



IEEE TRANSACTIONS ON

MAGNETICS

SEPTEMBER 1992

VOLUME 28

NUMBER 5

IEMGAQ

(ISSN 0018-9464)

A PUBLICATION OF THE IEEE MAGNETICS SOCIETY

PART II OF TWO PARTS

Magnetic Recording Heads: Inductive Thin Film and Laminated

Noise in thin-film inductive heads — <i>K. B. Klaassen and J. C. L. van Peppen</i>	2097
Correlation between noise-after-write and magnetization dynamics in thin film heads — <i>F. H. Liu, P. Ryan, X. Shi, and M. H. Kryder</i>	2100
The effect of track width and topography on composition uniformity of electroplated Permalloy in thin film heads — <i>S. Sahami and H. P. E. Lee</i>	2103
Dynamic field distributions of thin film inductive heads — <i>H. Takano, S. Sasaki, H. Shinada, K. Shiiki, and Y. Sugita</i>	2106
Thin film head characteristics studied by inductance change from bias current control — <i>K. Kawakami, T. Ohtu, and K. Oguri</i>	2109
Thin film magnetic head composed of inorganic materials — <i>H. Yoshimizu, W. Fujisawa, S. Orihara, and H. Homma</i>	2112
High frequency characteristics of multilayered CoTaZr cores for thin film heads — <i>R. Arai, K. Mitsuoka, H. Fukui, H. Akimoto, and S. Narishige</i>	2115
High abrasion resistance laminated Sendust VTR heads — <i>N. Ishiwata, T. Okumura, A. Osaka, S. Shinkai, N. Itonaga, M. Kitamura, and H. Urai</i>	2118
Read/write characteristics for laminated high moment Fe-Ta-N film heads for HDTV VTR — <i>T. Okumura, A. Osaka, N. Ishiwata, M. Kitamura, and H. Urai</i>	2121
Compatibility of silicon planar heads with conventional thin film heads in hard disk drives — <i>E. Autino, J. P. Lazzari, and C. Pisella</i> .	2124



IEEE MAGNETICS SOCIETY

The IEEE Magnetics Society is an association of IEEE members and affiliates with professional interests in the field of magnetics. All IEEE members are eligible for membership and will receive this TRANSACTIONS, the Society Newsletter, and other Society mailings upon payment of the annual Society membership fee of \$10.00. It is possible for members of other professional societies to become Society affiliates. Information on membership can be obtained by writing to the IEEE at the address below. *Member copies of Transactions/Journals are for personal use only.*

President
S. H. CHARAP

Vice President
D. A. THOMPSON

Officers

Secretary-Treasurer
C. E. YEACK-SCRANTON

Past President
R. M. JOSEPHS

Term Ending 12/31/92

J. D. ADAM F. B. HAGEDORN
P. P. BIRINGER J. E. OPFER
G. E. FISH C. E. PATTON
R. GERBER P. E. WIGEN

Administrative Committee

Term Ending 12/31/93

R. E. FONTANA, JR.
K. HARADA
R. INDECK
T. M. JAGIELINSKI

H. JOUVE
M. H. KRYDER
H. A. LEUPOLD
R. WOOD

Term Ending 12/31/94

J. A. CHRISTNER
E. DELLA TORRE
W. D. DOYLE
F. FRIEDLAENDER

C. M. PERLOV
D. J. SHULA
D. D. STANCIL
T. SUZUKI

Standing Committees Chairpersons

Constitution and Bylaws, F. J. FRIEDLAENDER
Education, D. D. STANCIL
Finance, G. E. FISH
Membership, M. R. RE
Nominations, D. I. GORDON
Planning, S. H. CHARAP
Publicity, R. S. INDECK

Department Chairpersons

Awards, F. J. FRIEDLAENDER
Chapters, H. S. GILL
Conference Executive Committee, C. D. GRAHAM
Publications, W. LORD
Technical Committees, C. M. PERLOV

IEEE United States Activities Board

C. E. JOHNSON, JR. and A. B. SMITH

Amorphous Magnetic Materials, R. HASEGAWA
Control and Power Processing, J. D. HARNDEN, JR.
Cryolectric Engineering, R. B. GOLDFARB
Electromagnetic Launch Technology and Levitated Transportation, H. H. KOLM
Heating by Induction, P. P. BIRINGER

Technical Committee Chairpersons

High Frequency Properties of Magnetic Materials, C. VITTORIA
Large Magnet Technology, P. C. MARSTON
Magnetic Recording, D. SPELIOTIS
Magnetic Separation, D. R. KELLAND
Magnetics in Life Sciences, R. B. FRANKEL

Magnetometers and Measurements, R. M. JOSEPHS
Magnetooptics, G. A. PRINZ
Memories, N. T. VEILLETTE
Permanent Magnets, K. STRNAT
Relay Magnetics, D. D. LINGELBACH
Soft Core Materials, K. J. OVERSHOTT

Special Publications Editors

IEEE TRANSLATION JOURNAL ON MAGNETICS IN JAPAN

Managing Editor, T. JAGIELINSKI
Associate Editors:
W. G. HAINES J. E. MONSON
D. R. KRAHN J. HURST

IEEE Magnetics Society Newsletter

J. A. CHRISTNER, *Editor*
IBM Corporation
HWY 55 & NW 37 St.
Rochester, MN 55901

T. SUZUKI, *Editor*
IBM Almaden Research Center
650 Harry Road
San Jose, CA 95120-6099

IEEE TRANSACTIONS® ON MAGNETICS

Editor-in-Chief
W. LORD
Dept. Elec. & Comput. Eng.
Iowa State Univ.
Ames, IA 50011

Reviews Editor
R. A. JOHNSON
Digital Equipment Corp.
SHRI-3/E15
333 South Street
Shrewsbury, MA 01545

Reviews Editor
DAVID C. JILES
Ames Laboratory
Iowa State Univ.
Ames, IA 50011

Advances in Magnetics Editor
M. R. PARKER
Dept. Elec. Eng.
University of Alabama
Tuscaloosa, AL 35487-8286

Conference Editor
R. B. GOLDFARB
Nat. Inst. Stand.
& Tech.
325 Broadway
Boulder, CO 80303

THE INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC.

Officers

MERRILL W. BUCKLEY, JR., *President*
MARSHA SLOAN, *President-Elect*
KARSTEN E. DRANGEID, *Secretary*
THEODORE W. HISSEY, JR., *Treasurer*
EDWARD A. PARRISH, *Vice President, Educational Activities*

ARVID G. LARSON, *Vice President, Professional Activities*
J. T. CAIN, *Vice President, Publication Activities*
LUIS T. GÁNDIA, *Vice President, Regional Activities*
MARCO W. MIGLIARO, *Vice President, Standards Activities*
FERNANDO ALDANA, *Vice President, Technical Activities*

MARTIN V. SCHNEIDER, *Director, Division IV—Electromagnetics and Radiation*

Headquarters Staff

ERIC HERZ, *Executive Director*

JOHN H. POWERS, *General Manager*

THOMAS W. BARTLETT, *Associate General Manager—Finance and Administration*

WILLIAM D. CRAWLEY, *Associate General Manager—Programs*

DONALD CHRISTIANSEN, *Editor, IEEE Spectrum*
IRVING ENGELSON, *Staff Director, Technical Activities*
LEO FANNING, *Staff Director, Professional Activities*
WILLIAM R. HABINGREITHER, *Staff Director, Customer Service Center*
PHYLLIS HALL, *Staff Director, Publishing Services*

PETER A. LEWIS, *Staff Director, Educational Activities*
MELVIN I. OLKEN, *Staff Director, Field Services*
EDWARD ROSENBERG, *Controller*
ANDREW SALEM, *Staff Director, Standards*

Publications Department

Publications Managers: ANN H. BURGMEYER, GAIL S. FERENC

IEEE TRANSACTIONS ON MAGNETICS is published bimonthly by The Institute of Electrical and Electronics Engineers, Inc. Responsibility for the contents rests upon the authors and not upon the IEEE, the Society, or its members. IEEE Headquarters: 345 East 47 Street, New York, NY 10017-2394. NY Telephone: 212-705 + extension: Information -7900; General Manager -7910; Public Information -7867; Publishing Services -7560; Spectrum -7556; Telecopiers: NY (Headquarters) 212-752-4929, NY (Publications) 212-705-7682; NY Telex: 236-411 (international messages only). IEEE Service Center (for orders, subscriptions, address changes, Educational Activities, Region/Section/Student Services, Standards): 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331. NJ Telephone: 908-981-0060; 908-562 + extension; Controller -5365; Technical Activities -3900. IEEE Washington Office (for U.S. professional activities): 1828 L Street, NW, Suite 1202, Washington, DC 20036-5104. Washington Telephone: 202-785-0017. Price/Publication order from \$1.00 to \$50.00, including prepaid orders.) Member and nonmember subscription prices available on request. Available in microfiche and the U.S. Copyright Law for private use of patrons: 1) those post-1977 articles that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through the Copyright Clearance Center, 27 Congress Street, Salem, MA 01970; 2) pre-1978 articles without fee. For all other copying, reprint, or republication permission, write to: Copyrights and Permissions Department, IEEE Publishing Services, 445 Hoes Lane, P.O. Box 1331, at New York, NY and at additional mailing offices. Postmaster: Send address changes to IEEE TRANSACTIONS ON MAGNETICS, IEEE, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331.

The effect of V or W additives to microstructure and coercivity of Nd-Fe-B based magnets — <i>J. Bernardi, J. Fidler, and F. Fodermayr</i>	2127
The origin of crystallographic texture produced during hot deformation in rapidly-quenched NdFeB permanent magnets — <i>L. Li and C. D. Graham, Jr.</i>	2130
Structural imperfections in Pr ₂ Fe ₁₄ B magnets with additions of Al, Cu, and Zn — <i>Y. J. Zhang, L. Withanawasam, and G. C. Hadjipanayis</i>	2133
Preferred crystalline orientation of melt-spun Nd-Fe-M-B flakes (M = Ti/Zr/Hf/V/Nb/Ta) — <i>T.-S. Chin, S. H. Huang, and J. M. Yao</i>	2136
Effect of added Cu on the Nd-rich phase in hot-deformed NdFeB magnets — <i>K. Ohmori, L. Li, and C. D. Graham, Jr.</i>	2139
Nd-Fe-B-Cu HD-processed sintered magnets: Properties and microstructure — <i>K. G. Knoch, A. Kianvash, I. R. Harris, and P. J. McGuiness</i>	2142
The disproportionation of Nd ₂ Fe ₁₄ B under hydrogen in Nd-Nd-Fe-B alloys — <i>D. Book and I. R. Harris</i>	2145
Phases and magnetic properties of mechanically milled Pr-Fe-B-X alloys during heat treatment — <i>D. G. Lee, D. Y. Kim, W. Y. Jeung, and I. K. Kang</i>	2148
A high performance Nd-Fe-B magnet with improved corrosion resistance — <i>A. S. Kim and F. E. Camp</i>	2151
Effects of Nb addition and/or casting method on the amount of precipitated Fe in NdFeB alloys — <i>W. L. Liu, Y. L. Liang, B. M. Ma, and C. O. Bounds</i>	2154
The oxidation of a NdFeB permanent magnet at 400°C: A SEM, microhardness and Mössbauer study — <i>J.-M. Le Breton, J. Teillet, P. J. McGuiness, D. S. Edgley, and I. R. Harris</i>	2157
Anisotropic HDDR epoxy bonded magnets from NdFeBZr — <i>P. J. McGuiness, C. L. Short, and I. R. Harris</i>	2160



Transformers and Inductors

A low loss transformer using a rotating magnetic field — <i>T. Nakata, N. Takahashi, K. Fujiwara, M. Nakano, and M. Nagao</i>	2163
Practical method for heat treating large toroids for pulse compression applications — <i>I. T. Collier, M. R. J. Gibbs, and N. Seddon</i>	2166
Proximity effects in coils for high frequency power applications — <i>A. W. Lotfi, P. M. Gradzki, and F. C. Lee</i>	2169
Analysis of energy make-up requirements for resonant-type ring magnet power supplies — <i>J. M. S. Kim</i>	2172
An improved technique of impedance measurement for thin film inductors over 10 MHz — <i>K. I. Arai, M. Yamaguchi, and H. Ohzeki</i>	2175
Detection of secondary current and torque of squirrel-cage induction motor using amorphous magnetic sensor — <i>K. Inuzuka and K. Mohri</i>	2178
Study of push-pull parametric transformer — <i>O. Ichinokura, K. Tajima, and T. Jinzenji</i>	2181
Transient operation of orthogonal-core type DC-AC converter for photovoltaic power system — <i>O. Ichinokura, K. Tajima, M. Maeda, H. Takahashi, and T. Jinzenji</i>	2184

Magnetic Sensors (Not Recording)

An absolute earth field ESR vectorial magnetometer — <i>D. Duret, M. Beranger, and M. Moussavi</i>	2187
Mechanical sensors based on re-entrant flux reversal — <i>E. Hristoforou and D. Niarchos</i>	2190
A new magnetic sensor using separated drift field — <i>S. K. Lee, K. H. Oh, U. S. Kang, and M. K. Han</i>	2193
New structures for linear displacement sensor with high magnetic field gradient — <i>C. Blache and G. Lamarquand</i>	2196
Inductive absolute angular position sensor — <i>V. Lemarquand and G. Lemarquand</i>	2199
A torque transducer utilizing a circularly polarized ring — <i>I. J. Garshelis</i>	2202
Non-contact torque sensor using the difference of maximum induction of amorphous cores — <i>D. Son, S. J. Lim, and C. S. Kim</i>	2205
Impedance analysis of acoustic vibration element using giant magnetostrictive material — <i>H. Wakiwaka, M. Lio, M. Nagumo, H. Yamada, K. Kobayashi, and T. Yoshikawa</i>	2208
Directionally-conductive, optically-transparent composites by magnetic alignment — <i>S. Jin, T. H. Tiefel, and R. Wolfe</i>	2211
Effect of biaxial stress on magnetoacoustic emission from nickel — <i>D. H. L. Ng, J. P. Jakubovics, C. B. Scruby, and G. A. D. Briggs</i>	2214

Microwave characteristics of YBCO coplanar waveguide resonator — <i>H. How, R. Seed, and C. Vittoria</i>	221
Suppression of intra- and intergranular properties by transport current in Bi-based ceramic superconductors — <i>A. M. Grishin, V. N. Korenivski, K. V. Rao, and A. Ulyanov</i>	222
Intrinsic critical current densities in high temperature superconducting film — <i>H. Jiang, A. Widom, Y. Huang, T. Yuan, and C. Vittoria</i>	222
Observation of macroscopic quantum effects in high T_c weak link superconducting rings — <i>Y. Huang, H. Jiang, A. Widom, and C. Vittoria</i>	222
Hysteretic magnetic forces calculation for type-II superconductors — <i>T. Torg, Q. Chen, B. Morton, and J. Lenz</i>	222
Loss characteristics of air-core superconducting transformer — <i>H. Yamaguchi, Y. Sato, and T. Kataoka</i>	222
Synthesis and properties of TiBaCaCuO films prepared by spray pyrolysis method — <i>A. Naziripour, H. M. Duan, J. Sharp, A. M. Hermann, L. P. de Rochemont, M. Squillante, J. G. Zhang, C. E. Oakes, P. A. Parilla, R. N. Bhattacharya, and R. D. Blaughier</i>	223

Field Calculations I

Surface power distribution in cross field heating of thin nonmagnetic plates — <i>K. V. Namjoshi and P. P. Biringer</i>	2238
A finite-element ballooning model for 2D eddy current open boundary problems for aerospace applications — <i>Z. Luo and N. A. Demerdash</i>	2241
The analysis of the magnetostatic fields surrounding a twisted-pair transmission line using integral methods — <i>Z. Luo and N. A. Demerdash</i>	2244
Overlapping finite elements for problems with movement — <i>I. A. Tsukerman</i>	2247
Analytical calculations of flux induction and forces of thick coils with finite length — <i>A. Rezzoug, J. P. Caron, and F. M. Sargos</i> .	2250
The inductance calculation of magnetic rods by using complementary finite element methods — <i>H. Watanabe and K. Kato</i>	2253
Finite element analysis of nonlinear magnetic devices combined with circuit equations by tableau approach — <i>S. Yamada, K. Bessho, and M. Kitagawa</i>	2256

Field Calculations II

3D eddy current analysis by the hybrid FE-BE method using magnetic field intensity H — <i>T. Onuki, S. Wakao, and M. Shimazaki</i>	2259
Stoner-Wohlfarth hysteresis model with stochastic input as a model of viscosity in magnetic materials — <i>G. Friedman and I. D. Mayergoyz</i>	2262
Three-dimensional nonlinear finite element modeling of a voltage source excited transformer feeding a rectifier load — <i>A. A. Arkadan and R. H. VanderHeiden</i>	2265
Experimental testing of the average Preisach model of hysteresis — <i>A. A. Adly and I. D. Mayergoyz</i>	2268
Investigation of the torque calculation of a DC PM motor — <i>A. Hamler, B. Kreca, and B. Hribernik</i>	2270
Static magnetic field deformation by a ferromagnetic body — <i>G. R. Kahler, E. Della Torre, and F. Vajda</i>	2274
Methods of calculation of magnetic fields and static characteristics of linear step motors for control rod drives of nuclear reactors — <i>S. H. Khan and A. A. Ivanov</i>	2277
Displacement eddy currents in magnetic laminates — <i>R. M. Walser and A. P. Valanju</i>	2280

Magnetic Recording Heads: Magnetoresistive

Magnetoresistive heads for magnetic tape and disk recording — <i>F. B. Shelledy and J. L. Nix</i>	2283
Study of recessed MR sensors with unlaminated and multi-laminated flux-guides — <i>C. Tsang, M. Krounbi, P. Kasirai, and R. Lee</i> .	2289
Dual magnetoresistive head for very high density recording — <i>N. Smith, J. Freeman, P. Koeppe, and T. Carr</i>	2292
Analysis of a dual magnetoresistive head — <i>N. Smith, D. R. Smith, and S. Shtrikman</i>	2295
Effect of azimuth angle and bias field on second harmonic distortion in differentially biased MR heads — <i>R. H. Dee</i>	2298
Performance comparison of unshielded and shielded MR read heads for digital tape recording — <i>M. M. Dovek, D. J. Seagel, T. J. Beaulieu, E. R. Christensen, and R. E. Fontana, Jr.</i>	2301
Microtrack profiling technique for narrow track tape heads — <i>M. M. Dovek, J. K. Spong, J. H. Eaton, and D. A. Thompson</i>	2304

Direct measurement of the sensitivity distribution of magnetoresistive heads by the SXM technique — <i>K. Sueoka, K. Wago, and F. Sai</i>	2307
Spatial mapping of the sensitivity function of magnetic recording heads using a magnetic force microscope as a local flux applicator — <i>G. A. Gibson, S. Schultz, T. Carr, and T. Jagielinski</i>	2310

Permanent Magnetics Nitrogenation – Present and Future

Magnetism of intermetallic nitrides: A review — <i>W. E. Wallace and M. Q. Huang</i>	2312
Neutron diffraction studies of rare earth transition metal nitrides — <i>W. B. Yelon and G. C. Hadjipanayis</i>	2316
Electronic structure and magnetic properties of $R_2Fe_{17}N_x$ — <i>S. S. Jaswal</i>	2322
Effect of nitrogen content on magnetic properties of $Sm_2Fe_{17}N_x$ ($0 < x < 6$) — <i>T. Iriyama, K. Kobayashi, N. Imaoka, T. Fukuda, H. Kato, and Y. Nakagawa</i>	2326
Gas phase interstitial modification of rare-earth intermetallics — <i>J. M. D. Coey, R. Skomski, and S. Wirth</i>	2332

Memory Devices: VBL, Bubble and Other

Partial grooving in vertical Bloch line memory — <i>J. C. Wu, R. R. Katti, and H. L. Stadler</i>	2338
A numerical investigation of stripe chopping in thin films with perpendicular anisotropy — <i>G. N. Patterson, R. C. Giles, and F. B. Humphrey</i>	2341
Dynamics of magnetic domain wall with loosely spaced vertical Bloch lines — <i>A. Bagneres and F. B. Humphrey</i>	2344
Generation of winding vertical Bloch lines and their effect on wall dynamics — <i>K. G. Navada, F. J. Friedlaender, J. A. Nyenhuis, and C. M. Srivastava</i>	2347
Collisions of vertical Bloch lines clusters — <i>M. V. Chetkin, I. V. Parygina, and L. L. Savchenko</i>	2350
Hardness and etching studies on flux grown $YFeO_3$ crystals — <i>K. K. Bamzai, P. N. Kotru, and B. M. Wanklyn</i>	2353
A high output mode for submicron M-R memory cells — <i>A. V. Pohn, J. M. Daughton, and K. E. Spears</i>	2356
High-speed (10–20 ns) nonvolatile MRAM with folded storage elements — <i>K. T. M. Ranmuthu, I. W. Ranmuthu, A. V. Pohn, C. S. Comstock, and M. Hassoun</i>	2359

Particulate Recording Media

A detailed study of the environmental stability of metal particle tapes — <i>M. C. A. Mathur, G. F. Hudson, and L. D. Hackett</i>	2362
Estimating the archival life of metal particulate tape — <i>Y. Okazaki, K. Hara, T. Kawashima, A. Sato, and T. Hirano</i>	2365
Magnetic and magneto-photoellipsometric evaluation of corrosion in metal-particle media — <i>M. R. Parker, S. Venkataram, and D. DeSmet</i>	2368
Dispersion quality of metal particle inks measured by a magnetic probing technique and its relation to tape quality — <i>C. Jung, S. Raghavan, and M. C. A. Mathur</i>	2371
Magnetic characterization of metal particle pigment dispersions — <i>P. I. Mayo, K. O'Grady, and P. C. Hobby</i>	2374
Magnetic orientation of acicular iron particle in recording media — <i>W. G. Peng, S. S. Wong, Y. S. Lin, and C. D. Wu</i>	2377
Hysteresis in random collections of isotropic interacting particles — <i>D. R. Fredkin, W. Chen, and T. R. Koehler</i>	2380
Effect of surface properties on cobalt modification of iron oxides — <i>A. V. Blagey and S. J. Hirz</i>	2382
Acicular γ - Fe_2O_3 particulate surface-coated with barium ferrite — <i>M. C. Deng, S. L. Hsu, and T. S. Chin</i>	2385
Orientation and angular dependence of magnetic properties for Ba-ferrite tapes — <i>T. Suzuki</i>	2388
Barium ferrite particulate tapes for high band 8mm VCR — <i>H. Yokoyama, T. Ito, M. Isshiki, K. Kurata, and T. Fukaya</i>	2391
Magnetic and thermomagnetic analysis of 4 megabyte barium ferrite flexible disks — <i>D. E. Speliotis</i>	2394

Life Science and Magnetic Separation

3D-CAD of an amorphous magnetostrictive sensor for monitoring the movements of the human spine — <i>T. Klinger, F. Schmöllerbeck, H. Pfützner, and P. Schönhuber</i>	2397
Magnetostrictive amorphous sensor for biomedical monitoring — <i>T. Klinger, H. Pfützner, P. Schönhuber, K. Hoffmann, and N. Bachl</i>	2400

Explore Litigation Insights



Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.