International Conference on

Magnetism and Magnetic Materials

October 09-10, 2017 London, UK

Keynote Forum
Day 1

Magnetic Materials 2017






Ian Baker
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Processing of τ- MnAl

τ- MnAl has an estimated maximum energy product, $(BH)_{max}$, of 12 MGOe, which is twice that of AlNiCo magnets and is composed of much cheaper elements. On a density-compensated basis $(BH)_{max}$ for τ- MnAl is almost two-thirds the value for SmCo magnets. In this presentation, we will outline various processing routes that we have used to produce powders of MnAl including gas atomization, rapid solidification processing using the Pratt and Whitney RSR process, and casting followed by pulverization. The resulting particulates were mechanically milled to produce nanocrystalline material using a Union Process attritor. The high temperature ε-phase was present both before and after milling along with significant amounts of equilibrium Υ_2 and β phases. In addition, ribbons were produced by melt spinning, which had a similar mix of ε, β and Υ_2 phases. We will outline the effects of annealing on the phases present and the magnetic properties of the various powders and ribbons. We will also present the results of the use of back-pressure assisted equal channel angular extrusion through which the powders are simultaneously consolidated and transformed to the τ phase.

Biography

Ian Baker obtained his BA and D. Phil in Metallurgy and Science of Materials from the University of Oxford. He is the Sherman Fairchild Professor of Engineering and Senior Associate Dean at the Thayer School of Engineering, Dartmouth College. He has published 400 papers and given over 300 presentations at universities, conferences and in industry, of which 150 were invited. He is a fellow of ASM, TMS, IOM[3], MRS and AAAS. He is the editor in Chief of *Materials Characterization*.

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Notes:

Valérie Paul-Boncour
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Metal hydride magnetocaloric compounds

Classical refrigeration technology is using refrigerants (CFC, HCFC, and HFC) which deplete the ozone layer and contribute to global warming, and are or will be forbidden by different climate protocols. The alternative refrigerants (HFO, NH_3, H_2O …) present also various drawbacks. Therefore, it is important to develop new refrigeration technologies without environmental problems such as magnetic refrigeration based on the magnetocaloric effect (MCE). Development of efficient magnetocaloric materials (MCM) for magnetic refrigeration near room temperature has become challenging since the discovery of a giant MCE in $Gd(Ge,Si)_5$ compounds. Intensive studies have yielded the development of several families of materials, among which the $La(Fe,Si)_{13}$ type compounds which display a giant MCE, are not too expensive and are environmental friendly. We have developed a rapid method of synthesis and shaping magnetocaloric $La(Fe,Si)_{13}$ compounds by combining high energy ball milling (BM) with reactive Spark Plasma Sintering (SPS) (Figure 1), a method which is already used to sinter and shape materials at an industrial scale. However, the Curie temperatures of these intermetallics, which is near 200 K, has to be increased near room temperature by Co for Fe substitution or light element insertion like hydrogen. The influence of combining both Fe for Co substitution and hydrogenation to increase T_C above RT and extend the application of these materials to domestic heat pump and low-grade heat recuperation will be presented. We are also searching new MCM families. The $Y_{1-x}R_xFe_2(H,D)_{4.2}$ compounds (R=Gd, Tb) show a ferro(ferri)-antiferromagnetic transition which display a giant isotope effect and MCE. This transition is highly sensitive to any volume changes due to its itinerant electron metamagnetic behavior. The magnetocaloric properties of these compounds will be presented and we will show how the transition temperature can be shifted near room temperature by appropriate chemical substitutions.

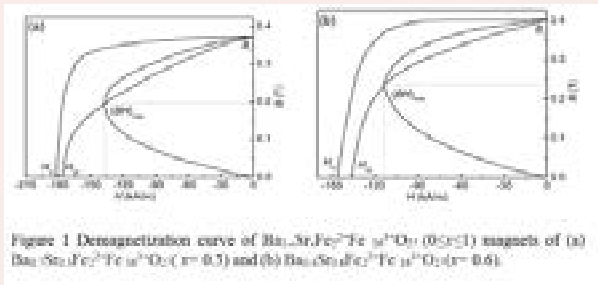

Figure 1: Influence of the temperature on the piston displacement and the XRD patterns of sample pressurized in SPS device. Inset: The magnetic entropy variation at 1273 K

Biography

Valérie Paul-Boncour has developed her expertise in the structural and physical properties of metal-hydrides systems since 1983. Hydrogen absorption in metal and intermetallic induces large structural changes (Cell volume increase, distortion, superstructure, amorphization) and significant modifications of the electronic and magnetic properties. She has developed an expertise in the hydrides of RM_n compounds (R= Rare Earth, M=Mn, Fe, Co, Ni) which display a large variety of original structural and magnetic properties. She has also used the ability of tuning the magnetic properties by hydrogen absorption to synthetize magnetocaloric materials for magnetic refrigeration or heat pumps. She belongs to the Institute of Chemistry and Materials Paris East (ICMPE) created in 2007, which develops multidisciplinary research activities around four main areas: materials for energy, nano-materials and scale effects, materials for the environment and sustainable development, and chemistry at the interface with health and living.

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Kaiyou Wang
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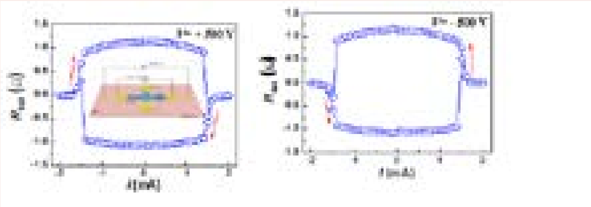
Control ferromagnets at room temperature without external magnetic field

Electrically controlling the spin in solids is the core of spintronics. We investigated that Spin Hall effect controls the magnetization switching in heavy metal/ferromagnet/heavy metal multilayers and also piezo voltages control the magnetization switching of Heusler alloy CoFeAl. By designing the device structure, we demonstrate a strong damping-like torque from the Spin Hall effect and unmeasurable field-like torque from Rashba effect. The spin-orbit effective fields due to the Spin Hall effect were investigated quantitatively and were found to be consistent with the switching effective fields after accounting for the switching current reduction due to thermal fluctuations from the current pulse. The spin-orbit torque switching controllably in above structures have to have the assistant of the external magnetic field. Without breaking the symmetry of the structure of the thin film, we realize the deterministic magnetization switching in a hybrid ferromagnetic/ferroelectric structure with Pt/Co/Ni/Co/Pt layers on PMN-PT substrate. The effective magnetic field can be reversed by changing the direction of the applied electric field on the PMN-PT substrate, which fully replaces the controllability function of the external magnetic field. We also investigated the planar Hall effect devices based on the tunability of the planar Hall resistance in ferromagnetic Co_2FeAl devices solely by piezo voltages. The room temperature magnetic NOT and NOR gates have been demonstrated based on the Co_2FeAl planar Hall effect devices without external magnetic field.



Without external magnetic field, with positive/negative in-plane polarized PMN-PT substrate, the current induced magnetization switching is opposite.

Biography

Kaiyou Wang, PhD, Professor in Institute of Semiconductors in Chinese Academy of Sciences, Deputy Director of State Key Laboratory for Superlattices & Microstructure, obtained his PhD in 2005 at School of Physics & Astronomy, University of Nottingham. He worked as a Researcher Assistant from March to the end of May/2005 in University of Nottingham. He then worked as a Researcher in Hitachi Cambridge Laboratory from June/2005 to the end of March/2009. During his stay in UK, he had twice short visits to Institute of Physics, Poland and also a short visit to Niels Bohr Institute, Copenhagen. He joined State Key Laboratory for Superlattices & Microstructure, Institute of Semiconductors in CAS as a member of "100 Talent Program". In 2012, he has been awarded the "National Outstanding Youth Foundation" from NSFC. In 2014, he was selected to be excellent in the "100 Talent Program" final assessment. His current research interests include: (1) spintronic devices; (2) physical properties based on low dimensional nano-electronic devices.

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Koki Takanashi
Tohoku University, Japan

Advanced spintronic materials based on ordered alloys

Materials used for spintronic devices should satisfy the following requirements like high spin polarization, leading to high efficiency in spin injection and high magnetoresistance, high magnetic anisotropy, leading to perpendicular magnetization and thermal stability of magnetization at reduced dimension and proper damping constant, leading to the optimization of the influence of spin transfer torque. It would be best to find a universal material that satisfies all these requirements; however, it is not easy. Starting from a material that satisfies one of each, usually, the way to extend the function by some modification of the material or to combine those materials might be adopted. We are interested in ordered alloys for spintronics, because some of ordered alloys show excellent functionalities such as high spin polarization and high magnetic anisotropy, and they are promising for the application to spintronics. Our group has been working on half-metallic Heusler alloys with high spin polarization, and demonstrated high CPP-GMR, which will be promising for the application to read heads in HDD. $Co_2MnSi/Ag/Co_2MnSi$, $Co_2FexMn_{1-x}Si/Ag/Co_2FexMn_{1-x}Si$ and $Co_2FexMn_{1-x}Si/Ag\text{-}Mg/Co_2FexMn_{1-x}Si$ epitaxial-layered structures were prepared by sputtering, and fabricated into pillar-shape by EB lithography for CPP-GMR measurements. The maximum MR ratio and the areal resistance change (ΔRA) obtained up to now are 62 % and 25 mΩ•µm2, respectively. CPP-GMR devices with half-metallic Heusler alloys also show high performance as spin torque oscillators (STOs) because of their low magnetic damping. A very high Q value of 4000 has been obtained with a power output of 10 nW.

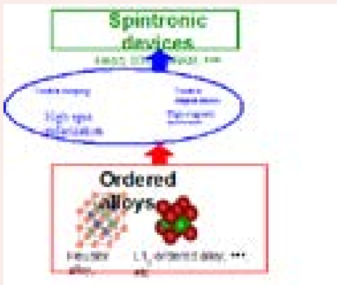

Figure 1: Importance of ordered alloys for spintronic devices.

Biography

Koki Takanashi received his BS, MS, and Ph.D. degrees in Physics from the University of Tokyo. After postdoctoral research at Tohoku University, he joined the faculty there and is now a Professor and the Director of the Institute for Materials Research at Tohoku University. In 1994-1995 he was an Alexander von Humboldt Research Fellow at the Forschunszentrum Jülich in Germany. He has published over 350 papers and has receive numerous awards, including the Outstanding Research Award (2004, Magnetic Society of Japan), Outstanding Paper Award (2009, Japan Society of Applied Physics), Masumoto Hakaru Award (2011, Japan Institute of Metals). Professor Takanashi was the leader of a national project in Japan: "Creation and Control of Spin Current" (2007-2011). His research interests include magnetism and magneto-transport in nanostructures, magnetic materials for spintronics, and spin current phenomena.

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Yshai Avishai

Ben Gurion University (Israel), NYU-Shanghai (China) and YITP (Japan)

Magnetic Impurities in cold atom systems

Motivated by the impressive recent advance in manipulating cold fermionic atoms I will focus on two problems involving magnetic impurities. Experimentally it requires the preparation of a Fermi sea of cold atoms that are confined by a shallow harmonic potential and a trapping of a few other atoms (that serve as magnetic impurities) in specially designed optical potential. When there is an antiferromagnetic exchange interaction between the itinerant atoms in the Fermi sea and the localized magnetic impurity it gives rise to the Kondo effect. The first problem employs the fact that fermionic atoms can have spin s>1/2 and thereby the magnetic impurity is over-screened. At low temperature, such system displays a non-Fermi liquid behavior. We establish a theoretical analysis of interacting cold fermionic atomic systems that are governed by an effective Hamiltonian whose low energy physics displays an over-screening by large spin. In addition, we indicate candidate systems in which it can be experimentally realized. In the second part, we explore and substantiate the feasibility of realizing the Coqblin-Schrieffer model in a gas of cold fermionic Yb atoms. Making use of different AC polarizabillities of the electronic ground state) and the long lived metastable state, it is substantiated that the latter can be localized and serve as a magnetic impurity while the former remains itinerant. The exchange mechanism between the itinerant $1S_0$ and the localized $3P_0$ atoms is analyzed and shown to be antiferromagnetic. The ensuing SU(6) symmetric Coqblin-Schrieffer Hamiltonian is constructed. A number of thermodynamic measurable observables are calculated in the weak coupling regime $T>T_K$ (using perturbative RG analysis) and in the strong coupling regime $T<T_K$ (employing known Bethe ansatz techniques).

Biography

Yshai Avishai did PhD at Weizmann institute. He is a professor of theoretical condensed matter Physics at Ben Gurion University, Beer Sheva Israel. He is a fellow of the American Physical Society, served as a Divisional Associate Editor for *Physical Review Letters,* was an Outstanding Referee for *APS journals*. He served as head of the Physics Department at Ben Gurion University, as head of the Ilse-Katz Center for Nanotechnology, as member of the Judging Committees for Israel prize in Physics and the Emet prize for exact Sciences. He is the author of 235 papers in high-level journals including *Physical Review Letters* and *Nature*, and an author of three books in Physics. He occasionally serves as Faculty Member at NYU-Shanghai University and YITP at Kyoto University, Japan. He visited and worked in numerous institutes around the world, Including Argonne National Laboratories, Lyon, Saclay, Orsay, Heidelberg, Tokyo, Kyoto, Hokkaido and others.

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A Chitharanjan Hegde

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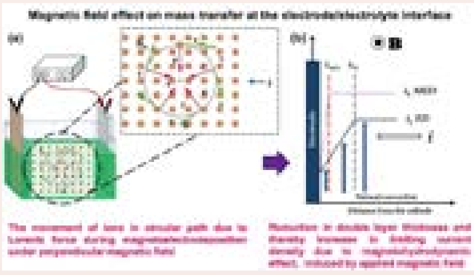
Effect of induced magnetic field on structure and properties of electrodeposited Ni-W alloy coatings

The effect of induced magnetic field on the process of electrodeposition of Ni-W alloy, and its water electrolysis character has been studied, with respect its intensity (0.1 T to 0.4 T) and direction (both parallel and perpendicular) of movement of metal ions. The experimental study revealed that electrodeposition under magnetic field, called magnetoelectrodeposition (MED) can be used as tool to alter the morphology, crystallinity and composition of the coatings, and thereby to increase its corrosion resistance and electrocatalytic activity for hydrogen evolution reaction (HER). The experimental results demonstrated that both corrosion resistance and HER activity of Ni-W alloy coatings has improved to many folds of its magnitude by MED approach. Drastic improvement in the performance MED coatings were attributed to the difference in process of electrocrystallization taking place under the influence of induced magnetic field, explained by magnetohydrodynamic (MHD) effect arises due to Lorentz force. The corrosion and electrocatalytic behaviors were tested using different electrochemical techniques. The experimental results were supported by advanced analytical techniques such as Scanning electron microscopy (SEM), Energy dispersive spectroscopy (EDS), and X-ray diffractometry (XRD), and experimental results were discussed with greater emphasis on the changed limiting current density (*iL*), affected due to applied magnetic field along with plausible mechanism.



Biography

A Chitharanjan Hegdeis a M.Sc. graduate with Ph. D. from Mangalore University in 1993. He served successfully as Head of the Department of Chemistry for three years at NITK, Surathkal (2011-2014), and presently he is a Professor at the same department, and pursuing his research in allied fields of electrochemistry. He has published more than 100 research papers in peer reviewed Journals of National and International repute. He completed many R&D projects, and guided seven Ph.D., 17 B. Tech. and 20 M.Sc. students.

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Edouard B Sonin

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Spin superfluidity, coherent spin precession and magnon BEC

Spin superfluidity, coherent spin precession, and magnon BEC are intensively investigated theoretically and experimentally nowadays. Meanwhile, clear definition and differentiation between these related phenomena is needed. Spin superfluidity is defined as a possibility of dissipation less spin transport on macroscopical distances with sufficiently large spin supercurrents. This possibility is realized at special topology of the magnetic-order-parameter space, such as, e.g., that in easy-plane ferro- and antiferromagnets, or in coherent precession states supported by pumping of energy and magnons. Recent claims on experimental observation of spin superfluidity (in yttrium-iron-garnet magnetic films, in particular) are discussed.

Biography

Edouard B Sonin is an Emeritus Professor at the Hebrew University of Jerusalem, Israel. His research interests focus on the superfluidity theory and the vortex dynamics in superfluids, superconductors, and magnetically ordered materials. He has over 230 publications including two books.

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