IEEE MAGNETICS SOCIETY NEWSLETTER

VOLUME 28, NO. 1 January 1991

CRAIG PERLOV, EDITOR

WHAT IS COMPETITIVENESS?

Edward J. Doyle

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In the past two decades, the United States has been losing its competitive edge in industry, first in automobiles and then in consumer electronics. These are two obvious areas, but there are many more, the steel industry being but one other example. Beginning in 1990, one of IEEE-USA's major projects has been to address the problem of U.S. competitiveness in a global economy.

"So what," one might comment. Americans are functioning well, with a standard of living equal to or better than those in our competitor nations. We have kept up that standard by having our government lower our taxes and borrow from other nations to help pay for U.S. Government expenses. The same thing is happening at the personal level. People are saving less and borrowing more. In the 1980s, borrowing money on homes and using it for living

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MARVIN CAMRAS RECEIVES NATION'S HIGHEST TECHNOLOGY AWARD

Dr. Camras, President and Mrs. Bush, Commerce Secretary Robert Mosbacher

The Commerce Department announced that President Bush named ten outstanding technologists and one company to receive the 1990 National Medal of Technology. The President presented the medals at a special joint ceremony with the other recipients of the National Medal of Science in the White House East Room.

"One cannot overstate the collective contributions of these outstanding technologists," Commerce Secretary Robert Al. Mosbacher said of the winners.

"I join with all Americans in congratulating them for their remarkable achievements, which have so profoundly changed our world." Mosbacher said. "These role models will inspire America's youth to studies and careers in science and technology."

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expenses became a new option. Borrowing makes it seem like our living standard is high, but it merely covers up the real facts.

Other statistics also mask the real situation. Family income is often cited as rising faster than the cost of living. However, increased family incomes have developed because now both husband and wife work. Individual incomes have not increased as rapidly. In the past decade, the spread of income between employees at the top and employees at the bottom has also expanded. The factory worker is at the wrong end of that spectrum.

Why is this happening? Some people will say the United States does not work as hard as its competitor nations, but the issue is far more complex. The important thing about the work ethic is not how *hard* we work, but how *efficiently* we work. This concept extends well beyond hours worked per day. Let's examine a more complex scenario.

It's a competitive world. Why do people buy your product rather than your competitor's? It either looks nicer, works better, costs less, or all three. A product can fail to meet these attributes for a wide variety of reasons. Everything begins at the plant, where the product is made.

The first requirement necessary to produce a competitive product is a modern manufacturing plant. Plants utilize robotics to lower labor costs for simple chores. The next necessity is modern equipment process control. Finally, modern measurement equipment is essential for measuring the product's quality. Manufacturing processes are expensive, requiring a high capital investment that pays for itself over a long period of time.

Long-term, reasonable-cost patient capital is just what the United States has very little of. U.S. investors seek high short-term profits and inventory. Long-term plant equipment is not their idea of fun. Not so for our competitors; long-term patient capital is the order of the day. So the United States encounters one of its first problems–the lack of long-term capital.

As previously mentioned, many of our simple manufacturing chores can be done with robotics, lowering U.S. labor charges. But U.S. plants still need employees to watch the entire process, adjusting various operations to conform with measurements. These employees need to be reasonably well-educated, with well-developed senses of responsibility.

Looking at the statistics on grades K through 12, U.S. educators find our results on the low end of the scale. Virtually all of our competitors educate their children at higher levels than the United States. Yet, children who are the least well-educated, from schools in economically poor areas, are the candidates to run U.S. plants. So, another area of concern is the U.S. education system.

The quality of a product, how well it works and how seldom it breaks down, is an important part of how well that product competes in world markets. When the assembly line first appeared, people agreed products were so cheaply made that quality didn't matter. After World War II, an American, Dr. Edward Deming, developed methodologies for improving the quality of products. The United States ignored his studies; so he sent them to Japan, where his procedures were quickly adopted. Soon afterward, Japanese products became more reliable than American products. The high quality of Japanese products made them extremely desirable.

A number of American companies are now moving toward quality procedures. Accomplishing this takes two requirements mentioned earlier: modern manufacturing facilities and well-educated workers. Dr. Deming's methodologies do work. Indications are that making high quality products actually saves money rather than loses it.

For the United States to remain on a competitive level with other countries, the Federal Government must implement more diverse research and development, because technology changes rapidly. The United States is currently on the same level as its competitors in terms of R&D expenditures. However, there is one significant difference between us and them. A large percentage of U.S. R&D is spent on military projects that do not readily convert into civilian R&D, unlike our competitors. As the Cold War winds down, the United States must be willing to transfer some military R&D spending to civilian areas.

In the European community, the action is in pre-competitive R&D, which works in such product areas as HDTV, but does not develop specific products to aid in promoting industry. The United States has accomplished something similar with Sematech and should do more.

Moving into emerging technologies requires money and manpower few individual companies possess. U.S. antitrust laws tend to inhibit companies getting together to do the job. These laws originated when all competitors resided in the United States. In a global economy, perhaps only

individual companies are competing. In order for the United States to compete, our antitrust laws need to be less stringent.

While this article reviews several issues related to U.S. competitiveness–cost of capital, education, quality control, R&D, and antitrust laws–all of them are important, and each has an impact on U.S. competitiveness. Efforts are under way in Congress, the Administration, state and local communities, and industry to resolve these problems. IEEE-USA's Committee on U.S. Competitiveness is keeping abreast of these efforts and supporting them where appropriate. We will keep our U.S. members informed of current activities, because member support will be crucial to helping accomplish our goals.

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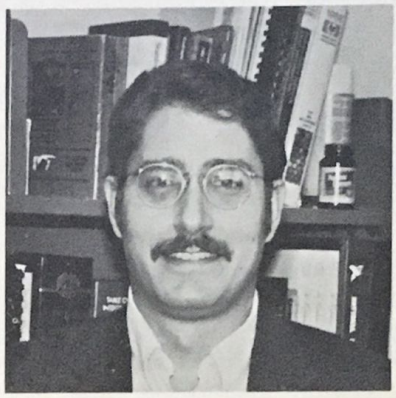
DR. ERNST SCHLOEMANN RECEIVES EXCELLENCE IN TECHNOLOGY AWARD

On June 12, 1990, Raytheon Company honored 18 engineers and scientists chosen among 27,000 for their technical achievements. The awards for "Excellence in Technology" are the highest distinction the company bestows for technical achievements. The current 18 award winners join the 16 other company scientists and engineers honored when the Excellence in Technology Awards were established in 1988. One of the recipients for 1990 was Dr. Ernst Schloemann, a consulting scientist with the Research Division.

Dr. Schloemann has been with Raytheon since 1955 after obtaining a Ph.D. in physics from the University of Gottigen, Germany, and post-doctoral work in solid state physics at MIT. The citation for the award reads:

"Thanks in large part to E. Schloemann, Raytheon can design, develop and manufacture any microwave ferrite device used in radar systems. His work has been fundamental to several of the company's most successful missile systems. His concepts were also used to help develop the giant Pave Paws radars on the East and West Coasts. Pave Paws can 'spot' an object the size of a basketball 1,200 miles away. Its primary function is to give early warning of a submarine-launched ballistic missile attack. His most recent findings on wideband circulators and circulator miniaturization are rapidly being incorporated into microwave circuits being developed at the Missile Systems and Equipment Divisions."

RON INDECK RECEIVES FACULTY DEVELOPMENT AWARD



Ronald S. Indeck

Ronald S. Indeck, Ph.D., was awarded an IBM Faculty Development Award, consisting of $30,000 per year for two years. This recently-received award is provided to only a few research professors in the world each year. In being presented with this award by Dr. Horacio Mendez of IBM on September 19, he was cited for his past technological achievements and promise for sustained research accomplishments, especially in the field of magnetic information systems.

Indeck joined the faculty of Washington University as an Assistant Professor of Electrical Engineering after a one-year National Science Foundation post-doctoral research fellowship in Japan. In 1989, he was awarded the National Science Foundation Presidential Young Investigator Award. Unique to this grant is a matching funds program whereby the National Science Foundation matches industrial gifts to support the investigator's research program on a dollar-for-dollar basis up to $37,500 per year for five years. Additionally, NSF provides $25,000 per year of up-front funds, bringing the five-year total funding level to $500,000.

Professor Indeck and senior faculty member Professor Marcel Muller have created a strong program in magnetics by complementing each other experimentally and theoretically. Their magnetics efforts can be broken into four principal projects:

1. Magnetic thin film transducers/coupled layer structures including Hall heads.
2. Computational analysis/modelling including massively parallel processing.
3. Multi-gap/multi-sensor heads, synthetic aperturing, track-edge following servo.

DISTINGUISHED LECTURER PROGRAM

The Magnetics Society is pleased to announce that Bernell Argyle has been named Distinguished Lecturer for 1990-91. The Distinguished Lecturer Program is intended to provide tutorial overviews of topical subjects in magnetics, to expose students to the excitement and challenges of magnetics, and to introduce developments in magnetics to the non-technical community. Local magnetics chapters, universities, and other educational, and business groups have an opportunity to hear outstanding members of the magnetics community. The cost will be borne by the Magnetics Society. Any interested group should contact the lecturer directly or the program chairman, Jack H. Judy, Department of Electrical Engineering, University of Minnesota, 200 Union Street SE, Minneapolis, MN 55455, (612) 625-7381.

OPTICAL IMAGING OF MAGENTIC DOMAINS AND IMPLICATIONS FOR MAGNETIC RECORDING

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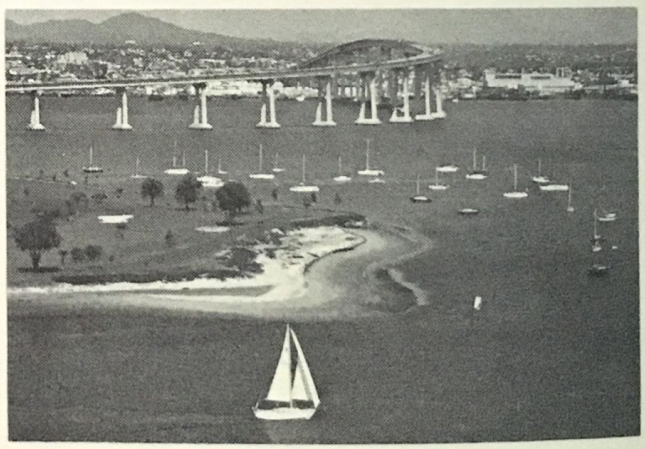
Observing magnetic domains and their motions has long been of natural physical interest to the curious. But today, these motions have important technological consequences via the physics of magnetic recording. After briefly introducing magneto-optic methods for imaging domains and domain walls, this talk will center on observations in soft magnetic film elements and in thin film recording heads from DC to 50 MHz. The compositions and dimensions of the elements studied are in the range of interest for recording devices. The results on magnetic domain behavior address device issues such as efficiency, stability, noise, and frequency response. Video animations and stills exemplifying domain physics and some technological implications will be presented.

Bernell Argyle received degrees in Engineering Physics from Lehigh University (B.S.'53), in Solid State Physics from Carnegie Mellon University (M.S.'59) and in Applied Quantum Physics from Yale (Ph.D.'71). His PhD thesis investigated crystal fields and magnetic exchange in rare earth garnets using magnetic light scattering. Since 1959, while at the IBM Research Division at Yorktown Heights, NY, his studies included: spin waves in transition metal crystals; magneto-optic, magneto-elastic, and magnetic-exchange effects in europium chalcogenides; and the dynamics of magnetic domains in garnet bubble films and permalloy thin film recording heads. In 1985 he constructed a Kerr-effect microscope capable of high-magnification imaging of domain dynamics in low Kerr contrast films. His group recently extended this capability to 5 nanosecond resolution. His research has lead to publications and patents in all of his major areas of interest.

1991 MMM CONFERENCE

The 1990 Magnetism and Magnetic Materials conference was held in San Diego from October 29 to November 1. The chairman's summary was not available at press time but the session summaries follow below. There was a very interesting evening session by Earl Callen on Magnetism Research in the Far East.



Session AA
Particulate Recording Media
M. P. Sharrock

The fifteen papers in the Particulate Recording Media session demonstrated the diversity and continuing vitality of this area. Six were concerned with acicular iron oxides, the type of particles most commonly used in recording tapes and in flexible disks.

Fukumoto et al discussed the effects of pretreatment with divalent IIA metal ions before cobalt addition; Ca, Sr, and Ba ions increased the resulting coercivity enhancement, but Mg was detrimental. A site-occupancy model consistent with the observations was proposed.

Tsuji et al described Mossbauer emission studies of cobalt-enhanced acicular oxides. Observed hyperfine fields were consistent with the model for IIA ion effects mentioned above.

Spada presented results indicating that the coercivity of acicular iron oxides can be markedly increased by treatment with sodium metaphosphate. The observations qualitatively confirmed the similar, and unexplained, results of Itoh et al in 1975 and 1977.

Parker et al contributed a study examining the issue of surface spin canting in oxides. In contrast with previous conclusions of Mirrish et al, they found the canting to be uniform throughout the particle volume.

Parker also discussed the spin behavior in cobalt-surface-modified oxides. A major conclusion was that the surface spins do not differ significantly in orientation from those in the interior of the particle.

Bottoni presented a study of cobalt-modified acicular oxides at various volume loadings. The mode of magnetic reversal was investigated by rotational hysteresis and by coercivity angular dependence. Interparticle magnetic interactions were investigated by remanence curves. The conclusion was that interactions tend to favor coherent reversal behavior.

Four papers dealt with barium ferrite, a relatively new material in recording applications.

Speliotis discussed evidence from remanence curves that thin-film media and particulate media containing oriented barium ferrite have interactions that are strong and positive (tending to stabilize magnetic saturation). Media containing acicular particles and nonoriented barium ferrite particles show interactions that are relatively weak and negative (destabilizing saturation).

Kodoma et al studied noise from rigid disks as a function of reverse DC erase. As a function of degree of erasure, the noise shows a dip for disks made with acicular particles and barium ferrite having a broad switching-field distribution (SFD) but a peak for barium ferrite of narrow SFD.

Tsutsumi et al presented model studies for the read/write behavior of barium ferrite media, as compared with other particulate materials. The importance of the distributions of switching field and anisotropy field was stressed.

Agresti et al were authors of a paper describing Mossbauer absorption studies of Co/Ti-substituted barium ferrite prepared by a melt/quench method. Five types of iron sites were used to fit the spectra.

Three papers dealt with the properties of metallic particles. Jung and Raghaven and Mathur discussed the use of flow microcalorimetry to characterize the interactions of metallic particles with the solvents, dispersants, and binders used in media manufacture.

Hsu, Kuo, and Lin described iron/cobalt alloy particles. The dependence of magnetic properties on cobalt content and on preparation procedures was discussed.

Kanai and Charap described iron-silica granular films made by sputtering. Although the iron granules are very small, about 5 nm, the resulting films were found to show relatively stable magnetization and high coercivity.

Two papers had a primarily theoretical emphasis. Schabes described a micromagnetic model of reversal in passivated metallic particles; an outer shell of iron oxide having different properties from those of the core was used to represent the passivation layer.

Vajda et al presented a theoretical study, with comparison to experimental results, of a vector moving Preisach model of particle magnetization. The model is able to describe the behavior of particulate materials subjected to fields at various angles and also to rotating fields.

Session AQ
Magnetoresistance and Hall Effect
Alison Chaiken

Posters in Session AQ emphasized that transport measurements in magnetic alloys, wires, and superlattices can give useful information about magnetic ordering, as well as being interesting in their own right. J. J. Vuillemin of the University of Arizona used resistivity measurements to study spin fluctuations in Pd. Also using p(T) measurements were Arthur Chin of Southern Illinois University, who observed magnetic order in thin rare earth wires, and P. Smit of Rand Afrikaans University, who looked at magnetic scattering in CrMoSi alloys. Roger Hajjar of the University of Arizona explained how resistivity hysteresis loops give information on the magnetic properties of magneto-optic recording media. A poster by researchers from the Naval Surface Weapons Center explained how the magnetoresistance of magnetostrictive Metglas may be exploited for strain-sensor applications. Jim Allen of Bellcore explained how MnAl films grown on III-V semiconductors could be useful for device applications. In a theoretical presentation, Luc Berger of Carnegie Mellon predicted that domain wall precession under the influence of an rf field may produce a frequency-dependent voltage across the domain walls similar to the Shapiro steps seen across Josephson junctions.

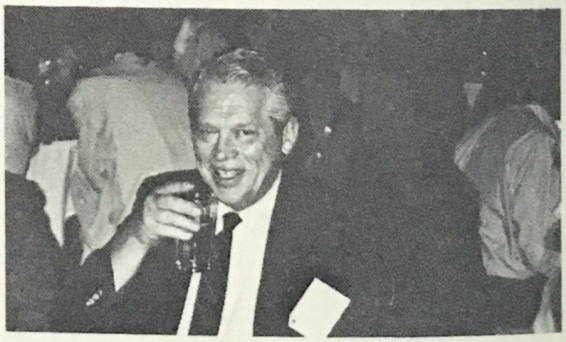
Session BB
Magneto-Optic Recording Materials
Charles Brucker

New material processing techniques, new materials, and new combinations of materials for improved magneto-optic recording performance were the central themes of Session BB, the second session on magneto-optic materials at this year's MMM conference. Rapid Thermal Annealing (RTA) techniques were described which show promise for resolving some nagging problems with thin film garnets for disk storage applications, namely grain-induced noise and high recrystallization temperature. T. Suzuki ((BM Almaden, USA) reported substantial reductions in granularity and surface roughness for BiDyiG films using RTA ramp-up rates of 50-100°C/s in a nitrogen atmosphere. B. Bechevet el al (LETI/MEM, Grenoble, France) succeeded in crystallizing amorphous CeDyiG films on glass substrates by RTA, and showed that grain structure and magnetic properties can be controllably adjusted over a wide range as a function of RTA and sputtering process parameters.

Amorphous U-Sb alloys of approximate composition U_3Sb_4 were described by R. Gambino et al (IBM Yorktown, USA) as having the highest Faraday rotation of any amorphous ferromagnetic material ($2x10^6$ deg/cm) and an exceptionally large Kerr rotation as well (∞3 degrees). These properties are unexpected given such a high U content, since U atoms must be isolated from each other in order to develop a magnetic moment. The surprising lack of 5f magnetic moment delocalization was attributed to the development of a chemical short range order favoring sb nearest neighbors for U. The Hall angle from the spontaneous Hall effect is also very large in these materials (~17 degrees), and a linear relationship between Kerr rotation and Hall angle was observed. A major hurdle yet to be overcome is the low Curie temperature of ∞135°K.

Novel double and triple layered media structures for short wavelength recording were described. Having found it difficult to write stable domains in Co/Pt multilayered films below 0.5 μm diameter due to low coercivity and low anisotropy field, R. Suzuki et al (Hitachi, Japan) took advantage of exchange coupling in a (Co/Pt)/(TbFeCo) double layer to boost the coercivity to ∞ 4 KOe. Small 0.3 μm domains could then be clearly written with a figure of merit $\sqrt{R8_k}$ twice that of conventional TbFeCo and approaching that of Co/Pt in the short wavelength region 400-500 nm. In another approach, S. Takayama et al (IBM, Japan) sandwiched a NdCo in-plane layer with strong Kerr response between two TbFeCo strongly perpendicular layers, exchange coupled at each interface. A figure of merit $\sqrt{R8_k}$ comparable to that of Co/Pt was measured in the wavelength region 400-630 nm.

K. Hayashi et al (NEC, Japan) found that the sputtering conditions used to form the SiN underlayers for a TbFeCo/NdFeCo/GdTbFeCo direct overwrite scheme had a significant effect on the microstructure and resulting CNR of the TbFeCo memory layer. It was found that low Ar sputtering pressure resulted in a structureless film free of any detectable microcrystallinity and with the highest CNR. N. Horiai et al (Hamaha, Japan) extended their previous work on the corrosion stability of Be-Cr doped TbFeCo disks to include BER recording characteristics. For doping levels of 12 at% Be and 2 at % Cr, the highest levels at which there is no significant degradation of CNR, they found minimal BER increase after exposure to 90% pH at 80°C for 2000 hours. P. Gerard et al (LETI/MEM, Grenoble France) examined the dependence of BaM hexaferrite texture on substrate (SiO_2, Zn0, $Gd_3Ga_5O_{12}$, and Al_2O_3) and thermal processing. A rich variety of transition layer compounds were observed on some substrates and none at all on others. In most cases the resulting BaM was strongly c-axis oriented, although in one case (Al_2O_3) there was no preferred orientation.



Session CA
Magneto-Optic Recording
C.-J. Frank Lin

Twelve papers were presented and discussed in this session. Dr. W. B. Zepper from Philips gave a very good invited paper on "Co/Pt and Co/Pd (to a lesser extent) Multilayers as New Magento-optical Recording Media." He reported the properties of Co/Pt multilayers in relation to the preparation techniques, and discussed how they optimized the Co/Pt layers for magneto-optical storage application. A CNR as high as 55 dB (1 MHz carrier at 5 m/s) was reported for Co/Pt multilayer media. C. D. Wright from the University of Manchester reported their studies of field-modulation direct overwrite performed in-situ with a magneto-optical scanning laser microscope. Dr. Craig Perlov from Hewlett-Packard discussed his modeling work of the direct overwriting behavior in exchange-coupled trilayer films using the cell model. He was able to obtain many key features of such direct overwrite process. Mark Shultz from Carnegie Mellon reported that, through the use of a high speed (10 ns time resolution) observation system, they were able to carry out dynamic thermal profiling in MO films during thermomagnetic recording, for both heating and cooling. Using a similar setup, i.e., a time-resolved microscope equipped with 5 ns observation pulse, Dr. David Shieh from IBM discussed his results of dynamics study of domain growth and contraction in GdTbFeCo films as functions of writing laser power, pulse length and bias field.

Dr. Terry McDaniel from IBM reported their experimental and computer simulation studies of the stability of themomagnetically written domains during magneto-optical readout. They measured and discussed the change in signal amplitude and domain size jitter as function of laser read-out power, number of read cycles and bias field. He also discussed adjacent track crosstalk issues, comparing modeling results with the measurements on various substrate materials to address the influence of substrate material. Mike Madison from IBM reported their experimental and modeling studies on peak shift in magneto-optical recording. Nelson Cheng from Carnegie Mellon reported the dependence of single-layer direct overwrite characteristics on the magnetization of DC-magnetron sputtered RE-TM films with various compensation and Curie temperatures.

Recording noise resulting from jagged domain boundary is an important issue. Bruce Bernacki from the University of Arizona, discussed how they consistently "measured" the degree of domain boundary jaggedness using the fractal dimension, and as examples, showed a "smooth" domain with a fraction dimension of 1.07 and a "rough" one with a fractal dimension of 1.27. The fractal dimension of a domain boundary was shown to depend on the composition, deposition conditions and the measurement temperature. Dr. Tukaram Hatwar from Eastman Kodak reported their high sensitivity, high performance and high corrosion resistance magneto-optical disks achieved through addition of 5 at.% Zr in TbFeCo.

In the final paper, Dr. Dan Dahlberg discussed how the extraordinary Hall effect can be used to measure the magnetization component perpendicular to the plane of magnetic thin films, enabling them to monitor the magnetization process in RE-TM films.

Session CB
Strongly Fluctuating Spin Systems
Stuart Trugman

The session consisted for four invited talks. CB-01, "A Strongly Fluctuating Quasi-Two Dimensional Magnetic Insulator," by C. Broholm and G. Aeppli, was given by Broholm. Broholm and Aeppli used neutron scattering to study a system with unusually strong quantum spin fluctuations. The system studied contains Cr^{3+} ions, which form a 2-dimensional lattice of spin 3/2 sites with Heisenberg antiferromagnetic coupling to nearest neighbors on a Kagome lattice.

A 2-d Heisenberg antiferromagnet on a triangular lattice would be a good candidate system for observing strong quantum fluctuations, because antiferromagnets fluctuate intrinsically, and because the system is frustrated. However, the classical ($S = \infty$) version of this model orders at zero temperature, forming a state with 3 sublattices. The Kagome lattice studied is the same as the triangular lattice, but with 1/3 of the sites removed. The removed sites prevent the order from being propagated uniquely, so that the classical system is disordered, with nonzero entropy even at zero temperature.

Broholm and Aeppli found only a short magnetic correlation length at the lowest temperatures, equal to about a second nearest-neighbor distance. They found hints of long range correlations in an order parameter not directly observable by neutron scattering, and presented results on dynamical correlations as well.

The second talk, CB-02, "Quantum Spin Nematics" by P. Chandra, presented a theory that naively seems to describe the above measurements by Broholm and Aeppli. The state that Chandra et al propose is a quantum helimagnet in which the sense of twist is global, but fluctuations in the pitch destroy long range spin correlations. The twist is like a "broken slinky." This system does not have long range order in any spin two-point function, but does have long range order in a four-point function. Chandra concludes, however, that the experiments in CB-01 cannot be explained by the simplest version of her theory. A correct explanation may involve vortex configurations or a double twist ("quantum blue fog").

The third talk was CB-03, "Exotic Magnetic States in Heisenberg Antiferromagnetism" by F. D. M. Haldane. This talk described the physics of spin-1 Heisenberg antiferromagnets in 1 spatial dimension. Dimension d=1 results in stronger fluctuations than higher dimensions. The spin system studied is quite different from spin-1/2, because even and odd half integer systems have strikingly different properties in 1d. Haldane emphasized the importance of writing down wave functions for the spin states, which take the form of polynomials, so as not to exclude certain possibilities as do less general notations.

The Hamiltonians study included nearest neighbor Heisenberg antiferromagnetic coupling, biquadratic interactions of the form $(\vec{s}_n.\vec{s}_{n+1})^2$, and Ising anisotropy of the form $(s^z_n)^2$. There are exact results for this problem at a number of special couplings, both from Bethe ansatz and from AKLT solutions. Haldane concludes that all of the exact solutions are at special, nongeneric points. He gave a rather complete phase diagram that includes both special and generic values of coupling constants.

The final talk was CB-04, "Marginal Fermi Liquids: A Phenomenology for High T_c Superconductors," by P. Littlewood. Littlewood reviewed the phenomenological theory for the normal state properties, which postulates a simple form for the susceptibility $X''(q,w)$. Several attempts to derive the functional form from microscopic diagrammatics have failed, and work in this direction continues.

The theory correctly describes a number of measured normal state properties at large doping (but not at small doping close to the Mott transition). The only failure noted by Littlewood is the temperature dependent Hall resistivity. Littlewood discussed recent Stanford angle resolved photoemission measurements in the superconducting state. These measurements in the ΓM direction (but not the ΓX direction) have nonmonotonic features that resemble marginal Fermi liquid results for the superconducting phase.

Session CO

New Instrumentation and Measurement Techniques

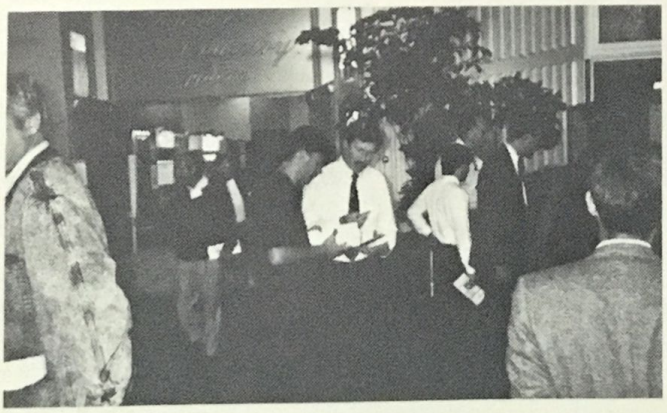
Mick Pechan

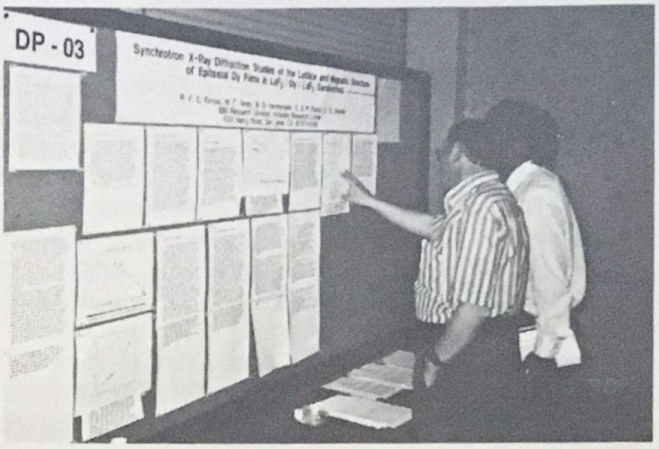
This exciting session featured a variety of new techniques and significant variations on existing technologies. A high sensitivity magnetoresistive magnetometer was on display and drew a large crowd. Based upon a thin film Permalloy sensor fed by thick film multilayer concentrators, the 10^{-5} Oe resolution of this $10mm^2$ sensor was dramatically demonstrated as the rotation of a small permanent magnet was detected from a distance of more than 10 meters. A torque magnetometer implementing a low compliance commercial force transducer was presented. Its main features are high dynamic range (0.01-500 dyne-cm), low cost, adaptability to low temperature and ease of automation. Errors introduced into SQUID measurements by various sample holder geometries were systematically quantified, the results of which should be noteworthy to those pressing the detection limits of their instruments. Simultaneous and separate determination of Kerr rotation and ellipticity in optical recording media has been achieved (without polarization modulation) by rotation of the detector about the axis of the reflected beam. Applying technology from fiber optical gyroscopes, a novel Kerr rotation interferometer was discussed which isolates non-reciprocal phase shifts and has better than 1μrad sensitivity. An ingenious two-axis attitude detector based upon that found in the human ear was presented. Induction coils, wrapped on tri-directionally coupled tubes containing magnetic fluid, change the frequency in Colpitts oscillators as the tubes are tilted by as little as 0.2 sec of arc. An automated, monolithic device measuring, with 10 μm resolution, local magnetic fields, magnetic losses and Kerr rotation has been developed for analyzing magnetic circuits and other soft magnetic materials. A constant rate of change of magnetization hysteresis loop tracer was described which determines directly the activation volume involved in the process of irreversible magnetization. The feedback controlling the field

scan rate is done entirely in software. Automated analysis of bulk ferromagnetic samples according to a Preisach type model was presented. The B-H loop is determined by a novel "rotating field" technique using GPIB control and acquisition. Video images of recording head gap fields have been obtained using a scanning electron microscope as the probe and a high speed photocon plate as the processor.

Session DC
Anisotropy and Magnetic Moments in Ultrathin Films
J. J. Krebs

An invited talk by A. J. Freeman discussed the magnetic anisotropy in ultrathin films of Fe and Co. The calculation used FLAPW basis wavefunctions along with spin-orbit via a variational procedure. Both Fe and Co free monolayers (MLs) should have in-plane anisotropy at the Ag or Au(001) lattice constants but perpendicular anisotropy for Fe MLs on Ag, Au or Pd(001) or for Co on Cu or Pd(001). The Simon Fraser University group reported FMR and BLS measurements on fcc Fe/Cu(001) and fcc Co/Cu(001). Three MLs of Fe show a perpendicular anisotropy while Co shows a strong in-plane preference. D. P. Pappas et al, using spin polarized secondary electron emission, made a detailed study of the temperature dependence of the perpendicular anisotropy in Fe/cu(001) while Sun and O'Handley used the same technique to support the possible existence of enhanced magnetostriction at the surface of $Co_{76}Cr_4B_{10}$ amorphous ribbons. U. Gradman showed that his measured surface anisotropy for Fe(110)/W(110) agrees with Neel's estimate in sign and order of magnitude. H. Hurdequint discussed evidence for the existence of a dynamic coupling between Fe layers in Fe/Ag(001) superlattices. The conditions need to observe a quasilinear temperature dependence of the magnetization at the surface of a ferromagnet was discussed by G. T. Rado which A. S. Arrott showed how to make "magnetostatics-free" calculations of micromagnetics in ultrathin films.





Session DD
Spin Glasses and Random Fields
D. H. Ryan

Reports of theoretical and experimental progress in spin glasses were presented at this session. The theoretical work was primarily Monte Carlo simulations of Ising models intended to distinguish between two current models of the spin glass ground state by examining the distribution of order parameter q and the spin glass susceptibility. Results seem, so far, to favor a mean-field form over the droplet model. Simulation work on the frustrated Heisenberg model showed that many of the details of experimental systems can be recovered with the minimum assumption of small concentrations of random exchange bonds, and confirmed that transverse spin freezing is the correct description of the lower ordering event, often mis-named "re-entrant."

The experimental papers covered a wider variety of topics, including studies of barrier height distributions in AgMn through the decay of the remanent magnetization, and a comparison of waiting time effects in 2-d and 3-d spin glasses which showed a stronger temperature dependence in the 2-d case indicating quite different dynamical behavior. Another report on Cu:CuMn multilayers demonstrated the predicted crossover from Ising-like to Heisenberg behavior in increasing magnetic fields. Work on diluted antiferromagnets is an external field which approximate a random field system obtained the expected scaling: $\Delta T_c(H) \sim H^{2/\phi}$, with $\phi = 1.42$ for a wide range of random field strengths. $Y_2Mn_2O_7$ was shown to be a spin glass, rather than a ferromagnet as previously though, as a result of the Mn ions being on a lattice of tetrahedra. A similar structure for $Gd_3Ga_5O_{12}$ leads to what was called the most frustrated material known, with a ratio of at least 50 between its Weiss constant and ordering temperature.

Session DR
Soft Materials
C. Piotrowski

Valanju, Cho, and Walser presented a paper on layered CoZr thin films. They found that by building up the film from thin (5-10*) layers the films remained amorphous for Zr content as high as 50%. In addition, coercivity remained approximately constant at 2-3 Oe for Zr contents varying from 10-50%. By subjecting the samples to rotating field annealing, they were able to keep the permeability flat out to 200 MHz.

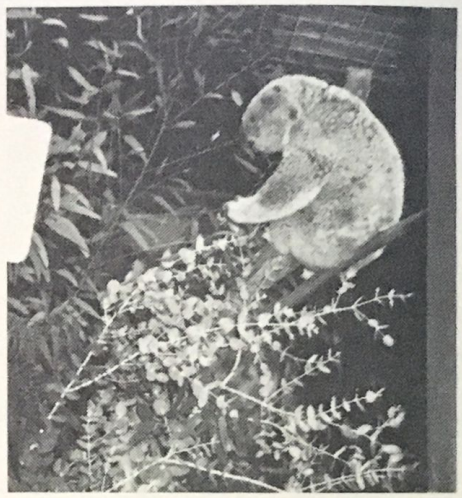
Piotrowski, Yagi, and Sawa reported on the frequency dependence of the coercivity of ultrathin Co-based amorphous ribbons. Measurement of the AC coercivity from 20 Hz to 20 kHz showed that ribbons of thickness 5.3 to 18 microns all exhibited a similar dependence of coercivity on a power of the measurement frequency. The exponent varied with ribbon thickness.

Gangopadhyay and Hadjipanayis presented results on transitions in amorphous $Fe_{44}R_{12}B_{44}$ ribbons (R=Nd, Y, Pr, and Gd). They observed decreases in magnetization from 66 to 18 emu/gm as R went from Nd to Gd, consistent with ferromagnetic coupling of R to Fe in the light-rare-earths and antiferromagnetic coupling in the heavy rare earths. They also observed temperature dependent peaks in the AC susceptibility, with the peak shape and characteristic temperature varying with R.

Dooling and Cook presented two papers in which the Mossbauer Effect was used to study the properties of zinc-nickel ferrite. In one paper, they calculated the expected magnetic field distribution at the octahedral site as a function of the number of zinc neighbors. They compared this calculated distribution with that determined by fitting the Mossbauer spectrum, and concluded that the agreement is good enough to allow them to isolate the magnetic field contributions due to most of the different numbers of neighboring zinc atoms. In a second paper, they report on phase changes in this same ferrite prepared by a plasma spraying process. They observed a separation of the plasma sprayed material into two phases. They found that annealing up to 650 C restored the magnetic and crystalline properties to values close to those measured in the unsprayed ferrite.

Lupi and Nunes reported on the design of a 25-50 kHz power matching transformer for induction heating applications which employed a Co-based amorphous alloy as core material. They concluded that the reduction in losses makes the use of amorphous alloy in this application economical.

Ninomiya et al reported on their work on 6.5% Si sheet steel. They observed significantly lower noise and core loss in transformers made from this material compared to those made from conventional 3% Si steel. They conclude that it should be possible to operate these transformers at higher flux densities and reduce transformer size.



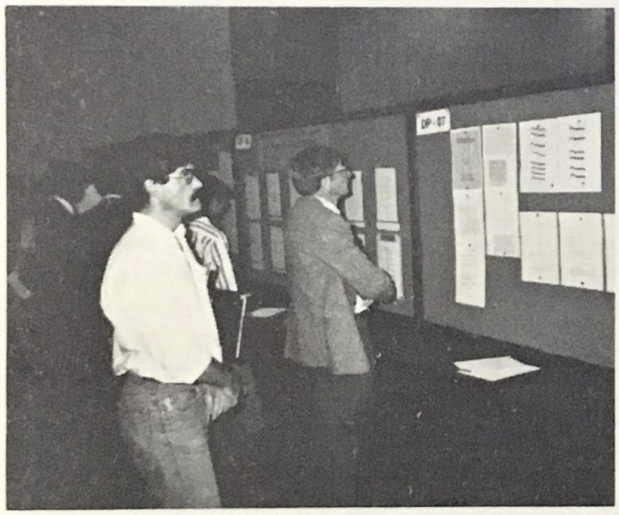
Session EA
High T_c and Magnetism II
Joe D. Thompson

The session opened with an invited talk by Mook (Oak Ridge) who has found from neutron scattering that the spin-spin correlation length in $La_{1.95}Ba_{.05}CuO_4$ is essentially temperature independent below 300 K, in contrast to the correlation length of the parent compound La_2CuO_4 which grows with decreasing temperature. Mook also reported small-angle neutron diffraction studies of the flux line lattice in $Ba_{1-x}K_xBiO_3$ and $La_{1.85}Sr_{0.15}CuO_4$ superconducting crystals. The flux lattice is crystalline, with no evidence for lattice melting or entanglement from this preliminary work. Kebede (Temple University) concluded from magnetic susceptibility and specific heat studies on $PrBa_2Cu_3O_y$ (y = 6 and 7) that Pr is tetravalent and that Pr orders at 17 and 10.2 K for y = 7 and 6, respectively. Possible roles of crystal field splitting much greater than 300 K were not considered. On the other hand, Boekema (San Jose State) believes, on the basis of μSR measurements, that Cu spins in the Cu-chain sites order at 17 K for y = 7. Clearly, further work is required to resolve the intriguing puzzle presented by $PrBa_2Cu_3O_y$.

Mossbauer spectroscopy on polycrystalline GdBa $(Cu_{1-x}Fe_x)_3O_y$ reported by Tang (Johns Hopkins) indicated that Fe^{3+} goes preferentially into the Cu-chain sites and tends to cluster. He suggested that Fe^{3+} globally depresses T_c and also produces locally normal regions about the Fe^{3+} ion in which short-range spin correlations among Cu ions exist. A somewhat different interpretation of Fe substitution in a single crystal of:

$YBa_2Cu_{2.85}Fe_{0.15}O_7$ was presented by McGuire (IBM, Yorktown). His analysis of neutron diffraction and magnetization measurements indicated that Fe^{2+} assumes exclusively Cu-chain sites. Critical current densities J_c inferred from a Beam-model analysis of magnetization measurements on this crystal, are anisotropic and depressed relative to an undoped crystal, even though the doped crystal structure is tetragonal, i.e., no twin boundaries.

The session closed with Dierker (University of Michigan), who determined the pressure dependence of the in-plane exchange J in La_2CuO_4 from two-magnon Raman scattering. Although J increased with pressures to 100kbar as expected, the rate of increase was less than theoretically predicted. These results raise doubts about our understanding of the exchange mechanism in La_2CuO_4.



Session EC
Nonlinear Dynamics and Self-Organized Criticality in Magnetic Materials
P. E. Wigen

Nonlinear studies in physics and materials science has long been an intriguing and important topic in a variety of materials and systems and magnetism has often contributed substantially to the progress in this field. In recent years, two new fields of nonlinear studies have evolved, Route to Chaos (RTC) and Self-Organized Criticality (SOC). This symposium reviews the role that magnetism is able to play in experimental tests of these new areas.

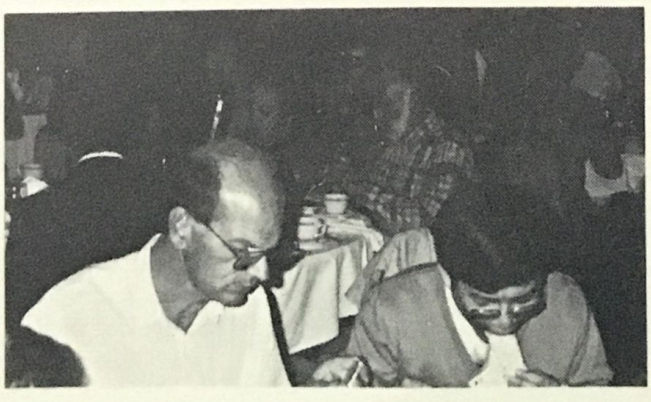
Magnetism has unique potential in the investigations of RTC because the Hamiltonian is well characterized and the coupled equations of motion can be evaluated from the fundamental parameters. A number of very pretty and useful investigations have involved bulk magnetic materials in which the driven modes are degenerate with a large number of spinwave modes. In order to model the system it is necessary to severely truncate the system to just a few of the coupled modes. As a result the response of the models is only approximated by the experiments. In the paper, "Organizing Centers of Bifurcation in Spin-Wave Instabilities," Prof. Rezende reviewed his extensive investigations and evaluates the dependence of the various models and the experiment on the material and geometrical parameters of the sample. His conclusion is that the details of the model interactions for a small number of modes does not adequately describe all of the observed features of the experiments. In the paper, "Parametric Excitation on Magnetostatic Modes in Thin YIG Films," Dr. McMichael indicated that in the perpendicular resonance orientation, the driven modes lie at the bottom of the spinwave band and the only modes that are important in this geometry are the nondegenerate modes associated with the magnetostatic spectrum. Being nondegenerate, the truncation to a few modes (4 to 6) is not a severe limitation of the system and the agreement reported between the model and the experiment agree to within 15% for both the auto-oscillation frequency and the onset power, proving to be one of the best systems for investigating these nonlinear effects.

In the SOC portion of the program, Dr. Greinstein's "Algebraic Correlations in Noisy Nonequilibrium Systems," reviewed development of the field and indicated that the information obtained from the time dependence of the avalanche motion of a system in a metastable state will have a power dependence in time with critical exponents. In the paper "Avalanche and Self-Organization in Cellular Magnetic Domain Patterns," Prof. Westervelt reviewed his results on the investigations of spatially-extended metastable domains observed in a "magnetic bubble" garnet film. By increasing the bias field in small steps, an avalanche in the structure of the disordered cellular froth is observed and the changes in the number, the size and the geometry of the domains is recorded. The measured distribution of the avalanche size and duration are then fit to a power law consistent with the predictions of SOC. In "Self-Organized Criticality in Magnetic Doman Formation," Prof. Suhl analyzed data available from the application of destabilization forces on recording tape media. Again the cascading of the system from one unstable state to another with the change in the bias field, the time dependence of the response is observed to decay with a power law that has a critical exponent. It is pointed out that the observations of the avalanche behavior of the SOC state in magnetic storage materials can be a valuable assistance in their characterization as it related to the time dependence and the stability of data points stored in the media.

Session ED
Amorphous Materials
R. Hasegawa

Studies of magnetic anisotropy and its related magnetic properties in several amorphous metallic systems were reported (ED-01 through 06). For rare-earth transition metal systems useful as magneto-optic recording media, anelastic bond-orientational anisotropy (ED-01 and 03) and surface-mediated amorphous phase texturing (ED-02) were proposed as the possible origin of anisotropy. During the period where authors were absent, a lively discussion on this subject was made with no consensus. Use of EXAFS, magnetization and FMR measurements on Co-base thin films (ED-06) is a kind of approach which should shed some light on the local structure-magnetism relationship. More work along similar lines should be done.

Two theoretical studies (ED-09 and 10) were on the magnetic moments, which appeared to require further refinements. For example, an average magnetic moment for Fe in amorphous matrix was obtained to be 2.46 μ_B, which is too high (ED-09). Studies of unconventional oxides would be helpful to search for new amorphous magnetic oxides. Magnetic properties of volcanic glasses (ED-12) and sputtered $BiFeO_3$-$PbZrO_3$ films (ED-13) were reported. Papers ED-07, 08 and 11 were not presented.



Session EQ
Hard Magnets II
R. T. Obermyer and S. G. Sankar

The first three papers (EQ-02 to 04) described the magnetization measurements at 4.2 K of RCo_{5+x}, Ho_2Co_{17} and $Gd_2Fe_{14}B$ intermetallics in external pulse fields up to ~57 Tesla. Several magnetic parameters were derived from these measurements. In this collaborative effort by the groups from the Netherlands and Osaka University, the authors have made excellent contributions towards improving our understanding on the fundamental properties of these rare earth intermetallics. Paper EQ-05 (del Moral et al) describes the spin reorientation transition in $(Er_xNd_{1-x})_2Fe_{14}B$ observed by small angle neutron scattering experiments down to very small q-momentum transfers ($\sim 0.0037\ A^{-1}$). Critical behavior of the spin reorientations in this series of intermetallics is clearly manifested from the divergences of the obtained spin correlation lengths. Lin et al (EQ-08) reported on the neutron diffraction studies on $YFe_{10-x}Co_xMo_2$ and concluded that molybdenum atoms exhibit a strong preference to occupy the 8i sites while the cobalt atoms prefer to occupy the 8f and 8j sites. The phenomenon of spin reorientation in $Nd_{1-x}Pr_x)_2Co_{14}B$, $(Er_{1-x}Tb_x)_2Fe_{14}B$ and $Nd_2Fe_{14}B$ were investigated by Sun et al, by Obermyer and Pourarian and by Foldeaki et al, respectively (EQ-06, 12 and 14).

Uma Devi and Gupta (EQ-11) reported the structural and magnetic properties of U and N phases in the MM-Co-Fe-Zr-Cu compositions. Four papers dealt with the magnetic properties of several intermetallics: RCo_4M (by Ido et al, EQ-07), $R_4Fe_1$and $R_4Fe_1H_x$ (by Bozukov and Apostolov, EQ-15), $Sm_2Fe_{17}C_x$ by Wang and Hadjipanayis, EQ-18) and $Y_2Fe_{14}B_{0.5}C_{0.5}$ (by Zhao Zhi-Gang et al, EQ-21).

Liu et al (EQ-10) described their magnetic viscosity studies on $Nd_{16}Fe_{77}B_7$ magnets and showed that a comparison between the weak pinning, strong pinning and nucleation models indicated that their results supported the localized weak pinning model. Rabenberg et al (EQ-19) reported on the results of Sm_2Co_{17} employing the Extended X-ray Absorption Fine Structure spectroscopy and determined the positions of the Zr atoms. Some preliminary results on the preferential occupancy of the Zr atoms in the 2:17 structure was reported by these authors. Magnetic and structural properties of $(Gd_{1-x}R_x)Si_4$, R being Y or La were reported by Elbicki et al (EQ-20); the change in magnetization near the Curie temperature was unusually sharp for some of these compositions.

Session FC
Multilayers of Cobalt with
Pt/Pd and Film Growth
Robin Farrow

The origin and control of magnetic anisotropy in ultrathin films of Co contained in Co/Pt and Pd multilayers is a very active topic at present because of the potential applications of such multilayers in optical storage media and the challenge of understanding the dependence of magnetic properties on the deposition conditions for the structures.

Session FC-03 reflected this activity with 9 papers on Co-based multilayers. Perpendicular anisotropy, which was demonstrated for evaporated multilayers as early as 1986 by P. Carcia and coworkers at duPont, has also now been confirmed for sputtered (CA-
01) and MBE grown structures. The first 3 papers in the session emphasized the magnetic and structural properties of epitaxial Co/Pd and Co/Pt structures grown under UHV conditions. Purcell and coworkers (Philips Research Laboratories) studied ferromagnetic resonance (FMR) in epitaxial Co/Pd bilayers with the growth axis aligned along Pd[III]. FMR spectra were obtained for the thickness range of Co ($\lesssim$20Å) in which the remanent magnetization was perpendicular to the interfaces. An interface anisotropy constant of $0.80\pm0.05 mi/m^2$ was determined and found to be only weakly dependent on temperature from 4.2K to room temperature. This result was in agreement with the data presented by Engel and coworkers (University of Arizona) who prepared Co/Pt multilayers with the same orientation but on a Pd film grown onto a GaAs substrate. The coercivity was found to increase as the Co thickness decreased, reaching 6.4KOc and 3Å Co. Farrow and coworkers (IBM Almaden and Stanford University, Materials Science Department) showed that in the case of Co/Pt the magnetic anisotropy was controlled by the crystalline axis of the multilayers, other parameters remaining constant. In situ studies by X-ray photoelectron forward scattering showed that the Co/Pt interfaces were not abrupt. This result suggests that the perpendicular anisotropy is magnetocrystalline in origin perhaps arising from a combination of defects, strain and local ordering in the interfacial alloy. The same may be true of the Co/Pd system which is also miscible and which den Broeder and coworkers at Philips Research Laboratores had shown in 1989 to have an orientation dependence of anisotropy.

Two other papers in the session, FC-05 and 06, dealt with the polarization of Pd and Pt in the multilayers. A significant polarization of Pd and Pt is expected theoretically and confirmed experimentally. In addition, Victoria et al (Eastman Kodak) suggested a significant enhancement of the spin on Co can result as a consequence of structural distortion of the Co environment in the multilayers.

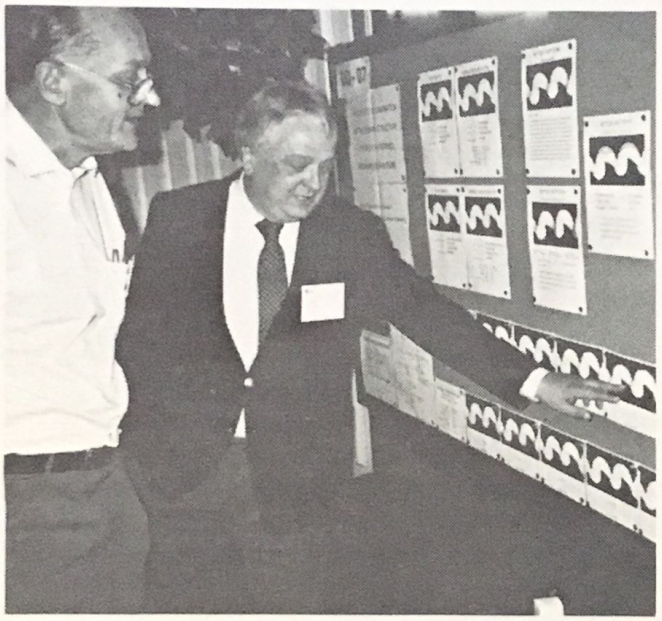
Session FP
Head Disk Interface
David N. Lambeth

This poster session showed the continuing, and necessary, developments required of new materials and processes to improve the head disk interface. Four of these papers are highlighted here.

The work by B. Marchon et al on a large variety of a-carbon films compared tribological wear, abrasive wear, and electrical resistivity to Raman Spectra. Films showing the more diamond-like sp3 bonding correlated well with lower wear rates and higher resistivity. M. S. Miller et al extended the recent overcoat work on yttria-stabilized zirconia to yttria-stabilized hafnia by performing frictional wear studies on non-lubricated films prepared by RF sputtering under various bias potentials and oxygen partial pressures. CSS curves indicated similar behavior for zirconia and hafnia and that both performed better when an oxygen deficient stoichiometry was maintained. Hafnia films showed slightly greater micro-cracking during the testing.

Two new non-mechanical surface texturing methods were introduced. Both methods demonstrated very well controlled roughness values and low friction build-up. The first paper, by N. Tsuya et al described an A1 substrate anodization, etching, plating and polishing process to produce a uniform texture of 20 nm. Substrates could then be coated in a conventional thin film sputtering process without the traditional electroless Ni-P layer. Roughness is controlled by the difference in the wear rate of the substrate materials as they are polished as opposed to being controlled by the size and pressure applied to a texturing grit. The other paper, by R. Ranjan et al, described a debris free

process of using a pulsed laser to produce small craters by melting and flowing the electroless NiP layer on the A1 substrate. By controlling the spot size, pulse duration, and laser power roughness could be varied. The laser texture was proposed to be used only for the landing zone so that extremely close flying heights could be maintained over the rest of the disk surface.



Session GQ
Magnetochemistry and Biomagnetism
Gary C. DeFotis

Harrison, Stager and Visser presented a poster on the properties of ND_4FeBr_3, a new member of the $AFeX_3$ family of one-dimensional induced moment magnets, although the present system is not very one-dimensional magnetically. Structural phase transitions with reduction of symmetry are seen near 200 K, and long-range magnetic order, despite the singlet ground state, develops at about 5K. Visser and coworkers presented two other posters. One dealt with the behavior of $KMnPo_4 \cdot H_20$, which susceptibility data suggest is magnetically two-dimensional. An antiferromagnetic transition, with the development of a weak ferromagnetic moment, occurs near 18 K; the degree of spin canting could not be determined from powder neutron diffraction data. The other poster dealt with $Rb_2CrCl_2I_2$, which analysis of susceptibility data suggests is a two-dimensional XY ferromagnet, a rarely realized magnetic model class. The material orders at 56.9 K, with intralayer J/k = 5.8 K, and with interlayer and intralayer anisotropy fields of 4.5 T and 0.16 T, respectively.

DeFotis and coworkers presented two posters. One dealt with $Fe[S_2CNC_4H_8]_2I$, the first pentacoordinate Fe(III) system of this type with a cyclic terminal group to be examined in detail. The unusual intermediate spin value S = 3/2 occurs, and a substantial zero-field splitting, with D/k = 9.3 K, of the quartet ground term was inferred from analysis of susceptibility data. An antiferromagnetic transition occurs at 2.21 K, and the helium range susceptibility is fit by a two-dimensional XY model. The other poster dealt with $Ni(SCN)_2(C_2H_5OH)_2$, the first Ni(II) system in this family of compounds to be examined in detail, and the first to exhibit predominant ferromagnetism. Susceptibility data are analyzed to infer exceptionally large zero-field splitting parameters, which lead to a quite unusual situation where the three spin states of the S = 1 ground term are well separated. Yet the exchange interaction inferred from the analysis is not weak enough to be subcritical, and a ferromagnetic transition occurs at 13.08 K.

Hatfield and colleagues presented two posters. One showed results on some lanthanide bis (phthalocyaninato) sandwich compounds, susceptibility data for which often indicate significant antiferromagnetic exchange between metal ion f-electrons and the phthalocyaninato radical electron. EPR spectra support this by showing no signal corresponding to independent free radicals. One of the systems, involving Yb(III), is the first example of a complex compound in which magnetism of substantial size arises solely from orbital angular momentum. The other poster was concerned with the effects of alternation in exchange coupling in linear chain compounds. Alternation along the chain in $[Cu(bpm)(OH)(H_2O)]_n$ is due to alternating positive-J hydroxy superexchange bridges and negative-J bipyrimidine bridges. This system is the first example where the alternating F and AF couplings are of comparable strength. In compounds of the type $AMn(sal)_2$, where adjacent Mn(III) ions occupy different coordination sites along the chain, the variation in relative intrachain and interchain interactions was studied as a function of A group, where A = Na^+, K^+ or NH_4^+. The potassium compound shows the weakest exchange interactions and the ammonium compound the strongest.

Oliver and coworkers displayed a poster concerned with Mossbauer and magnetic data on Eu(III) porphyrin compounds. This is the first time that Eu, rather than Fe or Sn, has been used as the Mossbauer nuclide in such systems. Pannaparayil et al presented a poster demonstrating that Fe(III) can be substituted for Si(IV) in silicate gels; such materials may serve as precursors for zeolite catalysts. Paduan-Filho, Carlin and coworkers displayed a poster examining the single crystal susceptibility of $Mn(L\text{-tartrate}) \cdot 4H_2O$, which is

interesting in part because very few tartrate complexes have been studied magnetically. An antiferromagnetic transition, with development of a weak ferromagnetic moment, occurs at about 1.83K. An unusual feature is that the weak moment is detected in two perpendicular directions, suggesting that the magnetic structure may involve more than two sublattices.

Four posters were presented in the area of biomagnetism. Three of these, by Ueno and coworkers of Kyushu, dealt with magnetophysiology. In one poster the optimal direction for stimulating motor activity in the hand and food by a magnetic field applied to a particular region in the human cortex was determined. A mechanism to account for the observed orientational anisotropy of response was proposed; it appears that only eddy currents induced by the applied field that flow in the sense soma-to-distal part of neural fiber are effective. In another poster a noninvasive method of stimulating the spinal cord was described, by concentrating induced eddy currents in a target area by a pair of opposing pulsed magnetic fields. The effects of electrical stimulation of peripheral nerves was also studied, and correlated with the magnetic field effects. Finally, a poster examining the magnetic fields associated with brain activity during sleep was presented. The orientations of source dipoles for such brain-generated fields were determined. The last poster in the biomagnetism category was by Pfutzner et al of Vienna. Magnetostactic bacteria, which can be extracted from sediment at the bottom of fresh or salt water bodies, were used to study domain effects. Such bacteria carry magnetic moments, for which interaction effects are also observed, and show a high field sensitivity. Eventual applications could include the use of such bacteria to carry drugs to target locations.

INTERMAG CONFERENCE JOINT MAGNETISM AND MAGNETIC MATERIALS

Pittsburgh, PA, June 18-21, 1991

The Fifth Joint Magnetism and Magnetic Materials, INTERMAG, Conference (M^3I) will be held at the Pittsburgh Hilton, This meeting combines the Annual Conference on Magnetism and Magnetic Materials and the INTERMAG Conference; ***it will be the only meeting of either of these two major conferences in 1991***. The Conference is jointly sponsored by the American Institute of Physics and the Magnetics Society of the IEEE, in cooperation with the American Physical Society, the Office of Naval Research, the Metallurgical Society of the AIME, the American Society for Testing and Materials, and the American Ceramic Society.

Members of the domestic and international science and engineering communities interested in recent developments in magnetism and its associated technologies are invited to attend the Conference and to contribute to the technical sessions. The scope of the Joint Conference embraces all areas of basic science, applied science and engineering in magnetism. These include experimental and theoretical research in magnetism, the properties and synthesis of new magnetic materials (including superconductors), new developments in applied magnetics (dc to microwave), information storage technology, magnetic separation, and applied superconductivity. The program will consist of invited and contributed papers. Selection of contributed papers is based on abstracts whose submission deadline in January 23, 1991.

The General Chairman of the Conference is Robert M. White and Local Chairman is Daniel Stancil. Persons or organizations who desire further information on the Conference or who wish to make additions to the the mailing list should contact Ms. Diane Suiters, $5M^3I$ Conference Coordinators, 655-15th Street, N.W., Suite 300, Washington, DC 20005, Tel: (202) 639-5088; FAX: (202) 347-6109.

CORRECTION

In the last issue of the Newsletter, the Milwaukee chapter of the Magnetics Society was inadvertently not listed among the other chapters. The local chairman is Roy Van der Heiden who can be reached at (414) 357-0339.

IEEE FELLOWS

The Magnetics Society wishes to congratulate its members who have been elected to Fellow grade.

J. Douglas Adam	For contributions to the development of microwave device applications of ferrite thin films.
Amikam Aharoni	For contributions to theoretical magnetism.
Prabhakar Bapat	For contributions to the growth of small-scale electrical machinery manufacuring industry.
Lawrence Burrage	For leadership in the development and application of advanced interrupters to distributions systems.
Wagih Fam	For contributions to the analysis and loss measure-ments of nonlinear magnetic devices.
Clark Johnson	For contributions to engineering management and design, especially in the field of high density magnetic recording.
James Kirtley, Jr.	For contributions to the theoretical understanding, development and implementation of superconducting turbogenerators.
Rolf Unbehauen	For contributions and leadership in the field of analog and digital filter design and signal processing.
Lewis Unnewehr	For contributions to the theory and design of switched reluctance motors and electrical vehicle drives.

CONFERENCE CALENDAR

EMMA '91, European Magnetic Materials and Applications Conference, Dresden, April 16-19, 1991. For information contact: Dr. S. Roth, Secretary of the Organizing Committee of EMMA '91. AdW d. DDR/ ZFW Helmholtzstr. 20/PF, DDR-8027 Dresden. Phone 4659327, Telex: 2131 zfw da.

Second International Conference Rare Earth Development and Applications, May 27-31, 1991 in Beijing, China. For further information contact: Senior Engineer Siu Aisheng, The Chinese Society of Rare Earths, 76 Xueyuan Nan Lu, Beijing 100081, P.R. China. Phone: 8312541 or 891666; Telex: 222297 CISRI CN; FAX: 8312144

Joint Magnetism and Magnetic Materials INTERMAG Conference, June 18-21, 1991, Pittsburgh, PA. See page 17 for further information.

Power Electronics Specialists Conference, June 24-28, 1991, Massachusetts Institute of Technology, Cambridge, MA, USA. Contact Conference Chairman for further information: Professor Martin F. Schlecht, Room 39-553, Department of EE and Computer Science, M.I.T., Cambridge, MA 02139, Tel: 617 253-3407

Portland Int'l. Conference on Management of Engineering and Technology (PICMET '91), October 27-31, 1991, Portland, OR. For further information contact: PICMET '91, Portland State University, P.O. Box 751, Portland, OR 97207-0751 USA. Telephone (503) 725-4660, FAX: (503) 725-4667

IEEE MAGNETICS SOCIETY NEWSLETTER
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