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# MAGNETICS SOCIETY NEWSLETTER

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JODIE CHRISTNER, EDITOR

## PRESIDENT'S COLUMN

*Stanley H. Charap*

There are many topics that deserve discussion here. I have chosen at this time to say something about membership in the Magnetic Society and about the Society's awards program. Assuming that I am elected to serve another year as president, I will cover other topics in this space then.

To begin with membership, this is a chairmanship that has recently changed hands. When Celia Yeack-Scranton was elected to the office of Secretary/Treasurer of the Society for 1991, Mark Re took over the post. I want to commend our membership chairmen for their efforts. They have used booths at our conferences, advertisements in the IEEE student magazine, *"Potentials,"* and personal letters to new members to attract and retain members for the Magnetics Society. One does not buck the trends in the IEEE as a whole. Membership in the IEEE shows a significant dip in February of each year, followed by a monotonic rise to a maximum in January of the following year. Since 1986 (the period for which I have data handy), the successive January peaks increase in height by something over 3%. Magnetics Society membership shows similar behavior, although our peak is in December. As of the latest report (July 1991), the Magnetics Society membership is nearly 3700; annual growth was 3.8%. We can look forward to a peak membership this December of about 3900. Worldwide, we constitute about 1% of the IEEE membership; a small but vital segment of the profession. We continue to encourage new membership, especially among students. Every Magnetician should regard himself as a part of Mark's membership committee.

Perhaps the most gratifying aspect of serving on the Magnetics Society AdCom (Administrative Committee) is having something to do with the Awards program. This is the program that encourages its members professionally and recognizes their achievements. Our Awards Department, chaired by Fritz Friedlaender, is to be commended for their constructive use of the funds that the Magnetics Society makes available.

The Society has two awards for exceptional achievement: the Magnetics Society Achievement Award, which

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## THE 5TH JOINT MMM-INTERMAG CONFERENCE PITTSBURGH, PENNSYLVANIA

Pittsburgh, Pennsylvania was the site of the 5th Joint MMM-Intermag Conference held June 18-21, 1991. It was preceded, on June 17, by an Executive Seminar and tours of Carnegie Mellon University. The following summaries were submitted by the session chairpersons.

### Executive Seminar

*Barbara Shula*

The idea for an Executive Seminar came from the general chairman, Bob White, who wanted to provide an opportunity for those people who would not otherwise be able to attend the whole conference to hear "hot" topics of the conference. The seminar was then developed by Barbara Shula under the industrial support area of the conference management.

The idea of connecting the Executive Seminar and the Industrial Support was two-fold. The first was to provide those executives who provide ongoing financial support to the conference a way of participating in the conference that did not require the same technical depth or time commitment as attending the technical sessions. The other aspect was a means of encouraging company executives to support the conference and to become more involved in the research that contributes to their business.

JOINT CONFERENCE *(Continued on page 2)*

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was presented this year to Emerson Pugh (in absentia), and the Information Storage Award, which was presented this year to Charles Coleman. Both presentations were part of the plenary session at the Joint INTERMAG-MMM Conference in Pittsburgh this spring. At that time we also recognized the student travel award recipients, who received partial support from the Society for their travel to the conference. A number of these travel awards are reserved each year for students from outside North America.

Our Distinguished Lecturer program makes available, to any group requesting it, a visit by a leading researcher in magnetics. These visits are sponsored by the Magnetics Society within fairly generous budgetary limitations. In the past year we appointed two lecturers, who each made about ten visits. For the coming year we have three lecturers; the announcement may be found elsewhere in this newsletter.

Members of the Magnetics Society have received announcement of the 1993 Magnetics Society Scholarship Award program. This program is administered for us by the National Merit Scholarship Corporation and students attending high school in the U.S. and having a parent who is a member of the Society may compete for a four year college scholarship sponsored by the Society. There are, in general, four college students receiving such scholarships at any one time.

Members may recall the Equipment Awards program; a program that assisted universities in acquiring equipment needed for magnetics research and/or education. Since 1987, this program has been "on hold". At that time the Society had found itself in some financial difficulty. One of the conditions imposed by the IEEE, as they assumed some of the responsibility for the situation, was that the Equipment Awards program be suspended for at least three years and not resumed without the agreement of the IEEE Executive Committee. Our Awards Department Chairman, Fritz Friedlaender and the Equipment Awards chairman, Jim Lommel, are currently working on this approval. One of the problems is that the IEEE puts limits on the amount of money the Society can "give away" in the form of awards. The extensive list that I have just enumerated will, when the Equipment Awards program is reinstated, exceed the guideline. This means that we must somehow convince the IEEE that we should be allowed to go ahead anyway.

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**JOINT CONFERENCE** *(Continued from page 1)*

The day was broken into six technical and business talks that were drawn from those topics which received the largest number of abstracts at the conference. Those topics were:

Multilayers of Magnetic Materials
Permanent Magnets
Superconductivity
Magnetic Recording
  Rigid Thin Film Disks
  Disk Heads
  Contact Recording in Rigid Disk Files

Short descriptions of these talks follow. The technical talks ranged from very technical and detailed to very broad and business-oriented so that each attendee found something that was of particular interest at their particular level. The luncheon speaker was Bob White who made comment on cooperative research within the United States.

The day was a successful experiment and you should look for the announcement for the Executive Seminar to be held on the Sunday, April 12 prior to the 1992 Intermag Conference in St. Louis.

### Multilayers of Magnetic Materials

*Kristl Hathaway, ONR Materials Division, Naval Surface Warfare Center*

Multilayered materials containing magnetic elements have received increasing attention over the last decade, beginning with three talks at the 1981 MMM Conference and a devoted session on "Metallic Superlatticaes and Modulated Films" at the 3rd Joint Intermag-MMM Conference in 1982. Early work on transition metal systems was rapidly expanded to include rare earth multilayers, with both efforts being focused on the effects of structure (e.g.; lattice mismatch, interdiffusion, strain), and interfacial chemistry on magnetic properties. The second half of the decade brought exciting discoveries of exchange coupling across interfaces, surface-induced perpendicular anisotrophy, and exchange coupling of magnetic layers through nonmagnetic metals, which discoveries made feasible for the first time, the engineering of magnetic properties through control of layers. The last few years have seen an explosion of work on two classes of multilayers with important applications potential: 1) Co/Pt and Co/Pd multilayers exhibit perpendicular anisotropy and large magneto-optical responses in the blue region of the spectrum which make them candidates for high performance, noncorroding magneto-optical recording media; and 2) Several transition metal multilayers (e.g.; Co/Cu) in which adjacent magnetic layers are oriented antiferromagnetically show room temperature magnetoresistance as high as 50%, promising improved performance for applications such as magnetoresistive heads, nonvolatile memories, and sensors. Multilayers of other magnetic materials (ferrites, garnets, rare earth-transition metal intermetallics, etc.) also offer exciting possibilities for new applications and improved performance but remain to be investigated.

### Permanent Magnets — An International Update

*Port Wheeler, Wheeler Associates*

Magnetic materials play a fundamental role in many electrical, electronic, and electromechanical systems. One category of magnetic materials — permanent magnets — can be defined as energy efficient and cost effective components of a wide range of devices that are crucial to modern industry and to high technology defense systems. For any country a direct relationship exists between the standard of living and the consumption of permanent magnets. This presentation reviewed the current international status of development and application of all permanent magnet materials including recent dramatic advances. Included

were projections for the year 2000 and beyond. A summary outlined reasoned recommendations for the permanent magnet industry.

### Prospects for the Development of Conductors of High Temperature Superconductors

*D.C. Larbalestier, Applied Superconductivity Center, University of Wisconsin-Madison*

Much interest has attended the prospect of a superconducting magnet technology capable of operating at temperatures above the liquid helium regime. In principle, this is well within the capability of existing high temperature superconductors (HTSC). However, several barriers are impeding the development of the technology: amongst the most important are the tendency of bulk samples to be granular, the strong anisotropy of the physical properties and the brittle nature of ceramics. Underlying all of this, the great complexity of the material science of HTSC which makes it very difficult to develop a microstructural understanding of their properties. Indeed, ignorance of many crucial aspects of the defect structure of the high temperature superconductors underlies many of the mysteries of HTSC. Nevertheless significant advances are being made in understanding (and improving) the granule properties, the flux pining and the mechanical properties of HTSC. For example, the Bi-based compounds are much less subject to granule behavior than the 123 compounds and prototype short length conductors having superior critical current density properties to the best $Nb_3Sn$ conductors have now been made. This talk surveyed the prospects for future conductor development within the above framework.

### Rigid Disc Magnetic Media: Past, Present, and Promises

*Gordon F. Hughes, Seagate Technology*

Examples of media commercialization from rigid disc drive history were used to predict future media trends; such as the IBM Ramac 1956 commercialization of oxide media twenty years after its research origins; cobalt-doped oxide media that easily commercialized in 5.25 drives in 1984-1985, only two years after its research origins; and the high-volume thin film media now nearly universal in 8-inch and smaller diameter drives, forty years after its research origins. The reasons underlying this history of rigid disc media implies lessons for the commercial prospects of vertical and barium ferrite hard disc media, and for contact recording rigid disc media.

### Historical Review and Trends - Disk Heads

*Robert E. Jones, Jr., IBM Corporation*

The evolution of disk heads has led to dramatic increase in recording density and reductions in flying height. At the same time we can trace the progress of head technology from magnetic metal laminations to ferrite to thin film technology. Nevertheless, with the exception of magnetoresistive heads, the basic design principles of disk heads have remained the same. Drawing from examples, this evolution was described, along with a discussion of future trends illustrated by abstracts of papers presented at the then upcoming conference.

### Contact Recording Aspects of Rigid Disk Files

*Robert Fontana, IBM Corporation*

This talk reviewed recent approaches to contact recording for rigid disk files. Data were presented on active sliders in which the problem of interface wear is reduced by bringing a small portion of the slider housing the element into contact only when a read/write operation is desired, which is relatively infrequently. Continuous rubbing schemes were also discussed, as well as the challenges in file design which result from an ability to fly very low or in contact.

## Session AA: Particulate Recording Media

*M. P. Sharrock*

The session devoted to particulate recording media showed, as in recent conferences, the continued vitality and diversity of this important area of technology. Hexagonal ferrites (substituted barium ferrites), especially, are attracting strong interest and accounted for six of the fifteen papers. Metallic particles, the other type of material attracting attention for potential advanced uses, were the subject of five papers. A brief summary of the individual papers follows:

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The objective of the **IEEE Magnetics Society Newsletter** is to publicize activities, conferences, workshops and other information of interest to the Society membership and technical people in the general area of applied magnetics. Copy is solicited from the Magnetics Society membership, organizers of conferences, officers of the Society and local chapters and other individuals with relevant material. Send copy to Dr. Jodie A. Christner, Dept. 2H2, IBM Corporation, 3605 Hwy 52 North, Rochester, MN 55901-7829, Telephone: (507) 253-5513 FAX: (507) 253-4146.

**JOINT CONFERENCE** *(Continued from page 3)*

Schmitt (Bayer AG) - Transverse susceptibility is an interesting and useful probe of anisotropy properties. Coatings containing iron oxides with and without cobalt showed anisotropy field/coercivity ratios of up to about 3. Deviations below this value were interpreted in terms of various cobalt deposition processes.

Chen, Wong, Tarng, Wu (Industrial Technology Research Inst., Taiwan) - Deposition of Sn hydrosols on the surface of cobalt-modified iron oxide particles is able to improve their dispersion properties and their orientation in coatings.

Kishimoto, Nakazumi, Ootani, Sueyoshi (Hitachi Maxell, Ltd.) - Cobalt/iron alloy particles, of e.g. 15/85 composition, have higher saturation moment than iron-based particles and lose proportionately less moment in aging at high temperature/humidity.

Chen, Wong, Peng, Lin, Wu (Industrial Technology Research Institute, Taiwan) - Acid-base interactions among metallic recording particles, dispersants, binder polymers, and solvents were studied in order to improve the quality and stability of dispersions for media coating.

Zhou, Horio, Morrish, Li (University of Manitoba), Hanawa (Showa Denka K. K.) - The relative merits, crystal structures, and ionic site occupancy in Co-Ti substituted barium ferrites of the M-type and W-type were discussed, using results of Mossbauer spectroscopy.

Zhou, Morrish, Li (University of Manitoba), Hong (Oriental Chemical Industry) - The effects and site occupancy of Co and Ti substituents in M-type barium ferrite were discussed.

Kubo, Ogawa (Toshiba Corp.) - The temperature dependances shown by Co-Ti substituted and Co-Ti-Sn substituted barium ferrite particles were explained in terms of the magnitudes and temperature dependences of the first and second anisotropy constants.

Spratt, Kodama, Inoue, Uesaka, Katsumoto (Hitachi, Ltd.) - The switching-field distribution of barium ferrite media was found to become narrower and magnetic interactions to become stronger as particle packing density was increased. The magnetic interaction between stacks of particles was suggested as a cause.

Hudson, Mathur (IBM Corp.), Raghaven (University of Arizona) - Organophosphate dispersants have strong interactions with the surface of both pure and Co-Ti substituted barium ferrite, as measured by flow microcalorimetry.

El Hilo, O'Grady (UCNW, Bangor), Chantrell (Keele University) - Magnetic interactions in nonoriented barium ferrite media were studied by means of magnetizing and demagnetizing remanence curves. The time-dependent magnetic effects were measured during both magnetization and demagnetization, with the result that the activation volumes were similar in the two processes and comparable to particle volumes.

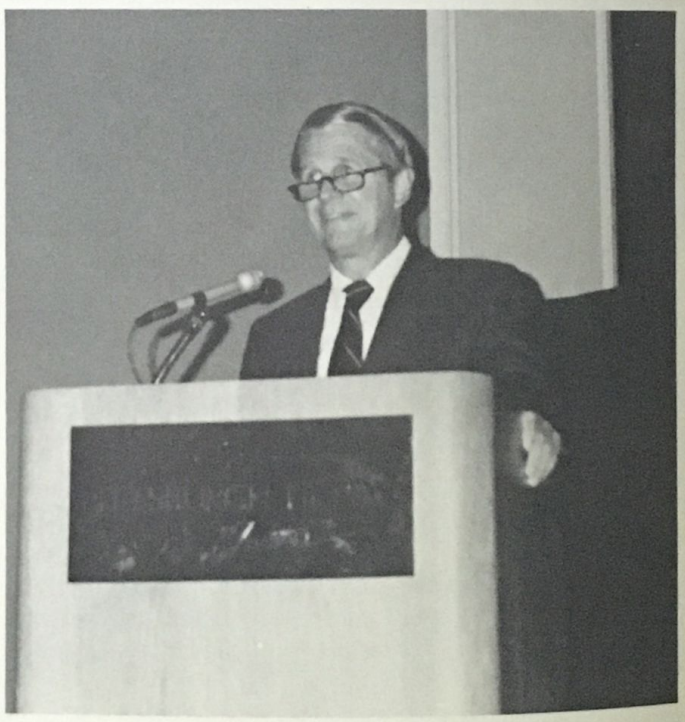
Auweter, Jachow, Jakusch, Schwab, Veitch (BASF) - Experimental evidence supporting the theoretically expected dependence of short-wavelength recording output on particle dimensions was presented. The effect of switching-field distribution was also discussed.

Jachow, Schwab, Veitch (BASF) - Time-dependent magnetic effects were observed in chromium dioxide and cobalt-modified iron oxides. When analyzed by the fluctuation-field formalism, the behavior seemed to depend little on coercivity level, but differed significantly between the two materials.

Mathur, Hudson, Martin, McKinley, Hackett (IBM Corp.) - The degradation of iron metal particles was found to follow two-stage kinetics, with the initial, faster stage more sensitive to moisture than to temperature.

Speliotis (Advanced Development Corp.), Peter (Media Logic Corp.) - Metal-particle and metal-evaporated tapes were found to show increased digital error rates after storage at elevated temperature and humidity. Barium ferrite tapes did not show this degradation.

Corcoran (Ampex corp.) - Metal-particle tapes of the D-2 format did not show increases of error rates after storage in the Batelle Class II environment (hydrogen sulfide, chlorine, nitrogen dioxide as air pollutants); the cassette shell was concluded to have a protective effect.

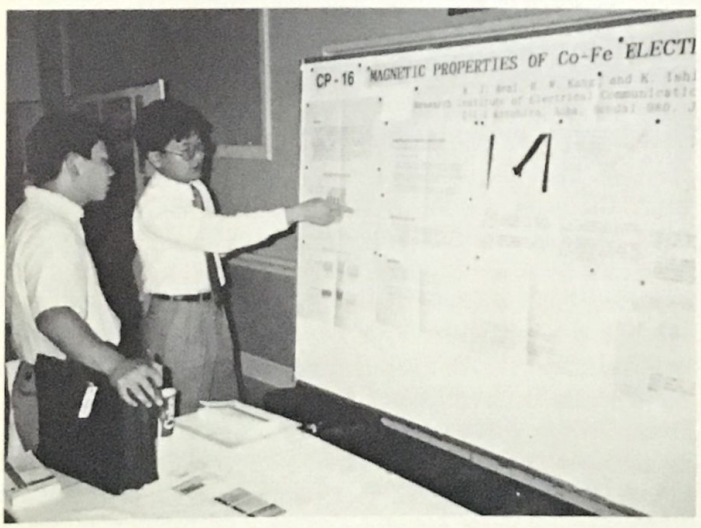


## Session AE: Transport and Magnetotransport in Magnetic Systems

*Alexander C. Ehrlich*

This session with nine presentations (eight experimental and one theoretical) on transport and magnetotransport covered a wide variety of materials. These were semiconductors, bulk crystalline alloys, bulk amorphous alloys and thin elemental, alloy and multilayer films. In an invited paper Terry et al. using photo-doping to create a quaisi-stable defect state were able to make transport measurements as a function of temperature in a single sample over a wide range of carrier concentrations. This made possible the photo-tuning of the Mott-Anderson transition and a delineation of the temperature dependent resistivity in the insulating phase. In a second invited paper, Barbara et al. explored the effect of magnetic impurities on weak

3-D localization in an amorphous alloy by varying the number of magnetic scattering centers as well as the applied magnetic field. Two multilayer presentations by Florczak et al. and Ehrlich et al. on Fe/Cu and Fe/Ni systems respectively focused on different phenomena. The first addressed the temperature and layer thickness dependence of the anisotropic magnetoresistance and found it to be linearly related to the multilayer resistivity. The second focused on the short wavelength multilayers where the Fe is in the fcc phase. Strong evidence for static spin scattering of electrons was developed and was attributed to interface effects. Indications for an fcc Fe saturation magnetization approximately 5 kilo-oersteds below bcc Fe was also given. Chen et al. studied magnetotransport in MBE grown Fe thin films as a function of the relative orientations of the magnetization, the current and the crystal structure. Gopalaswamy and Berger showed experimental evidence for the voltages across magnetic domain walls in the presence of electric current due to the combined effect of canting of the domain magnetization near the walls and the planer Hall effect. Nath and Majumdar reported magnetoresistance and Arrott plots on three FeNiCr alloys which show a complex magnetic phase diagram as a function of composition and temperature. Jen et al. found that their susceptibility and resistivity data on Pd based CoNiPd alloys could be adequately explained on the basis of a simple spin band model and this was particularly true of the ferromagnetic alloys. In the only theoretical paper of the session, Lutovinov presented a theory of indirect coupling between magnons and electrons via magnetic impurities which leads to a rather complex temperature dependence of electrical resistivity including a relatively low temperature maximum followed by a higher temperature minimum.




## Session BP: Rare Earth and Transition Metal Magnetism

*Tomasz Jagielinski/Subrata Dey*

Ryan and Hong Ren presented the cluster relaxation model in iron-rich amorphous FeXZrl00-X (X> = 88) near Tc. Based on their Mossbauer data in an applied field above Tc, they showed the evidence of correlated spin clusters. The presented data suggests that the clusters persist even after the onset of long range order. Also, the temperature dependence of the cluster size was explained.

Zbigniew Kaczkowski, et al., showed the influence of the magneto-thermal treatment and the magnetic bias field on the ultrasound velocities in iron-rich metallic glasses. The annealing below Tc removes only internal stresses and has little effect on velocity versus bias field. Above Tc, internal stress is removed, but the magnetic structure is destroyed, which in turn improves delta E and delta C which is important for magnetostrictive delay-line.

Zhun-Zhi Jin and Xian-Wu Zou studied the disaccommodation of Fe80B20 amorphous alloys in the temperature range 30-540 K after annealing treatment for 4 hours at 540 K. The calculated infrared divergence exponent N = 0.14 and characteristic relaxation time t = 2X10E-17 sec. The calculated actual activation energy Ea, at the temperature of the relaxation peak, is about 1.9 eV and the experimental activation energy derived from the crystallization, which is governed by boron diffusion, is about 1.87 eV. It shows that the relaxation results from boron diffusion in this amorphous alloys. Calculated energy Ea increases as the temperature rises. It implies that the larger free volumes vanish faster than the smaller one, as the temperature increases.

Sai, et al., presented high frequency characteristics of annealed Co-base amorphous alloy ribbon. They showed improvement in the high frequency magnetic properties of these alloys due to the reduction of core loss and have attributed this improvement to the presence of small nuclei precipitated during heat treatment. They concluded that these nuclei refine magnetic domains and reduce eddy current loss.

Magnetic resonance spectra of Fe3 + and Mn2 + ions in black obsidians from teotihuacan have been studied at 9 GHz and 35 GHz by Chavez-Rivas, et al. They observed that the temperature, granular and frequency dependence of the spectra of these natur glasses seems to support the presence of the superparamagnetic clusters of magnetite, and the short range order of the glassy state.

The evolution of magnetic properties and local atomic ordering during thermal annealing has been studied for amorphous Fe75Ni5B15Si5 thin films by Oliver, et al. The local environment around Fe atoms for as-deposited films is found to be in amorphous closed packed configuration. The Exafs and me results imply extensive rearrangement in the innermost Fe shell for these samples, with HMF distributions consistent with BCC alpha-Fe and BCC Fe3B local environments.

Harris, et al., presented the results of TM based (TM = Fe, Co and Ni) amorphous alloys and tried to evaluate its application to microwave devices. As deposited Fe-rich Fe80Co80-XB15Si5 and Fe80Ni80-XB15Si5 alloy films display superior as deposited soft magnetic properties as evident by high magnetization (> = 15 kOe) and low in plane anisotropy (< = 5 Oe) and coercive (.1 to 1 Oe) fields. In addition, these alloys have FMR linewidths comparable to IBS permalloy and experience magnetic resonance near or below 1 GHz with a zero applied field. Co-rich alloys were found to exhibit an anomalous sensitivity to heat treatment procedures when annealed below crystallization temperature.

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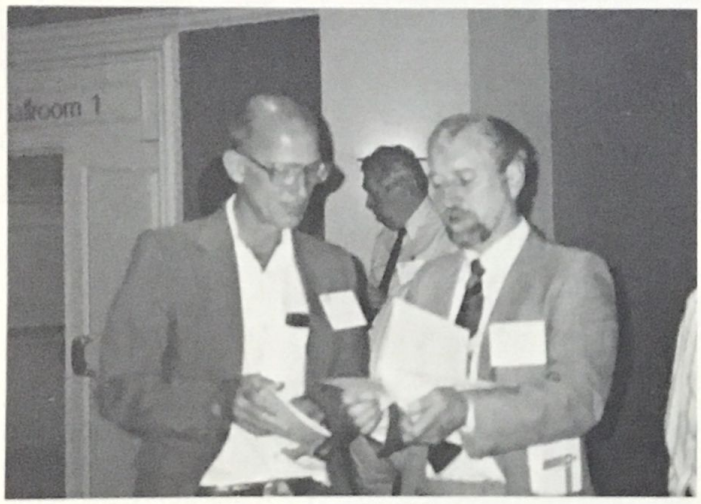
The effect of U-concentration on amorphous U-As films were presented by Plaskett, et al. For smaller U-concentrations, Tc became lower and at U = 32, it was non-magnetic. The magnetic moment per U atom had values about 0.20 to .35, about 25% for that found for USb. Hall effect is highest in U = 52 composition with the spontaneous resistivity about 20% of the sample resistivity (80 micro-ohm CM at 4.2 K). The most important feature of amorphous U-As over U-Sb is the large values of sample resistivity with a large negative P versus T slope which occurs below U = 52. At U = 39, P = 4500 micro-CM while lower U concentrations become insulators. They conclude that this freezing out of conduction electrons weakens ferromagnetic exchange interactions and causes the spontaneous Hall effect to disappear.



## Session CA: Thin Film Media I. Materials / Microstructure

*Mahbub R. Khan*

The session opened with an invited paper (CA-1) by Laughlin and Wong from Carnegie Mellon. In this review paper, the authors presented some of the evidence for the effect of Cr orientation on the Co-based thin films. The results are presented from x-ray diffraction, selected area electron diffraction, electron micro-diffraction, and atomic resolution electron microscopy. The authors show that a {110} Cr surface gives {1011} type Co-based alloy texture, whereas a {200} Cr produces a {1120} type Co-based alloy texture.

Suzuki et al., of Hitachi (CA-2) presented evidence of compositional separation of CoCr and CoCrPt films, where they chem etched the samples using dilute aqua regia. Maeda and Takei of NTT (CA-3) studied the compositional inhomogeneities in CoCrTa films using spin-echo $^{59}Co$ nuclear magnetic resonance method.

Tsai, Lal and Eltoukhy (CA-4) of HMT showed that the preferred orientation of Cr(200) is the key to obtain Co-alloy in-plane c-axis orientation for better read/write performance. They also reported that nonmetallic canasite substrates tend to promote Cr(110) rather than Cr(200). Yamashita et al. (CA-5) of Komag reported that sputtered NiP underlayer increases Hc and reduces media noise due to larger intergranular separation leading to reduced interparticle exchange.

Parker et al. of IBM (CA-6) talked about microstructural evolution of CoPtCr/Cr films and the effect on magnetic properties. Wong et al. of CMU (CA-7) studied CoNiCr films sputtered on [100] and [110] Cr single crystals. From Lorentz microscopy studies, the authors found relatively straight doman walls and the direction of magnetization within each domain was along the c-axis.

Tani et al. of ULVAC (CA-9) presented a new alloy CoCrPtB with very high coercivity of 3000 Oe for longitudinal recording. Lal, Tsai and Eltoukhy of HMT (CA-10) also reported a new alloy CoCrPtTa with HC ~ 2400 Oe and MrT ~ 1.3 memu/cm$^2$. Velu et al. of CMU (CA-11) reported 3000 Oe coercivity for CoSm films. They also presented results for CoSmBi and CoSmTa thin films.

The last four papers of this session (CA/12-15) were related to tapes. Arisaka et al. of Sony (CA-12) discussed Co obliquely evaporated tape and the magnetic and noise characteristics. Momono et al. of ULVAC (CA-13) demonstrated high signal output for their evaporated Co-O film. Matsubara and Sai of IBM-Japan (CA-14) with 3-dimensional vector VSM measurements found that their film does not have a simple uniaxial anisotropy, but has both an oblique uniaxial anisotropy and a shape anisotropy. Akiyama et al. of TIT (CA-15) were able to prepare stress-free CoCr thin film by Kr ion sputtering.

## Session CD: Recording Channels and Coding

*Jack Keil Wolf*

The session began with an invited paper entitled *"ACT-Enabled 100-MHz Channel Equalizer"* by D. Kumar and B. J. Hunsinger. The paper discussed a single chip programmable transversal filter with hundreds of tape and sampling rates in excess of 350 MHz. The second paper, *"Performance of a New Coding Scheme for the Peak Detecting Magnetic Recording Channel"* by A. Armstrong and J. K. Wolf, discussed a comparison of a new peak detection EPR4 channel with the (1,7) run length limited code. The third talk, by A. D. Weathers and J. K. Wolf entitled *"Biased Run-Length Limited Modulation"* discussed a new method of describing a particular type of write equalization. S. A. Roghavan and H. K. Thapar discussed new timing recovery schemes in their paper *"On Feedforward and Feedback Timing Recovery Methods for Digital Magnetic Systems." "An Adjustable Write Equalization on QIC-1350 Tape Drives"* by Y. Lin, B. Buchan and J. R. Howell was concerned with an application of write equalization to a Quarter Inch Cartridge system. J. Fitzpatrick and J. K. Wolf discussed an optimal processor for detection of signals corrupted by a nonlinear channel in their paper *"A Maximum Likelihood Detector for Nonlinear Magnetic Recording."* In the paper *"A Maximum Likelihood Peak Detection Channel"*, K. Chopra and D. D. Woods discussed the application of maximum likelihood principles to the peak detection channel. The goal of the paper *"Evaluation of Magnetic Recording Detection Schemes for Thin Film Media"* by J. G. Kenney, P. A. McEwen and L. R. Carley was to establish the performance advan-

tage of Fixed Delay Tree Search with Decision Feedback over peak detection and decision feedback equalization. P.A. Ziperovich considered nonlinear distortion in a PRML system in the paper *"Performance Degradation of PRML Channels Due to Nonlinear Distortions."* T. Inoue investigated bit shift due to overwrite in the paper *"Overwrite-Induced Bit Shift in Digital Magnetic Recording Systems"* J. Moon presented a paper discussing nonlinear effects in a high density recording channel in the paper *"Nonlinear Effects of Transition Broadening."* The paper *"Magnetic Recording Channel Model with Intertrack Interference"* by H. P. Vea and J. M. F. Moara discusses a pulse amplitude modulation model for intertrack interference. Finally, J. Moon's paper *"Signal-to-Noise Ratio Degradation with Channel Mismatch"* discusses the problem of mismatch due to ID/OD. The session was very well attended and the papers prompted a number of questions.

## Session EB: Recording Modeling and Phenomena

*Craig Perlov*

This session was a potpourri of recording papers. There was an excellent invited paper by Middleton and Miles discussing various analytical magnetization expressions and how the transition shape changes as the density increases. They also compared the predictions of superposition with measured results as a function of the various transition shapes. In a second paper by the same authors, they showed via numerical modeling that if one records magnetization transverse to the track direction, very high linear density is possible. Track density and readback signal are problems, however. Both papers stimulated much discussion. There was an excellent paper by Barndt et al. in which they modeled partial erasure during the recording process with a self-consistent LLG formalism. The erasure occurs when the tips of zigzags from neighboring transitions begin to touch and the domain walls unwrap each other creating a splotchy (or partially erased) magnetization pattern along the track. A paper by Wachenschwanz and Bertram showed that when a head goes into saturation during writing the transition shapes are not affected. There were two papers concerning macroscopic coercivity. One by Tagawa and Nakamura in which they claim that one can achieve 500 kfci with a narrow enough SFD (not demonstrated). The second paper by Speliotis and Judge contained angular dependent VSM measurements with a vector correction for demagnetization. The results show that for some media (CoCrPt) the remanence coercivity when the field angle is ~50° can be quite small (~100 Oe) even though it is large with the field in the sample plane. Kanai and Charap presented a simulation of the magnetic after effect in particulate media using a self consistent LLG model. They confirmed the claim by Sharrock that a reasonably stable transition requires a particle anisotropy energy ratio of about 120. There were three papers on perpendicular recording including one by Yamamori et al. using BaFe media and a MIG head with the metal on the leading edge of the gap. A paper on scaling by Cramer and Slob compared the intrinsic response from various media.

## Session ED: Symposium on Phase Transitions and Disorder in Magnetic Systems

*P. Schlottmann*

The five invited papers in this Symposium covered several exciting aspects of magnetic phase transitions, mostly in the context of disorder and bond frustration. Randomness and unsatisfied bonds typically reduce or suppress magnetic order and give rise in this way to new interesting phenomena. Among these phenomena are spin glasses, substantial changes of phase diagrams including the order of the transitions, enhanced quantum fluctuations as in resonant valence bonds, and Mott-type insulator-metal magnetic-nonmagnetic transitions as a consequence of doping.

A.N. Berker summarized the research in his group on the effect of bond randomness on temperature-driven first-order phase transitions. Transitions involving symmetry breaking are converted to second-order for a space dimension d smaller than a critical one, $d_c$; for $d>d_c$ this phenomenon still occurs, but requires a threshold amount of bond randomness. If no symmetry breaking is involved, temperature-driven first-order transitions are eliminated by bond-randomness. Multicritical phase diagrams are also drastically altered by bond-randomness.

T.F. Rosenbaum discussed the low frequency dynamics of dipolar magnetic glasses, presenting magnetic susceptibility, specific heat and neutron scattering data for the randomly diluted Ising magnet $LiHo_xY_{1-x}F_4$. The system orders ferromagnetically for $x>0.46$, a sample with $x=0.167$ shows the characteristic spin-glass relaxation spectrum (no gap), while an $x=0.045$ crystal has properties consistent with a single low-degeneracy groundstate with a large gap for excitations. A possible explanation for this distinct behavior is in terms of random clusters. Quantum fluctuations as induced by a transversal magnetic field depress the spin-glass properties.

A.P. Ramirez addressed geometrically frustrated magnets. These are systems without site disorder, but with frustration arising from nearest neighbor antiferromagnetic bonds on a triangle-based lattice, e.g., fcc, triangular and Kagomé lattices. Many unusual properties in the critical behavior, the phase diagram and the elementary excitations are expected as a consequence of the frustration. Among the compounds discussed are the quasi-two-dimensional spin-glass $SrCr_8Ga_4O_{19}$ and the fcc antiferromagnet $K_2PbCu\ (NO_2)_6$.

Pressure-induced insulator-metal transitions in $NiI_2$ and $CoI_2$ have been presented by M.P. Pasternak. These transition metal compounds are antiferromagnetic insulators as a consequence of the correlations in the narrow d-bands. The transition to a metallic state can be achieved either by selective doping (as in $La_2CuO_4$) or by very high pressures (diamond anvil cells). The latter technique does not break the translational invariance and is more adequate to study the Mott-transition. The $^{129}I$ Mössbauer spectra indicated an abrupt ($NiI_2$) or gradual ($CoI_2$) collapse of the magnetic state at a critical pressure $P_c$. This magnetic-nonmagnetic transition is accompanied by a insulator-metal transition, but by no crystallographic change.

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M.L. Plumer reviewed the status of his research on magnetic phase diagrams of geometrically spin-frustrated stacked triangular antiferromagnets. Results based on the phenomenological Landau theory, molecular field approximations and Monte Carlo simulations were presented, with emphasis on multicritical behavior and applications to $ABX_3$ compounds.

## Session GC: Magnetism and Microstructure of Cobalt-based Multilayers

*Roy Clarke*

The session was well attended reflecting the increased research activity in cobalt-based microstructures and multilayers. There was considerable interest in new results on the fabrication of ultrathin cobalt films for their unusual magnetic and magneto-optic properties. The current emphasis on large anisotropies, high coercivity and enhanced magneto-optic Kerr effect was evident in several of the contributions. A very exciting trend is the control of the microstructure to enhance magnetic characteristics relevant to recording media. There was a nice mix of basic science papers and applied work. Highlights of the session:

- *"Use of Heavy Inert Gas Atoms for Sputter Deposition of High Coercivity Co/Pd Films"*, (Kodak Research Labs)
- *"Pt/Co Multilayers - Control of Magnetic Properties"*, (University of Alabama, University of Salford)

## Session GB: Thin Film Media II. Noise/Multilayer Films

*Tadashi Yogi*

The key subjects of the 14 papers presented were multilayer/laminated media, structure-property relationships and micromagnetic modelling. The session was heavily attended with active discussion following each presentation.

Continuing the interest generated in Intermag'90, there were five papers on multilayer media undoubtedly due to the effectiveness in reducing media noise. SNR improvement of between 3 and 7 dB was reported, depending primarily on the number of layers. The interlayer was Cr in all cases. Ming et al. (GB-11) studied CoPtCr with up to 6 laminations and showed some evidence of grains growing through the entire film thickness. CoNi multilayers with up to 3 layers were reported by Duan et al. (GB-12). They attribute some of the enhancement in SNR to negative magnetostatic interaction between the layers based on the delta-M measurement. Similar qualitative argument was used by T. Min et al. (GB-13) to explain the observed SNR improvement beyond the expected 3-dB for a double layer. Also, more detailed characterization of multilayer media was performed using magnetic remanence measurement (GB-14, O'Grady et al.) and spin-wave Brillouin scattering (GB-15, Maruyama et al.). O'Grady et al. showed that the bottom-most layer could be distinguished macromagnetically from the upper layers. Maruyama et al. used Brillouin light scattering technique to determine the interlayer exchange coupling, which becomes negligible when the Cr interlayer is thicker than 2 nm, consistent with other works.

Studies of the relationship between magnetics, recording properties and microstructure were the subject of several presentations. Hara et al. (GB-01) reported high performance and low noise CoNiCr media on glass substrates with Ti-alloy intermediate layer. They showed that media with higher coercive squareness had better overall recording performance, resolution, overwrite and di-bit peak shift. Coughlin et al. (GB-04) on the other hand reported a case in which disks from two vendors had similar intermodulation noise while their in-plane anisotropy and out-of-plane torque values were notably different. Kawamoto et al. (GB-09) showed an experimental correlation between SNR and the maximum slope of initial magnetization curves of various Co-alloy media and proposed that the stability of domain wall plays an important role. CoCrTa alloy was investigated by several workers, for substrate temperature dependence using Facing-Targets-Sputtering by Kawanabe et al. (GB-03), and for micromagnetic images of recorded bit transitions by Cameron and Judy (GB-06).

Micromagnetic modelling continues to provide clear insights and assistance in a self-consistent interpretation of experimental data. Zhu (GB-07) simulated the interaction of di-bit transitions and showed that the noise in the second transition is strongly influenced by the magnetostatic field from the first previously recorded transition. This effect leads to a super-linear increase in noise of the second transition as the di-bit spacing is reduced, particularly for an array with strong exchange coupling. The simulated curve of noise vs. density is remarkably similar to experimentally observed noise power. Beardsley and Zhu (GB-05) conducted simulations of remanence curves for a range of media parameters. They found that the amount of intergranular exchange was the most important parameter determining the difference delta-M, but other factors such as anisotropy and ac-erasure procedure could cloud the interpretation. Bertram and Zhu (GB-08) investigated the role of out-of-plane anisotropy in medium noise. Torque curves and noise were simulated for two distinct anisotropy distributions and varying intergranular exchange coupling. They found no correlation between high field torque and noise, suggesting that other factors may be responsible for the experimentally observed correlation between noise and out-of-plane anisotropy.

## Session HB: MO Recording

*Han-Ping D. Shieh*

There were 15 papers in the magneto-optical recording session: six papers in exchange-coupled direct overwrite, three in micromagnetics, three in MO readout techniques, one in high data rate MO system, and two in alternative MO materials development. Among them, 9 papers were authored by Japanese, four by American, one by U.K. and Chinese, respectively.

Exchange-coupled layers continue to attract lots of interest for direct overwriting. The key issues of this technique are to optimize the magnetic and material properties of each layer such that the required switching magnetic field, materials sensitivity and data stability are adequate. By reducing the saturation magnetization of the control layer and lowering the Curie temperature of the complementary layer, the recording power sensitivity was reported to improve by 1.5 times with 51 dB CNR by Hayashi et al. of NEC. The effects of the interfacial domain wall energy density and the magnetic exchange strength on the overwriting processes and data stability were discussed by several authors. Ohutsuki et al. of IBM presented an exchange-coupled bilayer to achieve direct overwrite without an initializing magnetic field. The technique was based on the difference in the through-thickness temperature gradient induced by short and long laser pulses. Tokunaga et al. of Mitsubishi Electric reported the further improvement on the quadrilayer structure for direct-overwrite. At 400 Oe of bias field, central laser power margins of ± 20% with high and low laser powers of 13 and 5.5 mW, respectively. A CNR > 47 dB for a bit length of 0.76 μm and overwrite reliability of $10^6$ cycles, at no initializing filed, was reported. Giles and Mansuripur presented their ongoing work on the magnetization dynamics in the process of thermomagnetic recording. The temperature dependencies of subnetwork magnetizations, the effective fields, the gyromagnetic coefficient were calculated and used to simulate the thermomagnetic writing processes.

Fujiwara of Hitachi presented an 8 MByte/sec data rate MO disk system. The 10 inch diameter disk spins at 3600 rpm. The 2p-glass substrate disk had a recording density of 800 Mbits/in$^2$, and capacity of 30 GBytes. To increase the write sensitivity, the disk structure was optimized magnetically and optically such that a 30 to 40 mW diode laser could be used. A capping layer of PtCo exchanged-coupled to active TbFeCo on top was reported to improve the field sensitivity to as low as 100 Oe of switching filed for field modulation direct overwrite.

## Session HD: Head/Medium Interface II

*David B. Bogy*

This session contained 15 papers on various topics: numerical simulations and animation, novel slider designs, protective overcoats, contamination, disk substrates, lubrication and friction, and an analysis of head-disk contact force.

The simulation paper HD-01 presented results of a HDA simulation in which modal analysis techniques were used for the structural elements leading to a reduction in computation time from the previous version. A video was shown of the slider and suspension motions. HD-02 contained a simulation of flying-height fluctuation caused by air turbulence forces on the suspension, which were calculated by 2-D FEM.

The disk substrate paper HD-03 examined canasite. Due to differential hardness of the two phases (amorphous and crystalline) and the spatial distribution of the crystallites in the material, peaks are produced on the surface after polishing at frequencies in the range of 50-100/mm leading to a reduction in contact area and friction equivalent to that on textured NiP/Al disks. Paper HD-15 presented a study in the use of a "high performance" resin Benzocyclobutene for the planarization of disk substrates. The purpose

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is to eliminate the need for NiP coatings and polishing.

HD-04 presented a novel programmable air bearing slider. It contains a piezoelectric element that can deform the slider to cause it to fly lower when writing or reading. Otherwise, it flies higher for greater reliability.

There were two instumentation papers. HD-05 compared both steady fly-height and spacing variation measurements from a multichannel laser interferometer and capacitance probes embedded in the four corners of the slider. It was shown that a calibration of the cap probe obtained from fly-height cannot be used for spacing variation. The finite size of the cap probe and the functional form of spacing variation along a slider leads to a calibration that is different for spacing variation by as much as a factor of four from that used for fly height. HD-06 correlates slider-disk contact detection between acoustic emission and electrical resistance techniques. Cylindrical conductive asperities were fabricated using a sputter etch process. Results are relevant to calibration for glide testing.

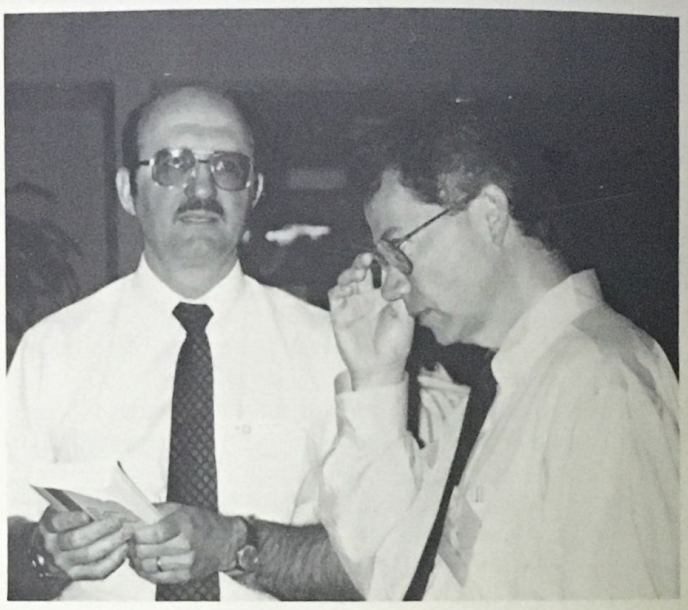
HD-07 entitled *"So how hard does a slider hit a disk"* presented an analysis that takes deformation into account as well as the statistical nature of asperity interaction. Various assumptions are made and the analysis predicts peak contact forces of about 0.1N for a typical thin film disk.

HD-08 through HD-11 were concerned with protective overcoats for thin film media disks. HD-08 describes the effects of environmental conditions on the friction of lubricated and unlubricated disks with carbon overcoats. It was found for both that sliding friction increases with the number of passes. Introduction of nitrogen reduced the friction. HD-09 examines the structure and mechanical properties of hydrogenated carbon film. Addition of a small amount of hydrogen gives harder films as well as slower buildup of friction. Other property differences were also reported. HD-10 presents work on the structure and durability of carbon films sputtered with some nitrogen gas in the chamber. It was found that durability increased and initial take-off velocity decreased for films made with higher partial pressures of nitrogen. HD-11 compared the film structure and surface chemistry of carbon and oxide disk overcoats. It was found that amorphous carbon films are superior to graphitic carbon films and those with microcrystalline graphite in an amorphous matrix. Crystalline zirconia films can exhibit good durability provided the grains are densely packed without networks of intergranular voids.

HD-12 is a study of whisker formation on flying sliders in which sub-micron, fluorescent polystyrene-latex spheres were injected into a drive. The particles accumulated on the taper and at the trailing edge. The presence of lubricant was necessary for the whiskers to form, so it was concluded that liquid lubricant may have adverse effects on reliability when large amounts of contaminants are present.

HD-13 and HD-14 were concerned with stiction and lubricants. In HD-13 the stiction force was mapped over a disk that had two regions with different texturing. The stiction map showed the presence of the different textures and the stiction increased with start/stop cycles. HD-14 described the relationship between the fluidity of Perfluoropolyether lubricants and the adsorption force on mechanical durability. Low molecular weight and high adsorption force gave high CSS durability.

The session attendance was in excess of 120 persons and the discussions were lively.



## Session HE: Soft Magnetic Materials I

*R.C. O'Handley*

Session HE contained talks in two general categories, soft nanocrystalline alloys derived from amorphous metals (HE1 to 8) and Si/Fe alloys for transformers (HE9 to 13). It was well attended by a lively and inquisitive audience, undaunted by the intermittent operation of the sound system.

The first talk, invited, described the structure and attractive soft magnetic properties of nanocrystalline Fe-Zr-B (Cu) and related alloys. Between the first (750 K) and second (900 K) crystallization peaks of the amorphous precursor phase a fine (20 nm) bcc phase dispersed in an amorphous matrix is observed. This composite has a resistivity of 56 $\mu\Omega$cm, about half that of the amorphous phase, and shows nearly zero magnetostriction.

Contributed papers, HE 2 to 8, focussed on more specific aspects of bulk and thin film nanocrystalline materials. The coercivity was shown to increase approximately with the cube of the nanocrystalline particle size. Melt spun ribbons based on the $Fe_4N$ phase show large saturation induction (18 kG) due to the strong Fe moment (2.14 $\mu_B$). Partial replacement of Fe by Ni decreases Hc. R.F. sputtering can also be used to produce nanocrystalline films with very attractive high frequency performance. In sputtered films such as FeZrN, the nitrogen makes a suitable glass former to replace boron and a strong anisotropy was able to be induced by field annealing. Thin sputtered films of FeRuGaSi were found to have low magnetostriction ($2 \times 10^{-6}$) and show relative permeability of 200 at 10 MHz. The attractive properties were found in the B-2 phase, not the $DO_3$ structure. Multilayers of Fe/Fe HfC showed interesting grain-on-grain epitaxy near the inter-

face when the amorphous phase crystallized.

Dynamic domain wall images of Si-Fe tape, generated by electron backscattering in an SEM, stimulated considerable interest. 6.5% Si steel prepared by secondary recrystallization was shown to have significantly lower loss ($B_m$ = 1T, $f$ = 50 to 1000 Hz) compared to 3% Si steel. Tertiary recrystallization of 3% Si steel was shown to give sheets with B(8) in excess of 1.9 T. Normal flux transfer between transformer laminations (measured with fine pickup coils placed between the laminations) was correlated with loss and large grain size. Measurements of elliptical fields in grain oriented steel sheets allowed separation of losses into rotational and pure alternating components.

## Session HP: Critical Phenomena and Disordered Systems II

*T.F. Rosenbaum*

This session addressed a broad range of issues associated with Disordered Magnets, spanning statics to dynamics, nearest-neighbor to long-range interactions, lower dimensional materials to bulk systems, perturbations on long-range order to spin glass freezing. Emphasis was found both on previously unobserved responses in particular systems (e.g. quasi-one-dimensional antiferromagnets, dipolar ferromagnets, and amorphous magnets) and on the universal aspects of disorder in magnetism. The session was handicapped by the absence of eight papers, primarily from Russian contributors.

## Session JP: Special Types of Materials

*Mahadevan Ramesh*

Studies on various special types of materials, ranging from magnetic semiconductors to magnetic refrigents to a variety of special applications magnetic garnets were presented.

Paper JP03 discussed anomalous variations of Faraday rotation in Gd doped Germanate IR glasses, as functions of wavelength and doping concentration. An explanation based on the formation of superparamagnetic fine particles of the dopants was proposed. Research on room temperature magnetic refrigents to substitute environmentally unsafe freon was presented in paper JP06. These are compounds of type $R_xR'_{2-x}Fe_{17}$ where R = Y or Pr and R′ = Ce. These inexpensive materials, with large magnetocaloric effects, seem very promising in commercial applications.

JP09 discussed the magnetic characterization of dilute magnetic semiconductor systems, V and Co based sulfides and selenides. Magnetization and susceptibility measurements were made for various compositions and theoretical models were proposed to fit the data and determine the exchange constants. Magnetic properties of $Ti_5S_3$, a material with great commercial potential, contaminated with fine iron particles during the ball milling (manufacturing) process were studied. The observed high magnetic stability was explained in terms of Katayama-Yoshida and Zunger model of interstitial 3d impurities in a polarizable semiconductor host system.

Local variations in the index of refraction in a Bi and Al doped garnet film by local laser annealing was studied in JP11. These variations have been found to be much larger than in Bi, Ga doped films, making this composition a potential target for 3 dimensional channel magneto-optical waveguides. Kerr rotation as a function of wavelength and ellipticity in superlattice-type structures such as Co/Pt and Co/Pd were studied in JP12. The multilayer analysis program developed by one of the authors was used to analyze the magneto-optical spectra. Paper JP15 discussed the effects of inadverdant sodium incorporation in Bi:YIG and YIG films, which were grown from LPE melts in which sodium had to be added to lower melt viscosity. While the magneto-optical effects did not change much, the uniaxial anisotropy in films grown from such melts decreased, compared to the sodium-free films. Calcium doped Bi:YIG sputtered films were studied in JP16. The sample preparation techniques and various magnetic and magneto-optical characterization results were outlined, for their possible applications in magneto-optical devices.

YIG films doped with Sn, Zr and Sb were studied in JP17 and anomalies were found in the temperature dependence of Faraday rotation, below about 50 degrees Kelvin. A tentative explanation in terms of dopant substitution at various crystal sites was proposed. Paper JP18 proposed a novel use of Bi:YIG with in planar anisotropy in detecting very low, alternating magnetic fields, using the magneto-optic effect. In JP19, the authors fabricated Bi:YIG films by pyrolysis and proposed a modification scheme to obtain films with optimum grain size for possible device applications. TbBi:YIG was studied in JP20 and the authors even exhibited an optical isolator fabricated using these films for a wavelength of 1.5 microns. Details of film growth and device fabrication were presented.

## Session KA: Symposium on the Limits of Inductive Recording

*Peter K. George*

Session KA was an experiment in focusing on a topic of current interest in a panel discussion format. Eight invited

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experts each gave ten minute presentations and this was then followed by a panel discussion prompted by audience questions.

Paper KA-01, by Ralph Simmons of HP, focused on the inductive recording requirements for high and low performance 95mm drives. The improvements in supporting technologies required to obtain the necessary signal to noise ratio for acceptable bit error rates were discussed. The conclusion was that existing technology would require breakthroughs in the 1996-1997 time frame.

Paper KA-02, by Paul Frank of AMC, contrasted inductive and magnetoresistive sensing with respect to output sensitivity and performance. The ultra high density recording demonstrations of IBM and Hitachi were compared and the future of MR technology discussed. Performance data for an AMC differential MR head design was presented.

Paper KA-03, by Ed Williams of Read-Rite, presented a hypothetical 400 Mb/in$^2$ inductive head design using conventional thin film heads. The conclusion was that at a 50 nm flying height with pulse equalization and with high coercivity media, acceptable error rates should be obtainable for a 5.25 inch drive.

Paper KA-04, by Hajime Aoi of Hitachi, suggested that 500 Mb/in$^2$ was possible with inductive recording but that higher moment pole pieces would be required to overwrite the high coercivity media, the results presented were for a 5400 RPM 5.25 inch drive.

Paper KA-05 by Jack Wolf of CMRR discussed several state-of-the-art detection and coding alternatives to present drive practice. A block diagram of the presently used channel was contrasted with that proposed for future use in which error correction is combined with the detection process. Also definitions of PRML, DFE and other acronyms were provided for those not expert in communication theory.

Paper KA-06, by Aric Kumaran, reviewed the effect of mechanical constraints on inductive recording. The two aspects discussed in detail were higher RPM spindle design and lower magnetic separation. The point was made that flying height variability would need to be reduced and new gimble designs would be required for contact recording.

Paper KA-07, by David Thompson of IBM gave a historical perspective on past recording projections and then presented scaling arguments for contact inductive recording. The conclusion was that 400-1000 Mb/in$^2$ was probably feasable but the question was — Might this not be easier done with an MR head?

Paper KA-08, by Jim Lemke of Visqus Corp., presented some early results on recording in near contact using a continually replenished lubricant that spins off the disk into a reservoir. The linear density performance appeared to be excellent and areal densities of 1 Gb/in$^2$ were anticipated. Some of the problems of this approach were discussed.

The panel discussion which followed focused on issues such as the feasibility of contact vs non-contact recording, conventional permalloy vs. high moment poles, SNR quantification of channel improvements, MR vs. inductive heads, noise in thin film inductive heads, future mechanical requirements for sliders and air bearings, and the projected limit for inductive recording.

## Session KB: Transition Metal and Rare Earth Magnetism

*Richard J. Gambino*

This session covered a wide range of materials and topics as the name suggests. An interesting metastable magnetic alloy of Gd and Cr was reported in KB-02 by J. H. Hsu et al. from Johns Hopkins University. These elements are immiscible under equilibrium conditions but can be vapor quenched to form metastable bcc or hcp alloys depending on the Gd concentration. The ferromagnetic $T_c$ of Gd decreases with Cr addition.

In KB-03, P. Rudolf et al., AT & T Bell Laboratories, reported on the study of the sublattice magnetization of gadolinium iron garnet using soft x-ray magnetic circular dichroism (SXMCD). By applying this method to a well known garnet system they are able to show that SXMCD can be used to measure element and site specific properties of multicomponet systems.

An intrinsic surface anisotropy contribution in amorphous ferrimagnets was described by Hong Fu and co-workers, University of Arizona (KB-05). This surface magnetic dipole contribution is calculated to be $10^3$ — $10^4$ erg/cm$^3$ in a 1000 Å film of amorphous GdCo. This mechanism gives only a small contribution compared to the single ion anisotropy of the non-S-state rare earths where amorphous alloys have anisotropy energies in the $10^7$ erg/cm$^3$ range.

Magnetic ordering in sputter quenched films of $BiFeO_3$ — $CuFe_2O_4$ was reported by B. U. M. Rao and G. Srinivasan, Oakland Univ., Rochester, MI (KB-06). The as sputtered films are paramagnetic but they develop a large moment when annealed in air at 100 to 550 C. The room temperature moment reaches a maximum when the annealing is in the 500 to 525 C range. These systems are x-ray amorphous but the annealing seems to produce phase separation and precipitation of a magnetic ferrite.

The last paper of the session was one of the most interesting. T. K. Hatwar of Eastman Kodak reported on a high reliability magneto-optic medium (KB-14). By alloying amorphous TbFeCo with both Pd and Zr a medium with improved corrosion resistance is obtained without degradation of the Kerr rotation. The CNR of the medium with 8% (Pd + Zr) was 60 dB in a 30 kHz resolution bandwidth, comparable to that obtained with the undoped TbFeCo medium.

## Session KE: Physics of Novel Materials (Principally Magneto-Optical)

*Paul Fumagalli*

This session on the physics of novel materials was rather heterogeneous. Main topics were quantum well structures, various iron garnets, doped magnetic semiconductors, multilayers, and exotic compounds.

Diluted magnetic semiconductors offer an opportunity to study spin-exchange effects. Using a dynamic Faraday-rotation method the effects of dimensionality on the spin system were studied in a CdTe-CdMnTe superlattice by M. Kohl, IBM Yorktown Heights (KE-01).

An interesting structure was described by B. T. Jonker and co-workers from Naval Research Laboratory (KE-02). In a ZnSe-ZnFeSe quantum well structure they found that both electrons and holes are spatially segregated according to their spin.

A record enhancement of the magneto-optical properties in the IR region was reported in Ce substituted yttrium iron garnet by M. Gomi et al. from Tokyo Institute of Technology (KE-06). The enhancement per Ce ion surpasses that of Bi-substituted YIG.

R. F. Belt and co-workers, Airtron Division of Litton Systems, demonstrated in KE-09 an increase of the coercivity in Bi-Tm garnets by excimer laser processing. The coercivity increased up to 20 Oe.

A nice example of the power of magneto-optical spectroscopy was given by M. Guillot et al. from C.N.R.S., France (KE-10). They determined the magnetic phase transitions in Sm iron garnet by measuring the Faraday susceptibility.

R. J. Gambino and co-workers, IBM Yorktown Heights, reported in KE-04 an unexpectedly high increase in Tc from 16 to 100 K in Tb doped EuS thin films. The increase is much bigger than in Gd doped EuS bulk samples and could be related to introducing vacancies during deposition.

An increase of the magneto-optical properties compared to CoCr thin films was reported in a CoCr/Al multilayer structure by T. Hirata et al., Osaka Vacuum Ltd. (KE-07). For films with an Al interlayer thickness of 7 Å an increase of the Kerr rotation to 0.21 deg was measured.

Using Al interlayers in amorphous TbFeCo films, K. Song and co-workers, Tokyo Institute of Technology (KE-08), could improve the figure of merit in the 400 nm regime.

A novel type of magnetic composite was introduced in session KE-11 by J. J. Krebs et al., Naval Research Laboratory. They are described as permalloy-coated sub-micron diameter hollow organic tubules.

A last talk (KE-13) dealt with the seldom heard magneto-electric effect (J. P. Rivera et al., University of Geneva), the electrical counterpart of the magneto-optic effect.

## Session MA: Recording Systems

*Giora J. Tarnopolsky*

The abstracts for this Friday morning session attracted a large audience. The papers presented dealt with record high-density systems, novel actuators, experimental techniques, and performance models.

Three papers from Hitachi authors (M. Futamoto et al.) described a 2 Gb/in$^2$ system. In order to accomplish this areal density, the authors chose a linear density of 120 kbpi, so as to limit the spacing loss, and a high track density of 17 ktpi. The recording head had separate inductive-record/MR-playback elements. The head also had a laser diode and photodetector for precise positioning of the complete structure above the 1μm-wide tracks. A multilayered Fe-based alloy, $M_s$ = 2T, was used for the record poles. The shunt-biased MR element sensitivity was 400 μV/μm at the head-medium separation of 3.2 μ". The diode laser sensed pits on the glass substrate by measuring the power

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feedback from the reflective disk. (This head was also described in session AC.) The media consisted of a multilayer structure with no isolation layer between the magnetic films, with the structure CoCrPt/CoCrPtSi/Cr — a system deemed to optimize the signal-to-noise ratio. $M_r\delta$ was about 1.6 memu/cm$^2$, and $H_c$ about 2100 Oe. Other innovations in this remarkable work included a two-stage piezoelectric actuator and a partial response channel.

A systematic study of multilayered media was presented by IBM authors (D. C. Palmer et al.). This work follows the investigations of E. S. Murdock et al. presented at the Brighton Intermag in 1990. The new research achieved narrow ranges of overall remanence-thickness products and coercivities, which allowed to better study the effect of multilayering the films. Various Cr underlayer thicknesses were used to control magnetic properties in spite of the wide range of isolation layers used in the CoCrPt/Cr structures. Extensive recording results were presented for up to six-layer films.

Y. Tang and C. Tsang (IBM) presented a most elegant method for measuring non-linear bitshift, as manifested in the Fourier analysis of the playback signal. The authors showed how to construct a record waveform by the linear superposition of three square-wave patterns. The relative phases of the three patterns were such that specific odd spectral components generally vanished. However, those spectral lines could reappear in the spectrum, but only as a consequence of non-linear bit shift. Experimental results were compared to time-domain observations of the same bit-shifted patterns. Good agreement was obtained between time-domain and the new, frequency-domain, analysis.

All of this work, as well as other contributions on modulation noise analysis, perpendicular recording, flexural actuators, track-edge noise, performance models, etc., will make the reading of the forthcoming Proceedings very worthwhile.

## Session NA: Applied Superconductivity

*Dean Peterson*

The session speakers emphasized progress made in the practical development of high temperature superconductors for applications.

K. Sato (Sumitomo Electric Industries) presented the status of their fabrication of wires, tapes, and coils based on bismuth high Tc superconductors clad in silver.

M. Naoe (Tokoyo Inst. of Technology) reported on their development of multilayer films composed of magnetic barium ferrite on top of a high Tc YBa2Cu3O7 superconductor.

R. Spyker (Wright Patterson AFB) described that degradation of melt processed YBa2Cu3O7 upon exposure to moisture appears to proceed primarily along grain boundaries.

A. Naziripour (University of Colorado-Boulder) reported on a method of processing Thallium-based superconducting thin films that involved annealing in face-to-face contact to optimize the thallium content.

T. Uchiyama (Nagoya University) described successful fabrication of a new high speed transitor switch module using a bulk high Tc superconductor core operating at liquid nitrogen temperature.

I. Chen (University of Houston) presented a phenomenological model which explained the field distribution of the trapped magnetic field in high Tc samples.

Conclusions concerning effects of size and geometry on the levitation force between permanent magnets and high Tc superconductors were described based on research conducted at Argonne National Lab.

T. Rossing (Argonne) discussed studies of discontinuities that can develop in guideways of magnetically levitated trains.

T. Tiefel (AT & T) presented high transport critical current densities obtained in layer structures of bismuth based high Tc superconductors coated on silver foils.

H. Lessure (Carnegie Mellon Univ.) described effects of neutron irradiation induced defects on the critical current densities and flux pinning in YBa2Cu3O7 superconductors.

## Session NC: High Frequency Excitations and Devices

*Gerald F. Dionne*

Benjamin Lax and John Pehowich opened this session with an invited paper that described a new perturbation theory approach to the analysis of microwave ferrite phase shifters. Successive application of dielectric and magnetic perturbations using orthonormal modes of a dielectrically loaded waveguide yields improved quantitative agreement for single and double toroidal phase shifters. The method has also been applied to the Faraday configuration of a toroidal ferrite surrounding an electro-optic crystal in a square waveguide.

R. Marcelli, P. De Gasperis, M. Rossi and M. Guglielmi reported on the design of tunable magnetostatic volume wave YIG film delay line filters with controllable bandwidth and dispersion. Insertion losses were less than 2 dB and bandwidths ranged from 20 MHz to 300 MHz.

H. How et al. demonstrated that the use of asymmetric stripline Y-junction circulators can increase both the stop-band width and the power handling capability of microwave filters through the use of the nonresonant properties of the ferrite.

R. Marcelli, P. De Gasperis, and L. Marescialli described planar microwave oscillators based on magnetostatic wave excitations in epitaxial garnet films which serve as straight edge resonators. Since these devices offer both tunability (up to 12 GHz) and high Q (> 4000) performance, they represent attractive compromises between fixed frequency, high Q dielectric oscillators and tunable, lower Q varactor oscillators.

H.A.M. van den Berg outlined his theoretical analysis of magnetostatic surface wave propagation in unbounded plane-parallel film stacks with finite electrical conductivity, from which large deviations from the standard theories for perfectly conducting ground planes were predicted.

B. Lax, R. S. Eng, and N.W. Harris reported on the application of the perturbation approach mentioned in the opening paper to the development of tunable ferrite-loaded electro-optic modulators. The paper concentrated on developing explicit expressions for the phase shifts and frequencies of longitudinal magnetized ferrite cores containing electro-optic crystals in waveguide and cavities.

N. Bilaniuk and D. D. Stancil reported unexpected dynamical spatial variations results in the "unconverted" exit beam from a magnetostatic-optical interaction in an epitaxial YIG film waveguide. The effect observed featured a 500-MHz bandwidth, which was fifty times greater than that of the anisotropic magnetostatic-optical collinear interaction.

M.G. Cottam and A.M. Slavin presented a full dipole-exchange theory of Brillouin light scattering from both the surface and volume SW modes propagating in films with general asymmetrically-pinned surface spins.

## NOMINATIONS SOUGHT FOR 1992 IEEE INFORMATION STORAGE AWARD

Nominations are being solicited by the Selection Committee of the Magnetics Society for the 1992 IEEE Information Storage Award. This award is presented annually for outstanding contributions to the broad area of information storage. The winner will receive a certificate and a remuneration of $2,000. Nominations for the award, sponsored by IBM, are sought from the technical and scientific community at large. Nominees need not be members of the IEEE or one of its societies. Previous winners have included: Sidney M. Rubens, Jay W. Forrester, Reynold B. Johnson, Marvin Camras, and Charles Coleman.

The closing date for nominations is December 15, 1991. Nominations with supporting material should be sent to:

William D. Doyle
Magnetics Society Selection Committee
IEEE Information Storage Award
The University of Alabama
Box 870209
Tuscaloosa, AL 35487-0209

## CALL FOR PAPERS

### Special issue of the IEEE Transactions on Education

Computation and Computers in Electrical Engineering Education will be the topic of a special issue of the IEEE Transactions on Education.

Because of the increasing importance of the role of computation and computers in the electrical engineering curriculum, the IEEE Transactions on Education has decided to devote the issue of November 1992 to this topic, consisting of invited papers from recognized authorities, as well as contributed papers. It is intended that the issue will serve as a source-reference for those planning new courses as well as programs.

Pursuant to this decision, this is a call for contributed papers addressing in novel ways the following and related issues:

i. General curricular issues: What must be taught? What can be left out?

ii. Teaching computing to freshmen: Choice of programming language, dealing with freshmen who are already computer proficient, the two-year gap between teaching programming and its use in the senior year. PC's versus workstations versus mainframes, resolution of conflicts between the electrical engineering department and the service department that teaches programming, and so on.

ii. Computer Science and Computer Engineering Programs within the Electrical Engineering Department: The resulting strengths and weaknesses. Equally welcome are curricular innovations in teaching subjects such as Compiler Design, Microprocessors, Artificial Intelligence, Software Development, Standards and Maintenance, Machine Organization, Operating Systems, Neural Networks, etc.

iii. Specialized Computing in the Curriculum: Circuit Theory, Computer Vision/Speech, Signal Processing, Electromagnetic Field Computation, Logic Circuits, Matrix Methods, Control Theory, Communications, Power Electronics, Power Systems, Symbolic Algebra, Others.

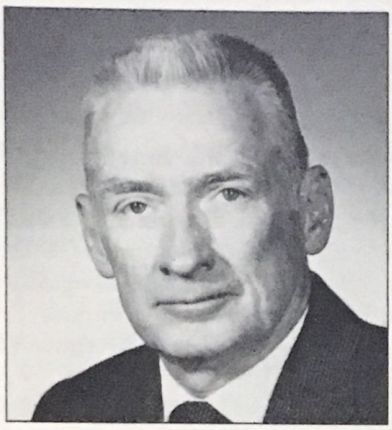
iv. The teaching of Design through computation and optimization

Contributions from overseas describing new teaching methods or their own problems and approaches to them are equally welcome. Interested authors are encouraged to send 2 copies of their contribution by Friday, **February 28, 1992** to

Professor S. Ratnajeevnan H. Hoole
Guest Editor: IEEE T-Ed Special Issue
Department of Engineering
Harvey Mudd College
Claremont, CA 91711.

Further inquiries may be directed to the Guest Editor at: Tel: 714 - 621 8019; Fax: 714 - 621 8465, E-Mail: JHoole@HMCVAX.BITNET

## COLEMAN RECEIVES INFORMATION STORAGE AWARD

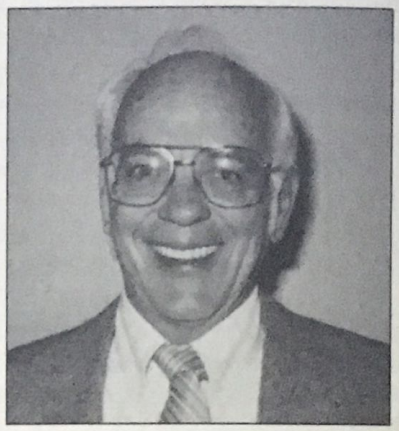


*Charles H. Coleman*

Charles H. Coleman is the winner of the 1991 IEEE Magnetics Society Information Storage Award. Mr. Coleman resides in Redwood City, California and recently retired from the AMPEX Corporation. He began his career in 1947 at the pioneer television station, WBKB, in Chicago, Illinois. He moved in 1953 to the CBS television station WBBM-TV in Chicago and then to AMPEX in Redwood City in 1960. For over 30 years, he was directly involved in the development of magnetic rotary recording systems. In the early 1960's, he showed that the microsecond time base errors found on a rotary head recorder could be reduced to under a nanosecond by using timing information in the color tones and electronic time base corrections. This single invention made color video tape recorders possible. Later, Mr. Coleman participated in an analysis of the FM recording process, which resulted in low distortion, higher bandwidth video recording standards. In the late 1960's, he developed a wide-range, timebase-correcting system employing ultrasonic delay lines and digital control. He spent several years studying high density and high bandwidth magnetic recording techniques, exploring mechanical, electronic, and magnetic aspects. This led to his development in the early 1980's of the DCRS, a six-head transverse scan rotary digital data recorder operating at 117 Megabits per second through a single head-tape interface with a head-tape scanning speed of 2560 inches per second. The system used Class 4 Partial Response post-equalization code and a digitally implemented Viterbi detector.

Mr. Coleman won the 1970 IEEE Vladimir K. Zworykin Award for highly significant contributions to technology of recording monochrome and color TV signals and also the 1970 SMPTE David Sarnoff Gold Medal for many original inventions, in particular for time domain electronic signal correction, making possible direct recovery of color signals from video tape, and for the conception and development of high band color video tape recording, now accepted throughout the world as standard in TV broadcasting. He holds more than 17 patents, many of which are still critical to television recording.

## HIGHLIGHTS OF TAB TECHNICAL MEETINGS COUNCIL ACTIVITIES



*Chuck Buntschuh*

*Chuck Buntschuh, July 15, 1991*

Through the good offices of Martin Schneider, the Director of the IEEE Division IV (Electromagnetics and Radiation), I have recently been appointed the Division's representative to the Technical Meetings Council of TAB.

The Technical Meetings Council is the new name for the old Meetings Committee, under the new organization of TAB. The Council recommends technical meetings policy to the Technical Activities Board, and is responsible for overseeing all technical meeting activities involving TAB, and assists Societies and other TAB entities in development and organization of technical meetings by providing information and guidance regarding IEEE policies and procedures.

The Council is working on a number of projects for 1991. In this report I'll highlight several which should be of general interest to those involved in planning, administrating, and managing technical conferences.

A new edition of the *Conference Manual* is into its second draft; the final document should be available to the Societies by the end of the year. Besides bringing the old edition up to date, the new one will be greatly expanded and so arranged that each Steering Committee member will find everything he or she needs in one chapter. Also it will contain a lot of checklists and blank forms to help make each committee member's job easier.

Last year a software package had been developed and introduced for Conference Registration. This year another package has been added for tracking of papers submitted to a conference. The program is now available for what might be considered alpha testing - I don't think it has been tested in action yet. Most of the larger Societies and Conferences already have well-developed systems, or let the jobs to outside contractors and thus may not have a need for these programs. However, if your Society or Conference is not so furnished, you may find one or the other of them a real boon.

What could be of considerable interest to all Societies is that the IEEE is getting into the conference management business. The Conference Management Services enterprise will be under the direction of the Technical Meetings Council and will offer a menu of services which ultimately

will cover everything from site selection to all of the local arrangements functions. The program is being run by IEEE staffer Mr. Peter Sensi, who is quite experienced in conference management. Also it will not be financially underwritten be the IEEE and must stand on its own and compete in the open market. Phase I of their business plan, which is already underway, is to manage several small conferences which have been contracted by the Technical Activities Department for several years. Phase II, which is also off to a modest start, will be to offer a limited menu of services. Phase III will provide the entire smorgasbord.

For more information, call Peter Sensi or Suzanne DeFilippo at the IEEE Service Center, Piscataway, NJ, 908-562-3871. This office can also supply more information on the registration and paper-tracking software. In my next report, I'll go into more detail on the program and what it has to offer.

# REPORT OF THE DIVISION IV DIRECTOR

*Martin V. Schneider, September 12, 1991*

## The Joys and Sorrows of Plagiarism

Since the beginning of this year I have been serving as chairperson of the Ethics Committee of the IEEE Technical Activities Board (TAB). Its mission is to investigate and recommend action to TAB and its entities (35 Technical Societies and Technical Councils) on ethical issues. As part of our assignment we contacted a number of IEEE editors and members of TABAC (Technical Activities Board Administrative Council) and asked them to let us know about recent occurrences of plagiarism and related ethical problems in publishing. Here are some of the horror stories which were brought to our attention:

- Jan Brown, President of the IEEE Ultrasonics, Ferroelectrics and Frequency Control Society, reported that a paper was referred to a reviewer who recognized that it was a replica of an article he himself had published ten years earlier. The referee rejected the paper, stating only that the work was not new.
- Steve Maas, editor of the IEEE Transactions on Microwave Theory and Techniques, wrote me a letter with a long list of problems related to publication ethics. In one case an author had published the same paper in the European Microwave Conference Proceedings and IEEE Transactions. In addition, one coauthor was omitted in the Transaction paper.
- Leda Lunardi, Associate Editor of the IEEE Electron Device Letters, informed me that an author had published the same paper in her journal and in the Applied Physics Letters. The author subsequently offered an apology, stating that he had been under physical and mental stress and was in ill health. It turned out that the paper had been submitted to the two journals on the same date.

  I would like to add that my own work has been copied (including the figures) on two occasions. As an author I felt flattered at the time because it indicated to me that my contributions were not only correct, but also relevant.

My committee on TAB Ethics has come up with the following preliminary recommendations to resolve these problems:

1. Raise the awareness of potential authors that CD-ROM databases (publications stored on read-only compact disks) are a powerful tool to find plagiarized contributions or repeated versions of the same work.
2. Attack the "publish or perish" syndrome by encouraging and emphasizing the value of poster sessions and workshops at technical conferences.
3. TAB is requested to appoint a task force to propose specific actions which will discourage unethical publication practices.

## IEEE Colloquium 1992

The year 1992 will mark the birth of the European Economic Community which will consist of 12 countries with a total population of 330 million. The event is not only of political and economic significance, but is also a challenge and opportunity for the IEEE to enhance the services offered to our members in Region 8 and at the same time to increase the IEEE membership in the EEC and surrounding countries. The following special events are being planned:

1. EUROCON '92 — IEEE Conference on European Electrotechnology in a Worldwide Market. This conference is sponsored by the IEEE Region 8, the Communications Society, Computer Society and the Switzerland Section of IEEE. It will be held from May 18-21, 1992 at the Congress Centre in Zurich, Switzerland. The first day will be reserved for tutorials, followed by workshops on the second day, and talks by industry leaders on the last day of the conference.
2. IEEE Colloquium '92.
   The purpose of this program is to offer the IEEE Sections in Region 8 the opportunity to invite a lecturer of their choice to present a one-day or two-day tutorial on a topic which will benefit the members. The events will take place throughout the year and will be sponsored by the IEEE Societies which are active in the Region, the IEEE Technical Activities Board, and IEEE Region 8.

   I am working actively with our Society President, Stanley Charap, to ensure that the Magnetics Society will be fully represented in this activity by suggesting speakers and topics which will interest our members and stimulate the technical activities in our field of interest. We plan to make good use of existing resources such as our Distinguished Lecturer Program which could be enhanced by additional experts who are already located in Europe. A meeting is planned during the forthcoming visit of Georgio Molinari (University of Genova, Italy and Region 8 Education Chairman) at the IEEE Service Center in Piscataway to work on some of the details of this program.

**DIVISION DIRECTOR** *(Continued on page 18)*

**DIVISION DIRECTOR** *(Continued from page 17)*

The Colloquium '92 organizing committee is co-chaired by Kurt Richter, Director Region 8, Troy Nagle, Past Vice-President of TAB, and Ed Parrish, Director Division V.

## New Technology Directions

The September 1991 report of the IEEE New Technology Directions Committee identifies key technologies which are expected to play a crucial role in this decade. The committee reports to the Technical Activities Board and is chaired by Bernard Yokelson. Its mission is to anticipate and determine the direction of new emerging technologies and to spearhead their investigation and development by the IEEE. The emphasis is on new, emerging technical areas which are not adequately covered by existing IEEE Societies and Councils, or which overlap the fields of interest of the existing Societies and Technical Councils.

As a member of the committee I made a number of suggestions on how to fulfill our mission. A survey was conducted in which the Society Presidents were asked to provide us with a list of "Key Emerging Technologies". The survey was divided into two areas: "Technologies Offering Solutions to Problems" and "Problems that Need a Technological Solution". The results of our survey were as follows:

I. Technologies Offering Solutions to Problems

| Rank | Technologies |
|---|---|
| 1 | High Performance Computing |
| 2 | Superconductors |
| 3 | Sensors and Signal Processing |
| 4 | Manufacturing Technology |
| 5 | Parallel Processing |
| 6 | High-Speed Digital Computer Network |
| 7 | New Materials |
| 8 | Robotics |
| 9 | Expert Systems |
| 10 | Microelectronic Circuits and Chip Capacity |

It is to be noted that about half of the above topics (Rank Numbers 1, 3, 5, 6, 8 and 9) are related to computers which are needed to process, store and transmit data and to crunch numbers. The problems and priorities are substantially different if we look at the next table:

II. Problems that Need a Technological Solution

| Rank | Technologies |
|---|---|
| 1 | Energy |
| 2 | Environmental Issues |
| 3 | Quality & Reliability in Manufacturing |
| 4 | Education |
| 5 | Information Access |
| 6 | Writing Software |
| 7 | Health Care |
| 8 | Software Reliability |
| 9 | Measuring — Improve Productivity & Quality |
| 10 | Testing of Complex Systems |

The consensus of our New Technology Directions Team was to proceed as follows:

- Focus action on the top-ranked problems which need a technological solution.
- Create steering committees for each topic after the model of the IEEE Steering Committee on Environmental, Health and Safety Issues pioneered by Diana Bendz.
- Encourage organizing "Emerging Technology Workshops" at IEEE Regional Conferences.
- Support the ongoing production of IEEE Videotapes on Emerging Technologies.

Our committee is interested in suggestions from the members of the Magnetics Society on ways to expand our activities and meet our mission. We are specifically interested in hearing about areas and topics which are not yet covered by the Societies and which may require the creation of a new entity, such as a forum for inventors or consultants. Please feel free to send any communication by mail, phone, FAX or electronic mail to

Martin V. Schneider
AT&T Bell Laboratories
791 Holmdel-Keyport Road
P.O. Box 400
Holmdel, NJ 07733-0400

Phone: (908) 888-7122
FAX: (908) 888-7074
E-MAIL (internet): mvs@hoh-1.att.com

## NATO-ASI SUMMER SCHOOL ON HIGH DENSITY DIGITAL RECORDING

This Advanced Study Institute will be held June 7-19, 1992 at the conference center "Il Ciocco" in the region of Tuscany in Italy. This ASI is designed to introduce young scientists and engineers to the field of high density digital recording. The ASI will cover both the fundamental aspects of digital recording and recording media and the engineering associated with their various applications. The multidisciplinary aspects of research in this economically important area of science and technology will be emphasized. Limited financial help is available to graduate students to attend this ASI.

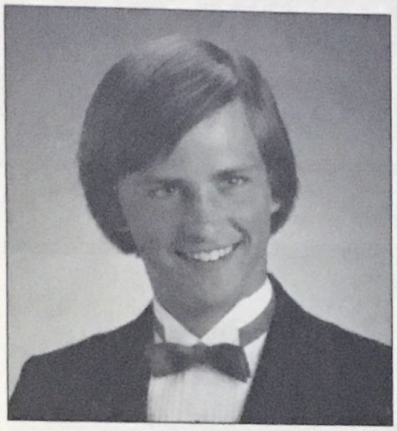
**The Invited Lecturers are:** A. Bell, IBM (USA), B. Bhushan, IBM (USA), R. W. Chantrell, Univ. Keele (UK), U. Gradmann, Techn. Univ. Clausthal (FRG), P. Hansen, Philips (FRG), H. Hibst, BASF (FRG), H. Jouve, CEA-LETI Grenoble (F), C. J. Lin, IBM (USA), S. B. Luitjens, Philips Res. Lab. (NL), B. K. Middleton, Univ. Manchester (UK), W. Reim, Siemens (FRG).

**For more information, please contact:**

**In America:** Prof. G. J. Long, Department of Chemistry
University of Missouri-Rolla, Rolla, MO 65401, USA
Tel.: 1-314-341-4438, Telefax: 1-314-341-6033
BITNET/EARN: C3126A at UMRVMA

**In Europe:** Prof. F. Grandjean, Institut de Physique, B5
Université de Liège, B-4000 Sart Tilman, Belgium
Tel: 32-41-563632, Telefax: 32-41-562355
BITNET/EARN: U2121FG at BLIULG11

## MERIT SCHOLARSHIP WINNER



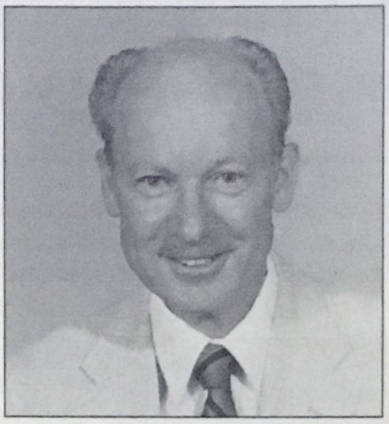
*John D. Owens*

We are happy to announce that the winner of the 1991 National Merit Scholarship, sponsored by the IEEE Magnetics Society, is John D. Owens, son of John M. Owens and Diane Owens of Los Gatos, California.

John will attend the University of California at Berkeley, and is interested in a career in electrical engineering. He has participated in NASA's Student Space Biology Program in which he worked with one of the scientists in the Electronic Systems Branch at NASA Ames Research Center. John helped with technical drawings, mathematical simulations, and troubleshooting.

John enjoys water polo and swimming and has been a regular contributor to his school newspaper. He is an Eagle Scout, and served on his town's Parks Commission and on the board of directors of *A Place for Teens,* a community group which is attempting to bring a teen center to Los Gatos.

## GSCHNEIDNER WINS SPEDDING AWARD



*Karl A. Gschneidner*

Karl A. Gschneidner of Ames Laboratory, the Rare-earth Information Center and Iowa State University (ISU), received the prestigious Frank H. Spedding Award this summer at the 19th Rare Earth Research Conference in Lexington, Kentucky. Gschneidner is a senior metallurgist at the Department of Energy's Ames Laboratory, Director of the Laboratory's Rare-earth Information Center and a distinguished professor of materials science and engineering at ISU.

This award, the sixth ever given, honors Gschneidner for his leadership and distinguished contributions to the field of rare-earth science, especially to the physical metallurgy and solid state physics of rare-earth materials. It is particularly meaningful to Gschneidner, who studied under Spedding at ISU in the mid-1950's.

Gschneidner is senior editor of the 14-volume *"Handbook on the Physics and Chemistry of Rare Earths"* and a member of the IEEE Magnetics Society.

## MAGNETICS SOCIETY SCHOLARSHIP PROGRAM COMPETITION

We are pleased to announce the 1993 competition of the Magnetics Society Scholarship Program. This program has been established for the children of Magnetics Society members through the annual nationwide scholarship competition conducted by the National Merit Scholarship Corporation.

One Magnetics Society Scholarship will be awarded in the Spring of 1993 to a student who will complete high school requirements and who will enter a regionally accredited U.S. college in 1993 to pursue courses of study leading to one of the traditional baccalaureate degrees.

The Magnetics Society winner will be chosen through the facilities of NMSC from among children of Magnetics Society members who meet the competition requirements established by NMSC. The winner will be chosen on the basis of test scores, academic record, leadership, and significant extracurricular accomplishments.

The Magnetics Society Scholarship will be a renewable award covering up to four years of full-time study or until baccalaureate degree requirements are completed, whichever occurs first. The amount of the stipend accompanying the scholarship will be related to the individual winner's financial situation and the costs of attending the college of the winner's choice. The maximum amount that may be awarded to a winner is $4,000.00 per year; the minimum will be $1,000.00 per year.

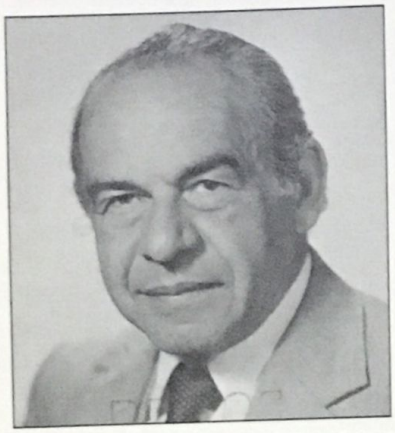
Descriptive material and entry blanks for the Magnetics Society Scholarship may be obtained by writing to the Magnetics Society Scholarship Program Director listed below. Interested children of members should arrange to take the PSAT exam in October of this year if they are high school juniors.

Completed entry blanks must be returned to the Program Director by January 1, 1992.

Dr. Bernard R. Cooper
Magnetics Society Scholarship Program Director
% Department of Physics
West Virginia University
Morgantown, WV 26506

# MAGNETICS SOCIETY ANNOUNCES THREE DISTINGUISHED LECTURERS FOR 1991 - 1992

The Magnetics Society is pleased to announce its Distinguished Lecturer program for 1991-1992. Magnetics Society chapters wishing to invite these speakers should contact them directly. Anyone seeking more information about this program can contact Edward Della Torre at (202) 994-5517.



## DR. PAUL P. BIRINGER

### Shielding and Use of Electromagnetic Fields to Improve the Efficiency of Processes and Devices

General introduction to eddy current phenomena, skin and proximity effects. Applications to induction heating, induction furnaces, arc and submerged arc furnaces. Electromagnetic molds and stirring. Estimation of induced losses in structural parts and in steel structures. Calculation of process efficiency.

#### Biography

Dr. Biringer is Professor Electrical Engineering at the University of Toronto. He received his Dipl. Eng. degree from the Technical University of Budapest, his M.A.Sc. degree from the Royal Institute of Technology, Stockholm and his Ph.D. from the University of Toronto, all in Electrical Engineering. He is a Fellow of IEEE and A Fellow of the Canadian Academy of Engineering. He is consultant to Ajax Magnethermic Corporation and to Hatch Associates Ltd. in the field of electric furnaces, induction heating, and electrometallurgical installations. Professor Biringer has many patents related to magnetic and solid state frequency changers, induction heating and shielding and over two hundred publications.

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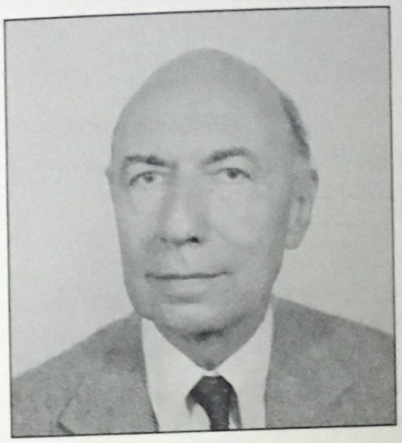

## DR. FRITZ J. FRIEDLAENDER

### From Ferrite Cores to Bloch Lines

Much of the progress in the understanding of the magnetization process and magnetic structure in thin films has been driven by the quest for better magnetic memories. The main emphasis of this talk is on the concepts of magnetic domains, domain walls and Bloch lines and their structure, with a discussion of wall and Bloch line chirality. Applications to a Bloch line memory and the direct optical observation of vertical Bloch lines will also receive attention as well as the concept of gyrotropic force.

#### Biography

Dr. Friedlaender received his B.S., M.S., and Ph.D. degrees in electrical engineering at Carnegie Institute of Technology (now Carnegie Mellon University). He is a Professor of Electrical Engineering at Purdue University and has had an active magnetics research group there since his arrival in 1955. Over the years he has moved from studies of the magnetization process in NiFe tapes, flux reversal processes in ferrites and domain wall structures in permalloy thin films, to such areas as high gradient magnetic separation and microwave ferrites. Current work includes research on wall and Bloch line dynamics in garnet films, preceded by research on magnetic bubble dynamics.

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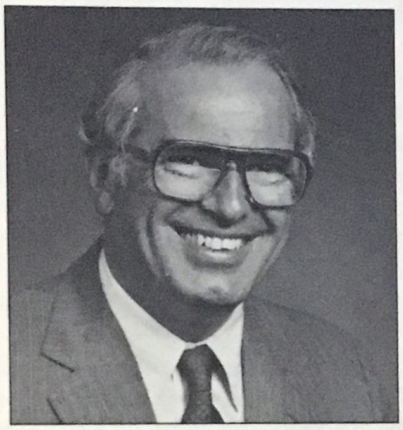

## DR. JAMES U. LEMKE

### Proximate Contact in Magnetic Recording

High-density magnetic recording is limited by the conflicting need to maintain the spacing between the head and storage medium as small as possible and the need for durability. Since the dominant losses in recording and reproducing are exponentially dependent upon the ratio of the spacing and the inverse wavelength, high recording densities of current and projected recorders/drives dictate near-contact between the head and medium. Inevitable asperity contacts generally limit the durability of the interface in current disk applications.

Efforts to prevent contact while achieving acceptably small interface spacings will be reviewed with emphasis on new liquid interfaces using non-Newtonian liquids. Wet-disks at head-spacings of 25 nm (1 μin.) can be made that exhibit no discernible wear after greater than 1E6 start-stop cycles. Other approaches to zero-contact recording will be discussed.

#### Biography

Dr. Lemke has been active in magnetic recording R&D most of his professional life. He is a member of the National Academy of Engineering and Adjunct Professor at UCSD. He received a Ph.D. in Theoretical Physics in 1966 from UCSB and has published a number of papers on the theory and practice of magnetic recording. He has also been granted a number of patents in the field. The Center for Magnetic Recording Research at UCSD was founded largely through his efforts and the efforts of Professor Al Hoagland, Santa Clara University.

In 1986 he founded Recording Physics, Inc. where he and his staff are currently developing new high-density tape recording technology. With Dr. Jeffrey Nash he co-founded VISqUS Corp., a disk drive development company perfecting his technology in wet-disk technology, (now a subsidiary of Conner Peripherals). In 1968 he co-founded Spin Physics, Inc. (now an Eastman Kodak Division), a major developer and manufacturer of magnetic recording heads and high-speed electronic/magnetic cameras, where he was President and CTO for 15 years. His earlier R&D in recording was at Bell & Howell Research Labs and IBM Watson Scientific Computing Labs at Columbia University.

He is a Member of the IEEE Magnetics Society, APS, AAPT, and STLE.

James U. Lemke
Recording Physics, Inc.
3560 Dunhill Street
San Diego, CA 92121
Tel: (619) 587-4040
FAX: (619) 587-8760

## CONFERENCE PROCEEDINGS AVAILABLE

If you were unable to attend a recent conference you can still order the conference proceedings. To order or request a free catalog call toll free in the U.S. and Canada 1-800-678-IEEE. In other countries call (908) 981-0060 or FAX (908) 981-9667. Or write IEEE Customer Service Department, 445 Hoes Lane, PO Box 1331, Piscataway, NJ 08855-1331 USA. In Europe, the Middle East, Africa or the USSR contact the New Brussels Office: call 32.2.770.22.42., FAX 32.2.770.85.05 or write IEEE TAB Office, 13, Avenue De L'Aquilon, B-1200 Brussels Belgium.

## NSF ANNOUNCES RESEARCH-EDUCATION PROGRAM

The Engineering Directorate of the National Science Foundation is announcing a new focus on innovative, combined research-curriculum development in technological areas of national importance. The objective of this important effort, for which NSF is seeking proposals, is to stimulate classroom involvement of research-oriented faculty. There are two components to this program: one involves research and the other, education. The research must include, although it is not confined exclusively to, an electrical and communications systems component and may involve only other disciplines represented by the Divisions of the Engineering Directorate. Proposals would be expected to show how such research results can be integrated into new or existing curriculum. Institutions would be required to commit to the utilization of such curriculum components. The deadline for submission of proposals to NSF is the end of January 1992. Inquiries regarding the education component of the program can be made to Dr. Frank D. Draper (202/786-9634), and to Dr. Albert B. Harvey (202/357-9618) regarding the research topic areas.

# FINAL CALL FOR PAPERS

## Conference on Electromagnetic Field Computation

The fifth IEEE biennial conference on electromagnetic field computation will be held at Harvey Mudd College in Claremont, California on August 3-5, 1992.

**The IEEE CEFC:** The IEEE Conference on Electromagnetic Field Computation was begun to bring together under one forum, scientists, engineers and other enthusiasts who had previously worked independently on electromagnetic field computation in such diverse areas as magnetics, micromagnetics, power, microwaves, antennas and propagation, remote sensing, optics, and biomedical engineering, among others, and thereby engender cross-fertilization of ideas. The need for such a forum and the success of the idea are reflected in the unusual and consistent growth of the conference over the years in both society sponsorship and attendance.

**Topics of Interest:** This is a call for papers on all aspects of electromagnetic field computation and its application in engineering for the Fifth IEEE CEFC. Numerical methods such as the finite element, finite difference and boundary element methods and their applications to specific industries, as much as algorithmic and software techniques like parallel computing and graphics post-processing are considered within the legitimate purview of the conference.

**Electromagnetics Education:** For this conference is also envisaged, under a special arrangement with the IEEE Education Society, a workshop on Computational Electromagnetics in Teaching Electromagnetics. So also is a pre-conference, 2-day, short course on Computational Electromagnetics for instructors of Engineering Electromagnetics that will be offered free on a limited basis by the CEFC for the furtherance of the discipline. Thus, papers on the use of software in electromagnetics education and curricular issues related to computation in electromagnetics education, are especially welcome.

**Publication Process and Deadlines: By February 21, 1992,** submit a 2 page digest to the IEEE CEFC Secretariat. The digest should emphasize results to show completeness of the work. Authors of accepted digests are invited to submit full papers by Aug. 4, 1992 for review for possible publication in the special CEFC sponsored issues of the IEEE Transactions on Magnetics or the IEEE Transactions on Education, as appropriate.

**TEAM/ACES Workshop:** The conference will be followed by a TEAM/ACES Workshop on the validation of computer code for field computation during Aug. 6-7, 1992.

**For more information contact:**

**CEFC Secretariat,** Harvey Mudd College, Claremont, CA 91711, U.S.A., Tel.: 714 - 621 8019, Fax: 714 - 621 8465, EMail: CEFC@HMCVAX.BITNET

**General Chairman & Special Issues Editor,**

S. Ratnajeevan H. Hoole, Harvey Mudd College

# OBITUARIES

## Gilbert Y. Chin

Dr. Gilbert Y. Chin, 56, passed away 5 May 1991. He recently retired as Director of the Passive Components Research Laboratory at AT&T Bell Laboratories.

Dr. Chin received S.B. and Sc.D. degrees in Metallurgy from Massachusetts Institute of Technology in 1959 and 1963, respectively.

Since joining Bell Laboratories in 1962, his research activities have been directed at, understanding the magnetic and mechanical behavior of metals and alloys, and at utilizing such understanding in developing commercially-useful alloys. He studied the mechanisms of slip-induced magnetic anisotropy in several alloy systems, and was involved in the development of magnetic alloys used in the magnetic memories and telephone receivers. He held a number of positions including: Head, Physical Metallurgy and Ceramics R&D Department; Director, Materials Research Laboratory; and Director, Passive Components Research Laboratory. He has served on a number of magnetics, metallurgy and materials society committees and advisory boards.

Dr. Chin was granted 11 patents and authored or coauthored 140 papers and three books. He was elected a member of the National Academy of Engineering in 1982 and ASM Fellow in 1983. To honor him, a graduate fellowship in his name is being funded in the Department of Materials Science and Engineering at M.I.T. Contributions can be sent to Professor Merton Flemings of M.I.T.

## Charles H. Wilts.

Professor Charles H. Wilts, IEEE and Magnetics Society member, passed away last March, 1991. He received his B.S., M.S. and Ph.D. degrees from Caltech in Pasadena, California, and has been a Caltech faculty member since 1947. In this capacity he taught, did research, initially in the field of Analog Computation, and later in Ferromagnetic thin films, and helped run the institute in various capacities including as executive officer for Electrical Engineering between 1972 and 1975. His high standards resulted in some of the best work in magnetic films, their synthesis, structure, static and dynamic properties as well as instrumentation and methods to characterize such properties as described in over 50 of his publications. His contributions and those of his students have become key reference standards in this field, a field important to storage of information in the computer and consumer electronics industries. He was also a lover of nature, an outdoorsman and a sportsman. He knew where to find the best helicopter skiing, the best white-water rafting, the best hikes in the Sierras, as well as the best rock climbing. We will all miss him, but, we will never forget him. His many and varied accomplishments, in his professional and private life, will survive all of us.

# *CONFERENCE CALENDAR*

**DECEMBER 9-10, 1991**

**CAMST Areas A and B Topical Meeting on Magnetic Recording.**
University of Manchester, England.
B.K. Middleton, Dept. of Electrical Engineering,
Manchester University, Dover Street, Manchester, M13 9PL,
Tel: +44-61-275-4551 or +44-61-275-4555, FAX: +44-61-275-4512.

**APRIL 13-16, 1992**

**International Magnetics Conference (INTERMAG),**
St. Louis, Missouri.
Ms. Diane Suiters, Courtesy Associates,
655 15th St NW, Suite 300, Washington, DC 20005,
Telephone: (202) 639-5088.

**JUNE 7-19, 1992**

**NATO-Advanced Study Institute on High Density Digital Recording.**
Il Ciocco, Italy.
Details on p 18.

**JULY 3-8, 1992**

**Second International Symposium on Physics of Magnetic Materials.**
Beijing, China.
Prof. Yang LUO, San Huan R/D Center, Academia Sinica,
PO Box 603, Beijing 100080, PR China,
Telex: 222592 SHI CN FAX: 2561268 or Dr. Karl Strnat,
KJS Associates, 1616 Hillrose Pl, Fairborn, OH 45324.

**JULY 16, 1992**

**Rare-Earth Magnets and Their Applications,**
**Twelfth International Workshop.**
Canberra, Australia.
Robert Street, Dept. of Physics, U of Western Australia,
Nedlands WA 6009 Australia.
Phone: (90) 380-2751 FAX: (09) 380-1014.

**AUGUST 3-5, 1992**

**Conference on Electromagnetic Field Computation,**
Harvey Mudd College, Claremont, CA, USA.
Details on p. 22.