoporous; neutrons

FA2-MS09-P04

Enhanced Orbital Magnetic Moment of An Highly Ordered Epitaxial FePt Thin Film Grown from Multilayers by Ion Assisted Sputtering Deposition.

Chih-Hao Lee[a], Yu-Sheng Chen[a] , Li-Jung Liu[a], J. C. A. Huang[b]. [a]*Department of Engineering and System Science, National Tsing Hua University, Hsinchu, Taiwan.* [b]*Department of Physics, National Cheng-Kung University, Tainan, Taiwan.*
E-mail: chlee@mx.nthu.edu.tw

FePt alloy in a *L*10 ordered structure is one of the best materials for the future high density perpendicular recording hard disk 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 mulitlayers grown by low energy ion assisted sputtering on the MgO(001) substrate. An epitaxial highly ordered (order parameter 0.95) L10 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 increases 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

FA2-MS09-P05

X-ray Scattering Study of the Phase Transition in $Nd_{1/2}Sr_{1/2}MnO_3$.

Chao-hung Du[a], C.-H. Yao[a], Y.-C. Lia[a], M. E. Ghazi[b], P. D. Hatton[c]. [a]*Department of Physics, Tamkang University, Tamsui 251, Taiwan.* [b]*Department of Physics, Shahrood Uiniversity of Technology, Shahrood, Iran.* [c]*Department of Physics, University of Durham, Durham DH1 3LE, UK.*
E-mail: chd@mail.tku.edu.tw

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 $Nd_{1-x}Sr_xMnO_3$ [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 $0.48 < x < 0.52$, $Nd_{1-x}Sr_xMnO_3$ 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 characterised by the alternate ordering of the Mn^{3+} and Mn^{4+} ions and by the ordering of $d(3x^2\text{-}r^2)$ and $d(3y^2\text{-}r^2)$ 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 sequent 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 sequent transition can be understood to be caused by the formation of different magnetic domains as that observed by neutron powder diffraction [3].

[1] For reviews see S-W. Cheong and C.H. Chen 'Stripe, Charge & Orbital Ordering in Perovskite Manganites', in *Colossal Magnetoresistance and related Properties* eds. B. Raveau and C.N.R. Rao (World Scientific) and *Colossal Magnetoresistance Oxides* ed. Y. Tokura (Gordon & Breach, London, **1999**. [2] H. Kuwahara, Y. Tomioka, A. Asamitsu, Y. Moritomo, and Y. Tokura, Science, 270, 961, **1995**. [3] C.-H. Du, M. E. Ghazi, P. D. Hatton, S. P. Collins, B. M. Murphy, B. G. Kim, and S.-W. Cheong, J. of Applied Physics, 104, 23517, **2008**. [4] C. Ritter, R. Mahendiran, M. R. Ibarra, L. Morellon, A. Maignan, B. Raveau, and C. N. R. Rao, Phys. Rev. B 61, R9229, **2000**.

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