IEEE MAGNETICS SOCIETY NEWSLETTER

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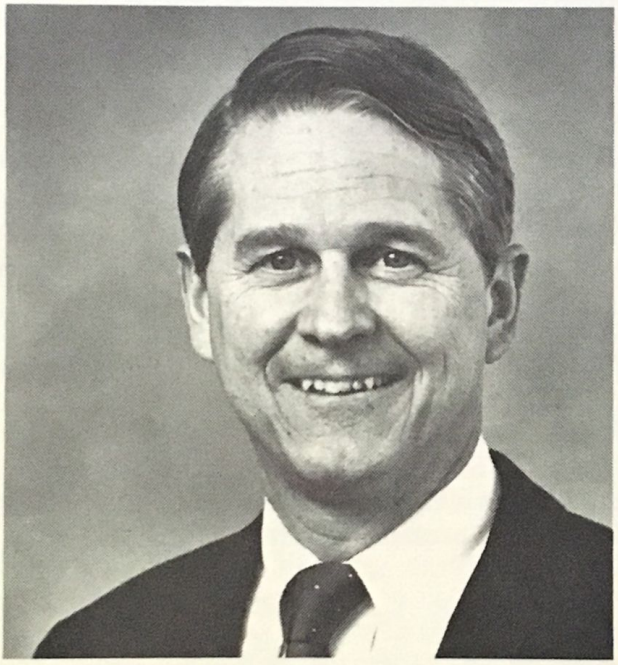
CRAIG PERLOV, EDITOR

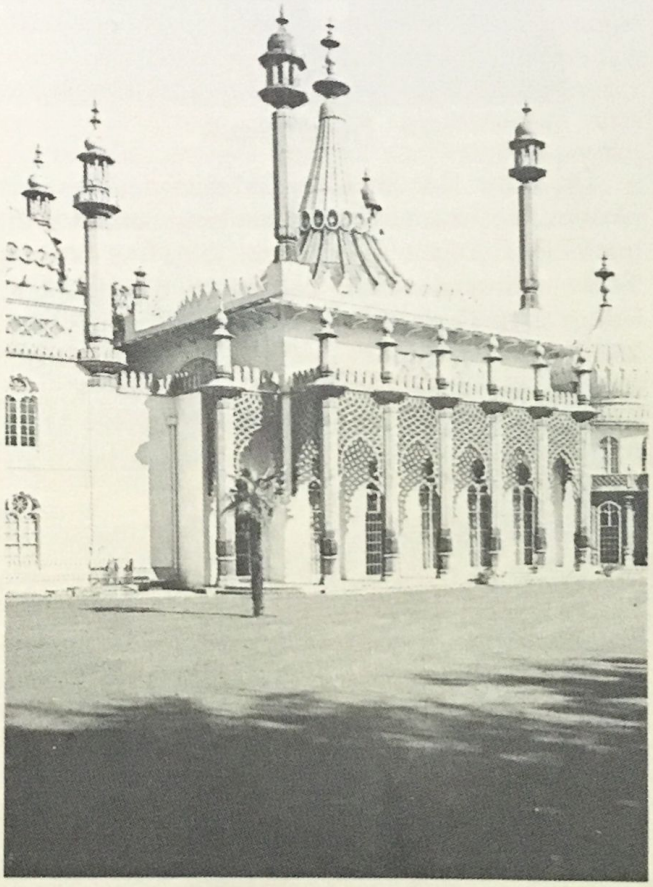
PRESIDENTIAL APPOINTMENT



R. M. White

Robert M. White has recently been appointed by President Bush as Under Secretary of Commerce for Technology. This is a new position created by the Omnibus Trade and Competitiveness Act of 1988. The Under Secretary serves as the Commerce Department's principal adviser to the Secretary and spokesperson for science and technology policy matters, and develops and promotes Federal technology policies to increase U.S. commercial and industrial innovation, productivity, and growth. The Under Secretary is also responsible for managing the Technology Administration, a new organization created by the Trade Act which includes the National Institute of Standards and Technology (NIST), the Assistant Secretary for Technology Policy, and the National Technical Information Service.

1990 INTERMAG CONFERENCE



The 1990 INTERMAG conference was held in Brighton, England from April 17 to April 20. The chairman's summary was not available at press time, but the session summaries are included in this issue of the newsletter. There were 900 papers divided into 55 sessions including a tutorial session on biomagnetism. Approximately 1100 people were in attendance.

(Session Summaries begin on Page 6)

NEW EDITOR OF TJMJ APPOINTED

Dr. Takao Suzuki

Dr. Takao Suzuki of the IBM Almaden Research Center, San Jose, California has been named as the new TJMJ Editor. Dr. Suzuki joins the ongoing TJMJ editorial team, consisting of Managing Editor Dr. Thmasz Jagielinski, Eastman Kodak, and Associate Editors Dr. W. G. Haines, Digital Equipment Corporation, Dr. D. R. Krahn, Honeywell, and Dr. J. E. Monson, Harvey Mudd College, in their work with this pioneering IEEE journal.

Persons interested in more information on TJMJ are invited to contact Dr. Suzuki:

Dr. Takao Suzuki, Editor
Translation Journal on Magnetics in Japan
IBM Almaden Research Center
650 Harry Road
San Jose, CA 95120-6099

The IEEE Magnetics Society Newsletter is published quarterly by the Institute of Electrical and Electronics Engineers, Inc., 345 East 47th Street, New York, NY 10017. The objective of the Newsletter is to publicize activities, conferences, workshops, and other information of interest to the membership of the Society and technical people in the general area of applied magnetics. Copy is solicited from the S-Mag membership, organizers of conferences, officers of the Society and local chapters, and other individuals or organizations with potentially relevant material. Copy should be sent to Dr. C. M. Perlov, Hewlett-Packard Labs, MS-2U, P.O. Box 10490, Palo Alto, CA 94303.

Takao Suzuki was born in Tokyo, Japan in 1938. He obtained B.S. and M.S. degrees in 1962 and 1964, respectively, from Waseda University, Tokyo. He received the Ph.D. degree in electrical engineering in 1969 from the California Institute of Technology. From 1969 to 1972, Dr. Suzuki was a visiting scientist at the Max Planck Institute fur Matallforschung in Stuttgart, where he worked on the electron microscopy and domain wall structure of magnetic thin films. In 1972, he joined the Department of Applied Physics, Tohoku University, Sendai, Japan as an Associate Professor. In 1978, Dr. Suzuki was a Visiting Professor at the Hungarian Academy of Science, Budapest, where he worked on magnetic bubbles. In 1988, Dr. Suzuki joined the Optical Storage Science and Technology Department of the IBM Almaden Research Center. His research interests include microstructure and magnetism in bulk magnetic materials and thin films. His current research at IBM involves magneto-optical recording materials.

Dr. Suzuki holds memberships in the Magnetics Society of Japan, IEEE Magnetics Society, the Materials Research Society, the Japan Society of Applied Physics, and the Physical Society of Japan. He is a member of the Steering Committee of the Magnetics Society of Japan and he is a member of the Corporate Participation Committee of the Materials Research Society.

NOMINATIONS INVITED FOR 1991 IEEE EDISON MEDAL

The IEEE Edison Medal was established by our predecessor Society, the AIEE, in 1904. It is presented for "a career of meritorious achievements in electrical science or electrical engineering or the electrical arts." The award consists of a gold medal, small gold replica, certificate and $10,000. IEEE members are strongly encouraged to submit candidates for consideration for this prestigious award and thereby support the Institute's program of recognition for outstanding technical achievement. Nominations must be received at IEEE Headquarters no later than *July 1, 1990*. Nomination forms and information may be obtained by contacting: Maureen Quinn, IEEE Awards Board Administrator, 345 E. 47th St., New York, NY 10017. Tel (212) 705-7882; Fax (212) 752-4929.

THE LOST ART OF ORATORY: DAMN THE OVERHEAD PROJECTOR

John S. Rigden

A dense quiet came over the crowd as the President of the United States stepped to the speaker's table. He placed a transparency on the stage of the overhead projector, and onto the screen was projected a map of the original 13 colonies of the United States. "Eighty-seven years ago," he began, as the image of his finger was seen to trace the coastline from North Carolina to Delaware, "this was the new country that our forefathers brought to us: North Carolina, Virginia, Delaware, *et cetera*. The propositions on which they based their thinking are contained in this famous document." The screen went brightly blank for a moment as the 13 colonies disappeared. Then a page of beautiful calligraphy starting with the words "We hold these truths to be self-evident," splendidly illuminated, came into view. The President turned, looked in silence at the projected words and smiled, obviously moved by the impact of their message. "Now our nation," he continued, shuffling through the stack of transparencies on the table, "is divided by civil war"–another map appeared, appropriately rendered in blue and gray-"which not only tests the basic propositions"–back came the illuminated words of the Declaration of Independence–"on which the country is based, but also threatens its very existence." And with that, the President brought back the transparency, took a wax pencil from his shirt pocket and proceeded to draw a sawtooth black line, which rent the national into two jagged-edged, broken, blue and gray parts. "We are here today . . ."

But Abraham Lincoln had no overhead projector. Without visual aids, with words alone, Lincoln spoke *to* his audience: "Fourscore and seven years ago our fathers brought forth on this continent a new nation, conceived in liberty and dedicated to the proposition that all men are created equal. Now we are engaged in a great civil war, testing whether than nation or any nation so conceived and so dedicated can long endure . . ." We all remember these powerfully moving words and we recite them still, 126 years later.

Contemporary physicists *do* have overhead projectors, and through their constant use we have developed an addiction to them. Physicists like symbols and diagrams; symbols and diagrams can easily be drawn on a transparent surface; drawings can be projected onto a screen. Ergo, a symbiosis.

Physicists employ various styles in their use of overhead projectors. There is the *big stack of transparancies* physicist, who in a 50-minute talk is able to move through transparancies at an average rate of about two per minute. The big stackers are typically fast talkers. There is the *efficient transparency* variety. Physicists of this ilk can condense one-quarter-of-a-century's worth of mathematical physics onto one transparency. With this technique a speaker has virtually all the needed information at his or her fingertips; unfortunately, all too often, little of that information is successfully transmitted to the audience. Few probing questions are motivated by an efficient transparency. Then there is the *scratched, smudged transparency* variety. These physicists have, over many years, developed a basic set of N transparancies, which can be ordered in $N!$ different way for $N!$ different lectures.

The wonderful thing about the use of overhead projectors is that you can prepare for a major talk in a matter of minutes. You merely shuffle through transparancies and put them in the sequence chosen for the occasion. The transparancies, as prompts, contain the essence of *what* is to be said, and there is little need to spend time pondering over the words to be used to say it. In fact, in a real pinch, you can simply read the transparancies. (It is curious that a professor who reads to a class from the textbok is severely chastised by the students, but the same professor, as distinguished speaker of note, can read one transparency after another to an audience of peers.)

Last year I attended a special sessionon the hot topic of cold fusion. *The New York Times* reported that there were 1800 physicists in the audience (a somewhat exaggerated estimate, I suggest). The press was there in full force, waiting for words of clarity on this controversial subject. What did they, and the audience get? One information-dense transparency after another. I was sitting with 1000 other physicists in the contiguous county, out of range of the screen. It was rather like sitting in

Swarthmore watching a drive-in movie playing in Philadelphia.

I. I. Rabi once said, "The power of physics is in words." Of course, Rabi had settled into fame and maturity before the overhead projector transformed the craft of oration into the industry of extemporaneous commentaries on projected equations. Rabi loved to quote from the speeches of Henry Rowland, who, as retiring president of The American Physical Society, spoke to physicists on 28 October 1899 about the state of the subject: "Then as to matter itself, how have our views changed and how are they constantly changing. The round hard atom of Newton, which God alone could break into pieces, has become a molecule composed of many atoms, and each of these smaller atoms has become so elastic that after vibrating 100,000 times its amplitude of vibration is scarcely diminished. It has become so complicated that it can vibrate with as many as a thousand notes. We cover the atom with patches of electricity here and there and make of it a system compared with which the planetary system, nay, the universe itself, is simplicity. Nay, more: Some of us even claim the power, which Newton attributed to God alone, of breaking the atom into smaller pieces whose size is left to the imagination. Where, then, is that person who ignorantly sneers at the study of matter as a material and gross study?" I can understand Rabi's fascination with words.

Enough. I have expressed my thoughts, and–to borrow once again from Lincoln–I have done so in the hope that the good and powerful words "of the people, by the people, for the people, shall not perish from the Earth."

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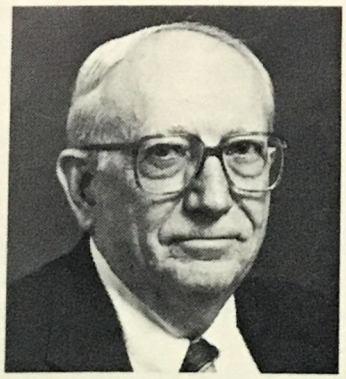
TAB PERIODICALS COUNCIL MEETING



Chester Smith

The first meeting of the newly organized IEEE Periodicals Council was held at the IEEE offices in Piscataway, NJ, on Tuesday, 13 February 1990. The meeting was called to order by the Chairman, Wallace Behnke, at 10:30 AM with seven council members along with eleven others, mostly staff personnel, present.

Reorganization. The main order of business was the review of the Technical Activities Board reorganization, including the functions and scope of the Periodicals Council. The reorganization is quite extensive, includes the consolidation of several previously existing and quasi-independent committees into the one council. The Council is responsible for IEEE Transactions, Magazines, Journals, Technical Letters and Newsletters. Newsletters included in this list present some problems yet to be addressed. Society Newsletters are readily identified coming as they do from Institute-wide organizations, but many Regions, Sections and in some cases individual Society Chapters, publish their own newsletters.

Mailing Issue. This is getting to be a broken record but there is good reason to have *all IEEE* material published under the central IEEE Permit at the New York Post Office. *Any document using the IEEE Logo is an IEEE Publication*. There are legal hazards to our wealth for failing to follow this directive. This requirement poses no real hardship on any unit since periodicals entered technically at New York may be physically posted at any U.S. Post Office. The in's and out's of this issue are more than somewhat convoluted (what area involving the Federal Government isn't?), but for the details, the why's and wherefore's, please do contact Dave Staiger in New York (212) 705-7548. He will be glad to lay it all out for you.

Publications Requests. The council approved a request for a monthly, *IEEE Microwave and Guided Wave Letters* to begin in 1991 and a proposal for *The IEEE Journal of Superconductivity*. These proposals were forwarded to the Publications Board for consideration. A request from the Coil Winders' Association to carry their Newsletter as an insert to the IEEE Electrical Insulation Magazine was disapproved.

Electronic Publishing. Stuart Rothenstein, Society Services Department, made an extensive presentation on the plans to convert to electronic publishing for all Society Publications by the end of this year (1990). Electronic Publishing technology promises to provide some major improvements, not only in timeliness and quality, but in cost savings as well. The target date to have this service

feature up, running and debugged in the end of December, 1990. There has already been some slippage of internal milestones, but so far nothing that threatens their making the end date. More about that later.

DIRECTOR DIVISION IV NEWSLETTER

The year 1989 was an extremely active year for the IEEE and especially the Technical Activities Board (TAB). Several changes were implemented including (1) moving of the Technical Activities Department (TAD) and portions of the Publishing Services Department to Piscataway, New Jersey from New York; (2) restructuring of TAB to include Society Presidents in decision making positions, (3) expanding e-mail services to volunteers and IEEE staff, (4) expanding Society office operations in Piscataway, and (5) increasing the international character of TAB through AdCom membership and IEEE offices outside the USA. The following Ad Hoc Committees and Task Forces were then set up to address these matters: TAB Restructuring, Society Support, Financial Reporting, E-mail, TAB International Opinion Survey, International Participation in Society Administration, Magazine Monitoring, Training Videos, Strategic Planning and Review, Society Self Study, and Technical Activities Department Organization.

During the TAD restructuring and subsequent move to Piscataway, two Society Associates were added to address the immediate needs of the Societies and their members.

Diane DeMarzo (201) 562-3853
Marsha Tickman (201) 562-3854

In 1990, the cost for the society associates is being paid by the TAB. They act as points of contact in the IEEE, and can act as Society administrators taking minutes at AdCom or committee meetings and sending out notices in support of Symposiums and other Society functions. If you need any help from the IEEE please feel free to contact these Society Associates at the above numbers.

NATO-ADVANCED STUDY INSTITUTE
Hard Magnetic Materials
10-23 June 1990, Il Ciocco, Italy

This ASI is designed to provide an advanced introduction to the field of hard permanent magnets to doctoral students, research scientists, and engineers. The ASI will cover the fundamentals of magnetism as they apply to hard permanent magnets, the preparation of new magnetic materials, and the engineering associated with the use of these new magnets in various practical applications.

For more information please contact:

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SECOND INT'L. CONFERENCE RARE EARTH DEVELOPMENT AND APPLICATIONS

Organized and sponsored by the Chinese Society of Rare Earths, the Second International Conference on Rare Earth Development and Applications will be held on May 27-31, 1991 in Bejing, China.

The program will be divided into plenary lectures, invited papers and contributed papers concerning original contributions in the following topics: RE Chemistry, RE Resources and Metallurgy and RE New Materials and Applications

Scientists wishing to present a paper are invited to return an abstract of no more than 1 page by December 15, 1990.

For further information contact:
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The Chinese Society of Rare Earths
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SESSION SUMMARIES

Session AR
Microwave Magnetics
Prof. A. J. Pointon

Microwave Magnetics was not well represented at Intermag '90, although there was additional interest in microwave measurements on High Tc superconductors. That does not means there were not some significant new results on show.

Kalinkos et al from Leningrad reported one of the first demonstrations of solidons in magnetostatic surface waves (MSWs). They clearly demonstrated how, as the energy of an input pulse (of width around 5 ns) was increased, either by increasing the height or the width of the pulse, the output pulse was initially sharpened–by as much as a factor two–and then split into two, then three and more peaks, largely in agreement with theoretical predictions.

Love-type magneto-surface-acoustic-waves (MSAWs) at 100 Mhz in highly magnetostrictive amorphous films of, for example, $Fe_{80}B_{20}$ have been shown by Inoue et al from Osaka to have potential as phase modulators due to the substantial change (around 30%) in the wave velocity with applied magnetic field: although the eddy current losses can give rise to large attenuation, these are likely to be reduced considerably by using multi-layer sandwiches of think magnetic and insulating films.

A "photothermal" technique has been developed at Bochum by von Geisau et al in which the local heating of a ferrite film by MSWs is detected by the scattering of a laser beam due to the change in refractive index with temperature: the spatial distribution of the MSW energy and its variation with field can be displayed by this technique.

A computation reported by Musal and Smith from Lockheed, Palo Alto, has generated a design chart to show how a layered magnetic absorber can be used to produce zero specular reflection. Kakuno from Yokohama has demonstrated how an em wave at 9 GHz can be effectively transmitted through a metallic magnetic film by the magneto-strictive generation of ultrasound; and Williams et al from the Naval Research Lab at Washington have shown how the anisotropy and linewidth of the new spin-spray films can be related to each other and to the columnar texture of the films.

Session BB
Domains and Domain Walls I
F. E. Luborsky and J. E. L. Bishop

This was evidently a most popular session, marked by a substantial overflow attendance. Ten papers were read, one more than originally listed in the Conference program booklet.

The invited paper was "Modified Differential Phase Contrast Lorentz Microscopy for Improved Imaging of Magnetic Structures," by J. N. Chapman, I. R. McFadyen and S. McVitie. After a lucid introduction to the principles of DPC microscopy, J. N. Chapman described a modification in which the usual quadrant detector is further subdivided by a concentric circular slot into a central disc and outer annular region, each of four quadrants. By altering the ratio of the slot radius to that of the electron beam, the authors were able to vary the signal to noise ratio for low spatial frequencies relative to those in the mid-band range and so enhance magnetic contrast over that of the granular background. This was demonstrated by examples of images of thin film recording media.

The following two papers concerned magnetic force microscopy. The first, "Domain Wall Imaging by Magnetic Force Microscopy," was by U. Hartmann, T. Goddenhenrich, H. Lemke and C. Heiden. Hartmann discussed in particular the influence of the nature of the magnetic probe used on the pattern observed. Probes in the form of perfect nickel spheres with diameters of order 100nm are employed to minimize disturbance to the sample caused by the field of the problem. Quantitative images of 90° and 180° domain walls intersecting on the surface of an iron whisker were shown. The second, "Observation of Recorded Tracks in Co-Cr Media by Magnetic Force Microscopy," by J. P. C. Bernards and A. J. den Boef, discussed the application of MFM to the comparative study of tracks with a wavelength of 0.5 μm in layers with coercivities of 15 and 45kA/m.

Papers four and five discussed micromagnetic calculations of domain structures in the limit that domains and walls are of comparable thickness. In four, "Numerical Micromagnetics: Rectangular Parallelopipeds," by Dr. R. Fredkin and T. R.

Koehler, some results were presented or detailed three dimensional numerical simulations of the nucleation, development and field evolution of micromagnetic structures–vortex wall structures and incipient domains–in a "sample" of dimensions 1.2μm x 0.6 μm x 0.12 μm. Paper five was "Micromagnetics of Strong Stripe Domains in NiCo Thin Films," by M. Labrune and J. Miltat. M. Labrune discussed two dimensional micromagnetic calculations of the well known periodic stripe domains in films with tilted anisotropy showing how the interior domains emerge as vortices and the surface closure domains as a continuous winding magnetization.

Paper six, "One Dimensional Domain Wall Motion with an In-plane Field Applied at an Arbitrary Angle," by T. T. Fang, A. A. Thiele and Z. J. Cendes, described a further generalization of the exact Walker solution for steady lossless domain wall motion. The authors have now treated the case that the principal axes of the anisotropy in the domain do not coincide with the global anisotropy.

Paper seven was entitled "Wall Transitions in Permalloy Double Films" by H. Niedoba, H. O. Gupta, I. Tomas and I. B. Puchalska. Magnetostatically coupled pairs of Neel walls were observed in two states. In one the intra-wall magnetizations are opposed and mutually flux-closing, in the other they are parallel with flux closed by additional quasi-walls. Hysteretic switching between these states was studied by varying the hard axis field.

A. Thiaville and J. Miltat, in the eighth paper "Direct Optical Observation of Vertical Bloch Lines in Bubble Garnets: New Experimental Evidences," reported their investigations into the process of magneto–optical imaging of VBLs. They exclude a model based on the standard line structure and Faraday effect and believe a wall deformation, much larger than expected on magnetostatic grounds, may be responsible for the observed behavior of the contrast.

In paper nine, "Dynamic Properties of a Cross-Tie Domain Wall," A. F. Popkov, A. S. Sigov, A. G. Shishkov and A. K. Zvezdin reported experimental and theoretical work on the dynamic interaction of circular and cross Bloch lines with the host Neel wall. They predict and observe a quadratic dependence of the reciprocal mobility on Bloch line density and also discussed creep in an alternating hard directed field.

The final paper, "An Examination of Transition Noise by Lorentz Electron Microscopy," by R. P. Ferrier, F. J. Martin, T. C. Arnoldussen and L. L. Nunnelley discussed a technique for numerical reconstruction of noise recorded on FeCoCr thin film from electron micrographs of the domain structure.

Session BP
Thin Film Media
Dr. R. W. Hardeman

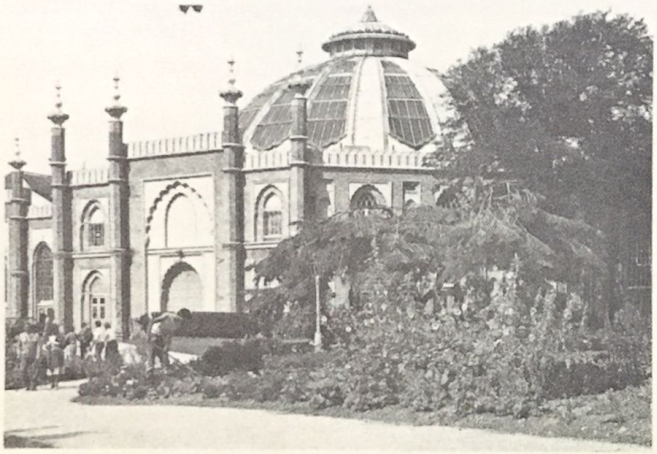
Over twenty posters were presented at this well-attended session. More than two-thirds of them contained data on the topic of the greatest interest for practical high-density magnetic recording, that of the dependence of micromagnetic and recording properties of Co-based films on their deposition conditions and underlayers.

The particular importance of atomic mobility in the Co alloy film, either during sputter disposition or subsequent annealing, was often stressed, with detailed studies in a variety of systems using ranges of deposition conditions. Many authors made extensive and telling use of high-resolution TEM, demonstrating the great value of this technique, especially in combination with electron and X-ray diffraction.

Even very thin underlayers promote "epitaxial" growth, and have profound effects on properties. Yeh et all (BP 06) demonstrated that even 9nm of Cr was sufficient to raise H_c from 500 Oe to 1200 Oe in CoCrTa on glass substrates. In a very different system, $Co_{79}Cr_{21}$/Ni-Fe rf sputtered on flexible PEN, Nakagawa et al (BP13) obtained tremendous enhancement in crystal texture with 10nm of $Co_{79}Cr_{21}$ underlayer. Workers from Ulvac (BP 04) observed the benefits of a NiP layer of 200nm sputtered on glass substrates in dramatically improving coercivity and orientation; how this will be interpreted in terms of the claims made for glass rigid disk substrates remains to be seen. Mapps et al (BP15) demonstrated that 20nm of Ti underlayer gave a large gain in loop squareness in perpendicular CoCr, especially for very thin films (<20nm). The very interesting matter of coercivity vs thickness relations was analyzed in two papers. In BP 09, Hsu et al showed a change from in-plane to perpendicular texture in CoCrTa films as thickness passes 100nm, and although this is more than the thickness usually employed in commercial products, the effects of the mechanism may also be seen in thinner layers. Fisher and Khan's results in CoNi based films (BP 20) are explained by a change in switching mechanism; at small thicknesses (20nm) fanning dominates in high coercivity films, while in thick films (100nm) domain wall motion is the primary mechanism.

The role of magnetic fields at the sputtering source was discussed by Toyama et al (BP 14) who predict improved film properties and target utilization from their TP magnetron with an additional magnet at the outer pole. Externally applied; magnetic fields between source and sub-

strate may also enhance performance in magnetron sputtering according to DEC (BP 17) who show control of coercivity by applying such fields, explained in terms of changes in microstrain in the film and a temperature gradient in the substrate in the reverse of the "usual" direction. The effect of strain in films was interpreted in magneto-elastic terms by Mauri et al (BP 03) who stressed thick (3um) films of Co alloys and determined a negative saturation magneto-striction constant. A pointer to the future may possibly be the use of laser induced chemical vapor deposition by workers in Trinity College, Dublin (BP21) for the growth of high quality perpendicular δ-Fe films. If someone produces a similar result for cobalt!?



Session CA
Recording Heads II
E. W. Hill

This very stimulating session began with a description of a 48 turn thin film head by Y. Ohdoi. Following work presented at the Washington Intermag, P. Deroux Dauphin described further advances in planar I.C. head technology and emphasized the potential of this technology. S. Akoh presented details of measurements on thin film heads which showed the importance of the yoke design and in particular the influence of the side angle on head performance. The head field distribution around thin film heads measured using electron beam deflection and computer tomography was discussed by H. Takano who related these measurements to patterns of written bits at rates up to 10 MHz. H. L. Huang showed how gap nulls in the spectral response of a recording head could be removed for the case of thin current sheets.

Three papers were presented on advances in VCR heads. A new process for fabricating video heads was described by K. Konishi which defined the track width and gap length by the thickness of deposited films. The work of Dirne and Ruigrok on a sputtered sandwich head was presented by P. Sillen. Finally the fabrication process for a thin film video head using rounded yoke edges for low contour effects was described by M. Miura.

One of the highlights of the session was the presentation by T. Tsang of details of the dual element recording heads used to achieve the $1Gb/in^2$ recording density recently demonstrated by IBM using separate MR read and inductive write elements. The effect of different types of recording head on the zig-zag transitions written onto thin film media was examined in the presentation given by M. Iizuka. The final paper of the session was presented by J. C. L. van Peppen and described a measurement technique for observing individual Barkhausen jumps in thin film heads.

Session CB
Magneto-Optics II
Ted Williams

Dr. G. Bayreuther gave an excellent invited paper on FeTb multilayerd films in which he reviewed the work of the Regensburg group in Germany. The layers were prepared by dc magnetron sputtering and covered by a protective layer of 6 to 10 nm aluminum. Magnetic properties were determined with vibrating sample, SQUID and torque magnetometer, conversion electron Mossbauer spectroscopy and magneto–optic domain observations. Maximum anistropy occurred for an iron layer thickness of 1 nm, and, for thicknesses of greater than 2.7 nm crystalline α Fe coexists with the intermetallic phase. Below 2.8 nm of iron the easy-axis of magnetization is normal to the surface whereas above 3 nm the easy-axis is in-plane. (The interface between the iron-terbium layers had a high density of vacancies.) Finally, this work confirmed the importance of this type of structure for high density optical recording. This conclusion was brought home by the IBM work report by Dr. Lin on cobalt/platinum multilayers. A carrier-to-noise ratio of 64 dB has been achieved with a reading power of 3mW at 20 m/s for a 2.5 MHz carrier. Optimum thickness was obtained using 23 layers of 0.3 nm cobalt with 1 nm of platinum. The films were prepared by e-beam evaporation.

Cobalt/platinum multilayers were also the subject of a joint paper by duPont and Phillips. In this case dc magnetron sputtering was used. With xenon in place of argon coecerivities of over 1,000 oe were achieved for 0.26 nm cobalt and 1.26 nm platinum layers. X-ray diffraction studies concluded that polycrystallic alloys of platinum and cobalt had been formed so that these were not true multilayers.

dc magnetron sputtering was also used by NEC for multilayers of terbium and FeCoTi. Magneto-optic discs made from this material had C/N values of 48 of dB. The terbium layer thickness was critical for the writing bias field.

rf sputtering was used by Nagaya University to prepare NdCo with cobalt (or iron) multilayers. The fundamental magnetic properties of these systems were investigated.

The final multi-layer paper in the session came from SKC Limited in Korea. They again used dc sputtering for terbium and FeCo multilayers. C/N of up to 54 dB were achieved with a write power for the infra-red laser of 7 mW.

The analysis of domain writing with anomolous Hall effect measurements by IBM has now shown that very low noise levels can be achieved so that this can be a very useful technique. Domains were also the subject of two further papers by IBM and Hitachi.

The closing paper showed some interesting results on spin coated garnet films with Rb added to improve the surface morphology.

In summary, this was an excellent session which confirmed that multilayers have a future in commercial magneto–optic systems.

Session CP
Crystalline and Amorphous Wires
Patrick T. Squire

Although amorphous wires have been around for several years, they are still something of a novelty not least because of their often unexpected properties. Of the nine posters in this session seven were devoted to amorphous wires. Study of the well-known large Barkhausen and Matteuci effects continues, and in a paper by Mohri, et al, results for the newer Fe-Cr alloys were presented, alongside those for a wide range of Fe-Co and Fe-Ni alloys. The scope for realizing novel applications of amorphous wires by suitable post-production treatment was illustrated in the paper by Ogasawara and Mohri by an ingenious 5 bit marker, based on tension annealing of cold-drawn CoFeSiB wires. This utilizes the different critical switching fields that can be obtained by annealing under different tensions at different temperatures.

Several of the papers were concerned with basic studies of the properties of amorphous wires related to the two-component structure of the core and sheath believed to exist. As yet, conclusive studies of the all important domain structure are frustratingly missing. In their absence a mass of indirect evidence is accumulating, against which the hypothetical internal domain structures can be tested and by which they might be refined.

Perhaps the most exciting development in this field has been that of crystalline wires of composition $Fe_{93.5}Si_{6.5}$. Unlike bulk SiFe with such high Si content, these wires are highly ductile, graphically illustrated by a photograph of a tightly knotted wire in the poster by Ichiryu, et al. This presented data on the very well defined bistable nature of suitably prepared specimens in which a single Bloch wall may exist over a length of several centimeters. Since λ_s is almost zero in these wires, their bistable properties are much less affected by applied stress than their amorphous counterparts. Allied to the higher Curie temperature of 700 C, this leads to a much more stable large Barkhausen effect, as reported by Mohri and Takamido.

In conclusion, one can predict many novel devices based on crystalline and amorphous wires. They are likely to occupy an honorable place in Intermag conferences for some years to come.

Session DA
Particulate Recording Media I
Roy Chantrell

Dr. K. O'Grady (UCNW, Bangor) gave an invited review of the techniques for characterization of recording media. The talk outlined the instrumentation, including problems of calibration. Use of the technique of comparison of remanence curves to investigate interaction effects was described. Techniques for the investigation of anisotropy were compared, including SPD and transverse susceptibility. Time dependence measurements were also considered as a lower determining limit to the useful particle size. The effective 'SFD' determined by the remanence curves of dispersions gave a useful characterization of dispersion quality.

Dr. R. Veitch (BASF) studied the relation between anhysteresis and an interaction field determined from the principal remanence curves. The width of the SFD is strongly dependent on the mean interaction field. The anhysteretic susceptibility gives a good correlation with mean interaction field.

R. Rosman (Delft University) and coworkers presented a study of correlation effects in measurements of noise and neutron depolarization. Angular dependence of the Neutron depolarization indicates the presence of large correlations in the tape direction. Noise measurements indicate that the correlation length depends on the magnetic state.

H. J. Richter (BASF, Ludwigshaven) compared anisotropy fields determined by the torsion pendulum method and transverse susceptibility. For undoped BaFe the methods give similar results. For highly doped BaFe and τ -Fe_2O_3 the H_k information is lost in the transverse susceptibility. This was attributed to particle/particle interactions.

G. Bottoni and coworkers (University of Ferrara) presented a study of interaction effects in Co-doped τ -Fe_2O_3. In this study the anhysteretic susceptibility correlates with the coercivity. Generally it was found that the reptation phenomenon increased with the strength of the interaction field.

A. R. Coradi (Magnox) and coworkers presented studies of magnetic stability as a function of particle size. Calculations show that current particle sizes are not much above the lower limit. Some improvements in stability can be achieved by processing.

Reversible magnetization changes have been studied by P. R. Bissell and A. Lyberatos (Lancashire Polytechnic). Results are in qualitative agreement with calculations based on Stone-Wohlfarth theory. Interaction effects were observed in a comparison of the magnetizing and demagnetizing processes.

J. Satoh and Y. Tokuoka (TDK) presented a paper on the orientational distribution of a particulate medium. Remanence measurements were used to determine the distribution function.

D. A. Speliotis (ADC/DMS) gave a paper on anisotropy field distributions and the relations to noise. No correlation was observed between SFD and the distribution of Hk, indicating that the narrow SFD arises from strong cooperative behavior, consistent with the link between SFD and noise.

P. I. Mayo and coworkers presented a study showing the effects of interactions in BaFe media. Stacking gives rise to interaction effects which are markedly different from standard particulate media and can be linked to the very square hysteresis loops via cooperative behavior.

A paper by Muller and coworkers (BASF, Ludwigshafen) discussed the magnetic analysis of high coercivity CrO_2 particles produced by iron doping. Coercivity can be extended to 9000e which has been made possible by improved efficiency of Fe^{3+} doping in the hydrothermal synthesis.

Session DC
Hard Materials III
Dr. John Ormerod

This was an extremely interesting and stimulating session focusing on Re-Fe-B based hard materials. Several papers described recent work aimed at improving the two main technological limiting features of these materials; corrosion resistance and temperature stability. Papers by Tenaud et al (DC 01), Sagawa et al (DC 10) and Hirosawa (DC 11) described the effect of V/Mo additions in NdFeB materials in combination with Dy and Co. Both corrosion resistance and temperature stability were shown to improve. Observed microstructural changes include the precipitation of V_2FeB_2 phase which replaces the B-rich $Nd_{1+x}Fe_4B_4$ phase typical in conventional NdFeB-based magnets. The paper by Mitchell (DC 02) emphasized the importance of optimizing substrate microstructure, pre and post coating treatments, deposition process and deposited material in order to obtain high quality and reliable NdFeB-based permanent magnets. All these developments will lead to an increase in the useful maximum operating temperature and conditions of NdFeB-based magnets and hence extend their range of applications. Other papers reporting either stability or corrosion phenomena were presented by Kim et al (DC 03), Shimotomai et al (DC 04) and Clegg et al (DC 05). Papers by Fidler et al (DC 07) Knoch et al (DC 08) and Grossinger et al (DC 09) provided further evidence of the improvement of coercivity by Ga additions.

The final paper by Yoneyama (DC 12) demonstrated an interesting 14 MGO_e bonded magnet prepared from rapidly quenched NdFeCoZrB alloy with improved magnetizability and high loop squareness.

Session DD
Soft Materials I
A. J. Moses

The session was made up of a varied selection of ten papers, a few related to Si-Fe, one to Co-Fe, three to high strength steels and two to soft Ferrites.

K. Arai presented two papers on tertiary recrystallized grain-oriented SiFe. Large effects of surface grooves were shown and the losses of ultra-thin steel were shown to be very low, matching those of amorphous ribbons up to 400Hz. T. Shimazu showed loss separation results from non-oriented SiFe and discussed the accuracy of a few eddy current calculation methods. Next E. Mivehchi

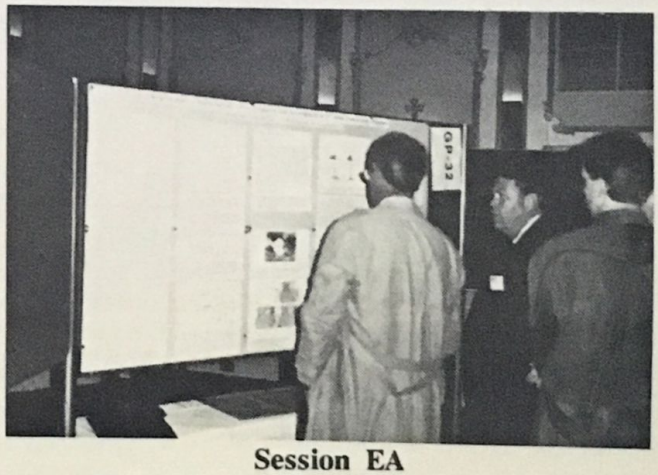
presented a technique based on an SEM and image processing software which has been developed to build up video pictures of dynamic domain movements. The value of the new method for studying domain movements in fully processed, coated grain-oriented SiFe was noted.

R. V. Major presented B-H and loss performance data from a range of Co-Fe based alloys which showed the attractiveness of the alloys for high temperature applications. Papers read by K. C. Pitman and I. J. Gorshelis showed different types of stress effects. Pitman described a general stress/magnetization model based on bysteresis data obtained from steel rods subjected to compressive stress whereas Gorshelis indicated the promise of high strength margaring steel wire for sensor applications because of its magnetic stress sensitivity. B. K. Kanner presented an analysis of the influence of microstructures of pearlitic steels on their magnetic properties. The work is very relevant to magnetic N.D.T. methods.

The final two papers discussed soft Ferrities. J. Nogues showed evidence that the role of different types of anisotropy can be strongly influenced by the Zn content in doped Fe_3O_4 based ferrites. M. T. Johnson described a permeability model for polycrystalline ferrites to attempt to explain grain size dependence of rotational processes. The method is claimed to be a good alternative to earlier models.

Session DQ
Sensors II
R. V. Major

This session was characterized by novel ideas creating inexpensive solutions for industrial and robotic sensing applications, primarily position measurements. Son and Sievert (DQ 01) described a force sensor whose core was an amorphous strip with a negative magnetostriction coefficient. The device has a resolution of $5x10^{-4}$ N and a linearity better than 1% over the 0-1.7 N range. Kano et al (DQ 02, 03) described two ideas for long stroke linear position sensing (tens of millimeters): an LVDT with canted square coils creates a device capable of long strokes with a linear output; sensing the fringing magnetic field between two rod shaped ferromagnetic cores can be linear over a considerable length. In DQ 04, Vértesy, Szöllosy and Lovas described a position sensor which employed a ferromagnetic vane in a magnetic circuit consisting of a transformer core and permanent magnet. A mangetoresistive transducer for sensing the position of a magnetic rotary encoding wheel was described by Campbell in DQ 05. Aroca, Rodriguez and Sanchez (DQ 06) employed an LVDT for continuous and high resolution monitoring of a fluid density. The change in magnetic and electrical properties of a thick film magnetic semiconductor was used by Seki, Shida, Matsui and Murakami in DQ 07 as an environmental sensor for temperature/humidity/gas. New fabrication methods and core geometries for fluxgate magnetometers were presented by Ripka, Gires and Machcek in DQ 09 which reportedly gave better stability and homogeneity than conventional tape-wound devices. Lemarquand (DQ 10) described an absolute rotary position sensor employing non-cylindrical rotor cores. Lemmarquand and Lemmarquand (DQ 11) described the modelling of a rotary sensor with prototype results yielding an accuracy of 12 arc seconds. Adl, Memon, Mapps and Rakowski (DQ 12) presented results for an improved magnetoresistive sensing scheme for tactile applications.



Session EA
Particulate Recording Media II
S. W. Charles

Matar presented a paper on a study of the effect of substitution of Ru, Os and Ir in Fe_4N. On substitution, Te decreased for Ru to Os to Ir and Hc decreased from 400 Oe for non-substituted Fe_4N to 100 Oe for 5 at % substitution. Increasing the amount of substitution produced a decrease of particle size leading to super paramagnetism.

Kishimoto presented data on a method of stabilizing metal particulate media by forming layers of inorganic compound. Unfortunately information of the surface treatment process was unavailable.

Dr. Bradshaw gave a review of the importance of proper binder selection to minimize chemical degradation induced deterioration of tape performance.

Dr. Süttinger gave a very interesting paper on the IR dichroism of magnetic tapes. The method would appear to have application in the on-line measurement of the orientation ratio in the production of magnetic tape.

Dr. Kishimoto described the results of the effect of coercivity and squareness on the recording characteristics in the cases of magnetic contact duplication and ring head direct recording of Ba ferrite tapes. It was found that the highest output in the wavelength range (10-0.67μm was obtained for tapes having highest squareness in the perpendicular direction.

Dr. Sugaya described a method of increasing recording density by double component multiple recording, which is suitable for FM audio and HDTV VTR. However further work is needed to understand the recording mechanism.

Dr. Denteneer presented the results of theoretical studies which showed that empirically established particle length–radius correlations play an important role in explaining flux noise spectral densities.

Dr. Kügiya and his coworkers have reported a magnetization model for non-polar particles which predicted that orientation of the particles is effective for increasing low density output but for high density recording it is important to reduce size distribution of the particles.

Dr. Lyberatos presented a paper on the calculation of the size dependence of the coercive force in fine particles using a Monte-Carlo method; and Dr. Kathrein described an improved Preisach model to describe bias recording. The theoretical model enabled prediction of the recording properties of a tape from its magnetostatic data, and thus is considered to be an aid for the development of improved pigments.

Session EB
Recording Theory
B. K. Middleton

In his paper on the modelling of digital magnetic recording channels Hermann used Volterra functions to take into account linear and non-linear distortions at high recording densities. Output waveforms from a cobalt alloy disk and MR read head were successfully predicted. Middleton, Miles and Noyau, however, took a simple analytical approach to investigating the role of the hysteresis properties of media in determining recorded transition shapes and how important the latter are to high density recording performance. The recording of audio and video signals on rotary head VHS machines as described by Schmitt and Eiling who produced predicitons from a numerically based Preisach type model. The audio signals were shown to be recorded deep into the tape while the video signals were recorded very near to its surface. Improvements to the methodology of simulation of magnetic recording processes were proposed by Shyamkumar and Cendes who described a new and efficient algorithm to aid convergence in numerical calculations.

By contrast Cramer et al described the perpendicular recording process on SLCoCr media. Recording performance was shown to be improved by the use of a single sided MIG head which produced high trailing edge fields sufficient to overwrite patterns written by the leading edge.

In the first paper on the micromagnetic modelling of the thin film media Miles and Middleton showed that the microstructure assumed to exist in the films had a strong influence on predicted magnetisation distributions. Zhu and Bertram, in their modelling of thin film media, produced predictions for the distribution of magnetic charge. The latter was found to be concentrated in 'walls' as opposed to 'domains' and noise was then predicted to arise from the former.

The final three papers of the session dealt with different aspects of recording system behaviour. A technique for estimating pulse position jitter in magnetic disk recording was described by Gatherer and Meng. On the other hand Loze and Saunders used a sophisticated model to investigate the influence of finite pole tip replay heads on the predicted error rates of digital recording systems and noted little improvements with reductions of pole tip length. Vos, Tanaka and Judy described measurements of the noise produced by a variety of rigid disk media and produced a model for its spectral content.

Session EC
Magnetic Recording Systems
T. Donnelly

A new, high performance, low cost tape storage system was described in an invited paper. 2 G Bytes can be read or written in 11 minutes at a rate of 3 M Bytes/sec using a specially designed 1/4" tape cartridge. Forty tracks are accessed by 5 passes of an 8-track, read-while-write, thin film, unshielded magnetoresistive head of unique design. The system employs combined read/write equalization which permits the side shields of the MR head (conventionally used to slim pulses) to be dispensed with thus giving simple design without sacrificing performance. Equalization was also covered in a paper on enhanced decision feedback equalization which can give a 1 dB gain advantage over decision feedback equalization.

Much interst was shown in the paper, "Demonstration of 500 Million Bits Per Square Inch Areal Density." This was accomplished by flying a thin film, inductive write/MR-read head 4 micro inches over a Co Pt Cr thin-film disk. Data were written with a linear density of 100 kbpi at

5000 tracks/inch and a total byte soft error rate of 10^{-6} was achieved.

Perpendicular and longitudian recording schemes using the same inductive-write, wide-shielded MR readback head were compared. Both exhibit good overwrite properties but constrained amplitude due to MR nonlinearity with differentiated vertical edging out longitudinal in improved resolution.

The trend towards low track width, high track density was noted in a paper in which maximum likelihood detection was proposed for the coherent detection of signals in the presence of track cross-talk. The importance of two-dimensional codes was emphasized in combating this problem.

Session ED
Finite Elements and Design
Bill Trowbridge

It was very encouraging, indeed, to be present at a session on computational electromagnetics addressing the optimization problem and related areas. Increasingly, investigators are recognizing that one of the more important topics is to solve the inverse problem and not to rely completely on heuristic experiments using field analysis software.

We began with a paper which examined strategies to reduce the number of trial finite element calculations for pole shape optimization using a technique similar to biological evolution (ED 01, Magele, Austria). The second paper described a method which reduces the number of boundary element calculations to optimize the shape of electrodes by calculating the maximum field at the surface but in this case the strategy used involved non-linear programming (ED 02, Liu, Jin, PR China). The last paper in this group considered the problem of speed-up in calculating the objective function gradients by using parallel computers (ED 03, Hoole, USA).

Another very important topic is error estimation which has a strong link with optimization. Paper (ED 05, Girdinio, Italy) introduced an important extension of the complete residual method which allows both errors on the solution and gradient to be computed. This was followed by a paper on the investigation of element ill-conditioning and demonstrated that considerable improvements in accuracy are possible if a judicial mix of first and second order elements are used (ED 07, Demerdash, USA). Two more papers dealt with the use of special elements to simplify the 3-D computations; first, a method that used 2-D air-gap elements in combination with 3-D elements to model a Claw-Pole alternator giving similar results to a full 3-D solution (ED 08, Brauer, USA) and secondly, the use of line elements to model thin regions (ED 09, Brunotte, France). Results in the latter paper showed good agreement with analytic tests, and also that the method has been applied to the induced magnetism in ships caused by the earth's field. A related paper (ED 12, Ueyama, Japan) considered the use of relative potential to model thin magnetic shielding in order to avoid the ill-conditioning often encountered, good agreement were shown against experiment.

One paper outside the general theme of modelling, meshes and optimization, described the analysis of non-linear dynamic fields using the harmonic balance FE Method (ED 10, Yamada, Japan). Several examples were shown relevant to electrical machine design.

Session EQ
Soft Materials II
L. Hobson

This session consisted of fourteen interesting papers and was well attended provoking a great deal of discussion over the three hour session.

The effects of new fabrication processes on the magnetic properties of various materials were described including grain oriented 3% silicon-iron and rapidly solidified high silicon-iron ribbon. Other effects such as mechanical alloyings, aluminum content and heat treatment processes such as annealing and case hardening were also commented on.

Various advances in ferrite magnetic core technology were presented in this session. Of special interest was the high frequency capabilities assessment and the evaluation of the low frequency losses.

Finally four papers concentrated on the more fundamental aspects of magnetic phenomena including eddy current interaction loss, and the study of magnetic hardness and transverse susceptibility in soft magnetic polycrystalline materials.

Session FA
Thin Film Media II
P. J. Grundy

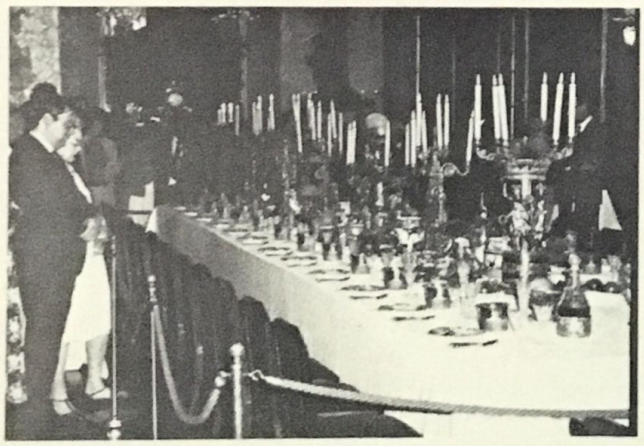
This session was very well attended and opened with an excellent presentation from IBM on the "design" and characterization of microstructure of in-plane media aimed at achieving very high storage densities with minimum media noise. This paper was related to several others in the Conference on the new 1 Gb/in^2 system. The following three papers continued with the theme of the microstructure and related recording performance in longitudinal media such as CoNiPt and CoNiZr films. Of particular importance is the role of the underlayer

film. It was shown very clearly that the type of underlayer, i.e., Cr, Mo or W, and deposition parameters can have a profound effect on the growth of the recording layer. Although some interpretations of the reasons given for the observed morphologies were questioned, this "clutch" of papers from Carnegie Mellon (FA 02) and Hitachi (FA 03, 04) highlighted the growing interest and activity in correlating microstructure and performance in optimized sputter coated disks.

Plated CoP media were discussed in the fifth paper from ICI and Lancashire Polytechnic. The presentation stressed the high density possibilities for such films and the important role of fundamental magnetic parameters in defining the media's potential.

Perpendicular CoCr media and deposition techniques for their fabrication were the subjects of papers from Tohoku (FA 06) and Twente (FA 07) Universities and from Matsushita (FA 08). A new high rate sputtering source for coating various substrates and oblique incidence evaporation techniques were discussed in the Japanese papers. A careful compositional analysis (Twente) of the surface and near-surface regions of CoCr films identified oxidation and segregation effects.

The importance of magnetic measurements in characterizing and simulating the recording process was reintroduced to the session in an interesting paper from Philips. Speakers from NTT and Tohoku closed the session with the last two papers (FA 10, 11) on novel and unusual media for perpendicular information storage, namely rare earth-transition metal films and "alumite" media.



Session FD
Eddy Currents
G. Molinari, D. Lowther

The session covered both novel applications and recent developments in techniques for eddy current analysis in both two and three-dimensions with and without motion present.

The scene was set in the invited talk by D. Rodger on a formulation for problems involving motion where the Minkowski transformation held. The method proposed used a three component magnetic vector potential coupled with a single scalar in the non-conducting regions, the electric scalar in the conducting regions was avoided and this was discussed further by P. Leonard in a later paper in the session.

Upwinding was used to stabilize the numerical system and this led to some discussion among the attendees concerning the various ways to implement this approach. Several alternate formulations were discussed by other authors. O. Biro proposed a split vector potential approach using a source and reduced vector potential. The method was illustrated in an application to eddy current evaluation in the casings of coils for fusion reactors. J. Webb proposed yet another scheme solving for the magnetic field directly in the current carrying region and using a reduced scaler potential everywhere else. This method was illustrated on the Bath cube problem. C. Emson also used a vector potential formulation but applied two extra constraints; the first was the use of the Lorentz gauge which allowed the formulation to work down to zero frequency, and the second was the imposition of a boundary coupling between the normal component of A and the electric scalar. This required the use of a weighting coefficient to ensure stability of the solution.

The use of the Lorentz gauge with upwinding for a moving medium problem (an eddy current brake) was also described by Y. Marechal. Several authors proposed methods for reducing the amount of work and simplifying the problem description in cases where thin magnetic or conducting sheets were present–a notoriously ill-conditioned situation for finite elements. F. Delince described the use of a boundary element method using vector potential and an adaptive approach to the boundary discretization. N. Takahashi proposed an alternate approach using special 'zero-volume' elements in a three-dimensional analysis wherever the field distribution could be assumed to have no variation in one dimension. Boundary elements were also applied in a technique proposed by D. Lavers for computing the eddy current distributions in liquid metal stirring applications. The problem here was solved using the method of fundamental solutions coupled with an adaptive calculation of the positions for the source points.

A practical application of two-dimensional eddy current analysis was discussed by J-C. Sabonnadiere in the analysis of power distribution

cables. This included an adaptive mesh generation scheme and the ability to describe the driving voltage. The aim was to compute the impedance matrices for further circuit analysis.

Finally, J. Sturgess produced an interesting set of equivalencies allowing a two-dimensional magnetic vector potential package to be used for an eddy current problem in which the currents were x and y directed. The application was to determine the forces present in a circuit breaker when it was on the point of tripping. This work demonstrated how existing programs can be applied to problems which might be considered out of their usual domain if the user has sufficient understanding.

The session was well attended throughout the three hours with numbers ranging from 40 to 100. The opinion of all present was that the papers presented were of great interest and high quality.

Session GA
Head Media Interface III
J. Chapman and Roger F. Hoyt

Session GA on Friday morning consisted of one invited and ten contributed papers. The papers presented fell under the three broad categories of durability and wear for contact recording, stiction, and air bearing slider dynamics. The papers were all concerned with technical and engineering issues related to low flying on advanced recording media. The first paper, (invited) by C. Yeack-Scranton of IBM discussed the design and performance of a "taildragger slider". The slider incorporates a Piezo active element in the body. This element could be energized as needed by a voltage to bring the head into the contact regime above a recording medium. This concept allows contact recording to be achieved, (the main body of the slider flies at a "safe" distance above a disk) while minimizing this possibility of media damage. Data were presented which showed the mechanical, magnetic, and lifetime properties of the device could all be made to function at acceptable levels.

There were several papers in the session dealing with stiction and how to reduce it. Paper GA 02, presented by Ishimaru of the University of Tokyo, described a modified slider suspension. The design allowed the center of rotation of the slider in the pitch direction to be below the surface of the disk. This substantially reduced the static friction (stiction), when starting disk rotation from contact. Having the center of pitch rotation below the disk surface forces the slider to pitch backward to the tailing edge, breaking contact of the rails with the disk. Data on the performance of the design and issues of pitch and roll stiffness were also discussed. Next, papers GA 03, as well as GA 08, GA 09 and GA 10 all focused on the issue of absorbed liquids, surface roughness and their contributions to slider-disk stiction. F. Talke of CMRR/UCSD presented a paper GA 03 on a study of the effects of humidity on stiction. For relative humidity in excess of 85%, large stiction values were observed. At these levels, evidence was also presented from ellipsometry studies of absorbed water layers of greater than 30 Å on the surface. K. Yanagi of Nagaoka University (GA 08) discussed the combined effects of the surface roughness and liquid overcoat of the stiction properties. M. Smallen of Seagate (GA 09) showed evidence that disks contaminated with low levels of DOP (dioctylphalate) during manufacture could have high stiction levels. K. Nishimori of Nagaoka University (GA 10) presented a low energy photo-electron spectroscopy technique for determining surface contamination levels on carbon coated disks in an ambient atmosphere.

The behavior of air bearings during start-up and flying were discussed in papers GA 04 and GA 05, presented by D. Bogy of U.C. Berkeley. In paper GA 04, evidence for contacts of the slider with the suspension pivot during full velocity load-unload were presented. Previous studies with a laser interferometer and acoustic emission studies suggested that several initial contacts with the disk occurred during the loading process. Further studies presented here indicated at higher velocities during loading, many of the signals coming from the acoustic emission sensor originate in the slider-suspension contacts, while stronger head-disk contacts do occur at lower velocities. Paper GA 05 showed that low disk roughness of about 3nm (RA) had negligible effect on a slider flying at about 300 nm.

Papers GA 06, GA 07 and GA 11 all dealt with disk wear and durability. GA 06, by P. B. Phipps of IBM discussed techniques of measuring film disk wear using the magnetic readback signal. The read signal was shown to be a sensitive detector of a second head, running in contact on the disk surface. Signatures in the signal loss associated with wear and third body interactions were discussed in detail. V. Novotny, also of IBM, discussed (GA 07) a tin oxide overcoat for thin film media which provided good wear performance.

Finally, in paper GA 11, V. I. Petinov of the USSR Academy of Sciences presented studies of particulate disk durability. The use of acoustic emission and thermocouple sensors allowed the detail effects of contacts and surface roughness on lifetime to be measured.

Session GD
Magnetic Measurements II
Patrick Squire

Of the ten papers presented in this session, three were concerned with the ongoing need for reliable measurements of the basic magnetic properties of sheet steels. The invited paper by Sievert reviewed the current position of power loss measurements, especially for rotational power loss. Despite steady progress there are many outstanding problems to be overcome. The long-serving Epstein ring method, requiring tedious specimen preparation, may soon be replaced for routing measurements by one and two-dimensional alternating field methods using a single square sheet. Under favorable conditions the rotational power loss may be measured with a standard deviation of 1-2% by such means.

Measurements by Fiorillo over a frequency range from 1-10^5 Hz with various waveforms are directed towards achieving useful general descriptions of power loss for sheet steels, which cannot be obtained from the standard 50Hz measurements.

Lively interest was shown in three papers concerned with the rapid testing of thin film disc media for quality control. The approach described by Johnson uses a rotating multiple head to scan the disc, whereas that described by Gudeman uses a polarization-modulated Kerr system (Kerr, MIT). The latter approach allows a 200 point map of key parameters, such as Hc, to be obtained in 5 minutes with 2mm resolution. The emphasis is directed towards uniformity of properties across the surface. An extension of this technique also allows the saturation magnetostriction to be mapped across a disc with a resolution ~10^{-7}. Although small in practical media, its effect on magnetic properties may not be negligible, so such information may be useful for quality control.

In marked contrast to the fine scale of these disc testing methods was a portable inspection system described by Jiles. The ultimate objective of this system is the in-situ detection of incipient failure in steel objects, such as rail tracks. Extensive laboratory tests have shown marked changes in magnetic parameters, such as coercivity and B/H loop area, resulting from repeated mechanical cycling up to failure. As yet the results are insufficiently precise for accurate diagnosis, but the techniques look promising.

Session HP
Magneto-Optics IV
W. H. Meiklejohn

The papers in this session are divided into three groups:

Kerr and Faraday Effects

Co-doped hexagonal ferrites exhibit a large Kerr rotation of 4 degrees with perpendicular anisotropy but a small Hc of less than 500 Oe.

$VFe_{10}Si_2$ has a maximum Kerr rotation of 0.55 degrees at 0.75 e^V which is about equal to that of Fe without any magnetic contribution from V.

The Faraday rotation in YIG is calculated allowing three circularly polarized transitions to a particular unoccupied S-state.

Wave Guides

Perturbation calculations on a multinational MO waveguide isolator show that the whole element can be mathematically described by the multiplication of the complex matrices.

The interaction between guided optical modes and backward volume magnetostatic waves in YIG-GGG dielectric wave guides exhibit more efficient mode conversion within a wider range of H than forward volume magnetostatic waves.

Anisotropy

Epitaxial growth of ferrite-garnet films on (210) substrates increases the domain wall velocities due to increased orthorhombic anisotropy.

A semiclassical calculation of the optical anisotropy of isotropic crystals induced by magnetic ordering is made based upon one-electron transitions from p- to d- states.

CONFERENCE CALENDAR

TMRC (The Magnetic Recording Conference), July 23-26, 1990 at the University of California, San Diego. The topic of the conference will be magnetic recording heads. For information contact Prof. John Mallinson, Director, Center for Magnetic Recording Research, R-001, University of California San Diego, La Jolla, CA 92093, USA. Phone (619) 534-6210.

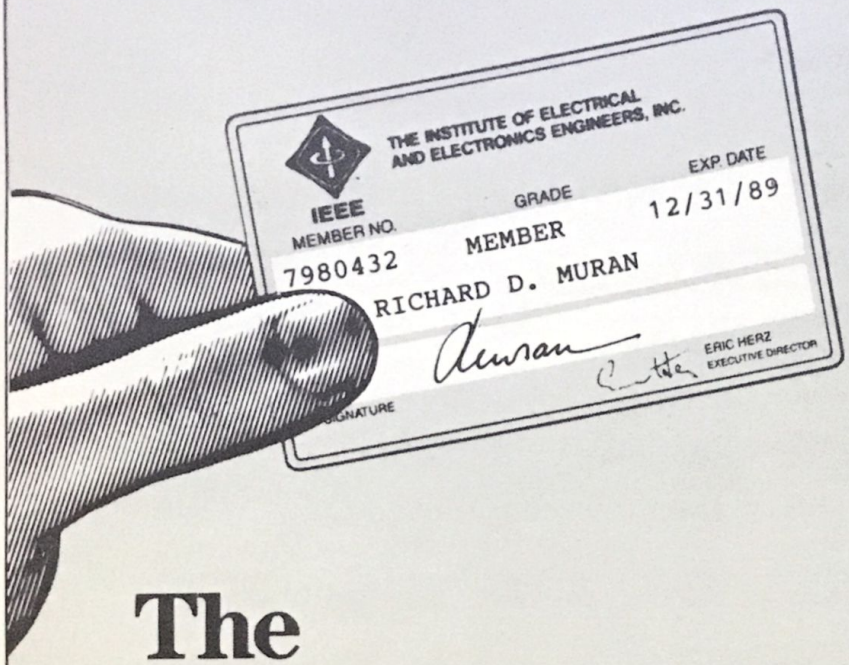
The 4th Biennial IEEE Conference on Electromagnetic Field Computation will be held at the Westbury Hotel, Toronto, Canada, October 22-24, 1990. Contact: CEFC '90 Conference Secretariat, Department of Electrical Engineering, University of Toronto, Toronto, CANADA M5S 1A4.

11th International Workshop on Rare-Earth Magnets and Their Applications, October 21-24, 1990, and 6th International Symposium on Magnetic Anisotropy and Coercivity in Rare-Earth-Transition Metal Alloys, October 25, 1990 are to be held at Carnegie Mellon University, Pittsburgh, PA. Contact: S. G. Sankar, Chairman, 11th Int'l. Workshop Rare Earth Magnets, Carnegie Mellon University, Mellon Inst., 4400 Fifth Avenue, Pittsburgh, PA 15213. (412) 268-5649, Fax (412) 268-3101.

35th Magnetism and Magnetic Materials Conference, October 29-November 1, 1990 Town and Country Hotel, San Diego, CA. Contact: Diane Suiters, Courtesy Associates, 655 15th Street N.W., Suite 300, Washington, D.C. 20005

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

Second International Conference Rare Earth Development and Applications, May 27-31, 1991 in Beijing, China. See page 5 for further information.



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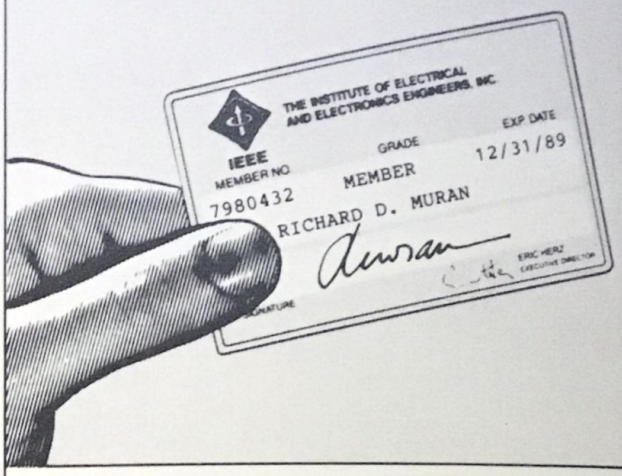

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