A. John Mardinly

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Education: *Ph.D., Materials Science,* University of Michigan, 1982.
M.S.E., Materials Science, University of Michigan, 1974.
B.S.E., Materials Science, University of Michigan, 1972.
B.S.E., *Engineering Physics,* University of Michigan, 1972.
Licensed Professional Engineer (P.E.), March 1981 (by examination).

Materials Scientists/Electron Microscopist

Extensive experience in Analytical Transmission Electron Microscopy. Looking for an opportunity to apply and advance Analytical Transmission Electron Microscopy and associated instrumentation to solving challenging materials problems in a high technology area.

Core Competency Summary:

Expert in Brightfield & Darkfield imaging, HRTEM, SAD & CBED, HAADF STEM, quantitative EDX (ZAF & Cliff-Lorimer) plus line scans, spectral imaging mapping and principle component analysis, GIF, STEM-EELS line scans and spectral imaging, Tomography, Aberration Correctors, Omniprobe, SEM & Dual Beam FIB, X-ray diffraction, Disco saw, Microprocessor and ETOX memory processing technologies, and magnetic recording technologies, yield engineering and Failure Analysis, Phase Change memories, Tool Selection, Installation and Optimization, Hands-on tool debugging and vendor FSE management, Laboratory productivity and work tracking. Licensed PE for litigation testimony, extensive university involvement teaching, mentoring and research advising, 12 invited talks, 43 external publications, over 1,000 internal reports at Intel and over 100 at Western Digital.

Professional Experience:

WESTERN DIGITAL CORPORATION, MEDIA OPERATIONS (formerly KOMAG), (2009-Present) Senior Engineer in the Transmission Electron Microscopy laboratory. Responsible for advanced characterization of complex multilayer multi-component sputtered films for perpendicular recording technology and heat/energy-assisted magnetic recording using HRTEM, EELS, EDX and electron diffraction.

NUMONYX CORPORATION, CALIFORNIA TECHNOLOGY CENTER, *(*2008-2009*)* Senior Engineer and manager of Transmission Electron Microscopy laboratory supporting both ETOX and phase change (chalcogenide) advanced non-volatile memory development. This is essentially the same Intel laboratory under a different business name. I spend 1 day per week at

Stanford University doing X-Ray Diffraction studies of phase change memory materials. Most recently, I have developed techniques using EDX Principle Component Analysis to map and quantify compositional segregation in phase change memory devices and to directly map arsenic implant profiles in CMOS transistors.

INTEL CORPORATION, SANTA CLARA MATERIALS TECHNOLOGY DEPT., (1992-2008)
Senior Engineer and manager of Transmission Electron Microscopy laboratory for Intel Santa Clara. The lab performs over 1000 TEM analyses each year of semiconductor devices and materials, in support of R&D, advanced manufacturing process development, yield and performance engineering, and failure analysis. In addition, we implement new microanalysis and imaging techniques, and carry out efforts for development for new methods of specimen preparation to meet the challenges presented by continuation of Moore's Law. Expert in HRTEM, HAADF STEM, quantitative EDX plus line scans, mapping and principle component analysis, and EELS spectral imaging and GIF, tomography, Omniprobe, dual beam FIB, X-ray diffraction, Disco saw, etc. Authored over 600 internal reports in the past six years and published 25 external publications while working at Intel. Mentor for seven successful interns, all of whom went on to finish Ph.D.s and start successful careers, (four of whom were hired by Intel). Responsible for proliferating TEM's at Intel (from just two in 1992 to eleven in 2008), first Field Emission TEM at Intel, first EELS at Intel, first Aberration Corrected TEM at Intel, as well as four TEM Room Builds and installations and one FIB installation.

LOCKHEED MISSILES AND SPACE COMPANY, Failure Analysis Laboratory (1983-1992) (Lead Engineer for 4 years). Responsible for Electron Microscopy, X-ray Diffraction, and Failure Analysis. Established Electron Probe and TEM Laboratories, and supervised eight engineers. The Laboratory provided complete materials characterization services to the entire Sunnyvale (Manufacturing) and Palo Alto (R&D) facilities. The lab supported structural materials, as well as electronic materials and packaging. Work was coordinated with XPS, Auger, FTIR, GC-MS, XRF, GC, HPLC, Thermal, Mechanical, NMR, Rheological, and other analyses done in adjacent departments. From 1986-1992, I concentrated on TEM imaging and analysis, and specimen preparation techniques for study of MOCVD GaAs-Ge solar cells, MBE GaAs-InGaAs SLS and quantum-well materials for photonics and HEMT's, ion implantation and radiation damage of semiconductors, sputtered thin films and multi-layer materials.

NORTHROP AIRCRAFT DIVISION, (1982-1983)
Engineering Specialist in the Microstructural Analysis Laboratory (1 year). Responsible for materials characterization for internal and contract research programs for 12 program managers, division-wide failure analysis, and a laboratory capability improvement program. Supported research in superplastic forming, powder metallurgy, aluminum-lithium alloy development, high-strength aluminum castings, composites, and radar absorbing materials for the B-2 Stealth Bomber.

UNIVERSITY OF MICHIGAN ELECTRON MICROBEAM ANALYSIS LABORATORY in the Department of Materials and Metallurgical Engineering. (part-time 1972-1982)
Involved in all phases of operation of a campus-wide central Analytical Services facility providing SEM, TEM and Electron Probe Micro-Analysis to over 150 graduate students and faculty, local corporations, and consultants. Taught lab courses, provided individual instruction to professors and graduate students, repaired and maintained instruments, built new specimen preparation and analytical equipment.

Awards: *Presidential Scholarship,* Electron Microscopy Society of America, 1979.
Student Scholarship Award, Microbeam Analysis Society, 1977 & 1980.
Alpha Sigma Mu (Metallurgical Honor Society), 1975.

Professional Society Membership and Service:

Microscopy Society of America (1973-Present), President of Northern California Chapter (1992-1993), Council Member (1990-1991)
National Center for Electron Microscopy at Berkeley Proposal Review Committee Member, 2007-Present.
Microbeam Analysis Society (1973-1991), President-West Coast Chapter, 1986,Program Chairman-1985,),
American Society for Metals, 25 year member, Chairman of Santa Clara Chapter (1990-1991), Vice Chairman (1989-1990), Treasurer (1988-1989), Executive Board Member, (1987-1998), member of National Chapter Operations Committee (1990-1991)

University Lecturing:

STANFORD UNIVERSITY Engineering & Science Institute, **The Effect of Moore's Law on the Criticality of Nano-Scale Imaging and Microanalysis in the Semiconductor Industry,** Continuing Education Course, taught in 2004. I was invited back for 2005 due to high scores in the evaluation forms, but the course was canceled for financial reasons.

UNIVERSITY of SOUTHERN CALIFORNIA EXTENSION, Adjunct Faculty Member, 1990. Taught basic Materials Science course.

SAN JOSE STATE UNIVERSITY, Adjunct Faculty Member, 1988, 1992. In 1988, while working for Lockheed, I taught a course on mechanical behavior of solids in the Materials Science department. In 1992 I taught a course on electron microscopy in the Materials Science department. However, working in the high-pressure Intel environment combined with teaching was a tremendous strain and I did not teach any more full-semester courses while working for Intel.

UNIVERSITY OF MICHIGAN, Teaching Assistant, 1977-1978, Laboratory Instructor for SEM, TEM, & Electron Probe Microanalysis, 1972-1982. I worked as a teaching assistant for the basic Materials Science Survey course taught to all undergraduate engineering students, and four ten years provided 1:1 instruction on the use of Scanning and Transmission Electron microscopes and associated specimen preparation techniques.

Other Teaching:

Herb David Music Studio While I was an undergraduate I provided classical guitar instruction at a private music studio on Saturdays instead of going to football games. This may sound like heresy to Big Ten football fans, but it was my preference. Reluctantly, I decided I did not have time for this from my senior year on.

Personal

Married, 8 year old daughter, after playing with my daughter, I enjoy swimming, physical fitness, playing classical guitar and listening to classical music.

Invited Talks:

Microscopy Applications in the Semiconductor Industry, Microscopy & Microanalysis 2007, Ft. Lauderdale, FL

Moore's Law and its Effect on Microscopy in the Semiconductor Industry
Microscopy of Semiconductors XV, Cambridge, UK, 2007.

Future Science Needs and Opportunities for Electron Scattering, Department of Energy workshop to propose future microscopy challenges and opportunities. 2007.

Aberration Corrected Microscopy and Moore's Law: Capabilities Aiding Progress for the Next Decade, UC Berkeley Student Symposium, December 2005.

Aberration Corrected Microscopy and Moore's Law: Capabilities Aiding Progress for the Next Decade Microscopy & Microanalysis 2005, Honolulu, Hawaii.

The Effect of Moore's Law on the Criticality of Nano-Scale Imaging and Microanalysis in the Semiconductor Industry, Stanford Engineering & Science Institute, Continuing Education Course, 2004.

Applications of TEM in the Semiconductor Industry, Northern California Society for Electron Microscopy, 2003.

Applications and Problems for TEM of Semiconductor Products, Microscopy of Semiconductors XI, Oxford, UK, 1999.

Transmission Electron Microscopy of Semiconductor Based Products, MRS Spring Meeting 1998, San Francisco, CA.

Applications of Transmission Electron Microscopy in the Semiconductor Industry, Arizona State University Student Symposium, 1994

Applications of Microscopy in the Semiconductor Industry, Northern California Society for Electron Microscopy, 1994.

Applications of Contemporary Electron Microscopy, Stanford University Symposium, 1991

Publications:

"Correlation of microstructure, intrinsic magnetization switching properties and recording performance in exchange-coupled composite media", Kumar Srinivasan, Eric Roddick; Ramamurthy Acharya; John Mardinly, 55th MMM Meeting, November 2010, Journal of Applied Physics, in print.

Microscopy Applications in the Semiconductor Industry, Microscopy & Microanalysis 13(Supl 2) 2007, Cambridge University Press, New York, NY, pp. 530-531 CD.

Moore's Law: A Review of Feature Size Shrinkage and its Effect on Microscopy in the Semiconductor Industry, Microscopy Today, Vol. 15 #3, May 2007, pp. 6-11.

Moore's Law and its Effect on Microscopy in the Semiconductor Industry
Microscopy of Semiconductors XV, Cambridge, UK, 2007, pp.361-373.

Analysis of Nano-scale Strain Near Shallow Trench Isolation Structures by Energy-filtered Convergent Beam Electron Diffraction with
P. Zhang, O. Karpenko, A. Istratov, H. He, J. Ager, C Nelson, E. Stach, C. Kisielowski, E. Weber and J. C.H. Spence, Microscopy and Microanalysis (2006), 12: 938-939

Analysis of Nanoscale Stress in Strained Silicon Materials and Microelectronics Devices by Energy-Filtered Convergent Beam Electron Diffraction P. Zhang, A.A. Istratov, H. He, J.W. Ager, C. Nelson, E. Stach, C. Kisielowski, E.R. Weber, and J.C.H. Spence, ECS Transactions 2 (2), 559-568 (2006) Silicon Materials Science and Technology X, The 209th Meeting of the Electrochemical Society, May 7-12, 2006 Denver, Colorado

Electron Tomography and Three-Dimensional Aspects of Transmission Electron Microscopy, Electronic Devices and Failure Analysis, 2005, Vol.7 No.3, pp.6-11.

Electron Tomography of Microelectronic Device Interconnects with Qing Yang, Christian Kübel, Chris Nelson, and Christian Kisielowski, Proceedings, Electron Microscopy Society of America, 2005, p. 2138

Aberration Corrected Microscopy and Moore's Law: Capabilities Aiding Progress for the Next Decade Proceedings, Electron Microscopy Society of America, 2005, p.2090

The Effect of Moore's Law on the Criticality of Nano-Scale Imaging and Microanalysis in the Semiconductor Industry, Stanford Engineering & Science Institute, Continuing Education Course, 2004.

Electron Tomography of Microelectronic Devices with K.-H. Min, Proceedings, Electron Microscopy Society of America, 2003
Poster won an award for 2nd place in 'Best New Instrumentation'.

HRTEM Simulations for the Study of Ultra-Thin Gate Oxide with Seth T. Taylor, and Michael A. O'Keefe, Microscopy & MicroAnalysis, 2002, Vol. 8, #5, p. 412.

THE EFFECT OF MOORE'S LAW ON THE GROWING ROLE OF TRANSMISSION ELECTRON MICROSCOPY IN THE SEMICONDUCTOR INDUSTRY, Proceedings, Electron Microscopy Society of America, 2001.

HRTEM Image Simulations of Structural Defects in Gate Oxides, with S. Taylor, M.A. O'Keefe, and R. Gronsky, Proceedings, Electron Microscopy Society of America, 2000.

HRTEM Image Simulations for Gate Oxide Metrology, with S. Taylor, M.A. O'Keefe, and R. Gronsky, Proceedings, Electron Microscopy Society of America, 2000.

HRTEM Image Simulations of Structural Defects in Gate Oxides with
S. Taylor, M.A. O'Keefe, and R. Gronsky, Proceedings, Characterization and Metrology for ULSI Technology:2000 International Conference, American Institute for Physics, , **550**, P.125, Melville, NY, 2001

HRTEM Image Simulations for Gate Oxide Metrology with
S. Taylor, M.A. O'Keefe, and R. Gronsky, Proceedings, Characterization and Metrology for ULSI Technology:2000 International Conference, American Institute for Physics, , **550**, P.125, Melville, NY, 2001

Precision Ion Milling for Transmission Electron Microscopy Specimen Preparation with R. Jamison, R. Gronsky, and D.W. Susnitzky Proceedings, Electron Microscopy Society of America, 2000.

Computational and Experimental Computation of Focused Ion Beam Damage in Silicon during TEM Specimen Preparation, Robert B. Jamison, U.C. Berkeley Ph.D. Dissertation, Member of Ph.D. Dissertation Committee, with R. Gronsky, T. Sands, and N. Cheung, Spring 2000.

Applications and Problems for TEM of Semiconductor Products
Microscopy of Semiconductors XI, Invited Talk, Oxford, UK, Institute of Physics Conference Series #164, pp. 575-584, 1999.

Combining an Argon Ion Mill and a Field Emission Scanning Electron Microscope for Ultra High Precision Endpoint Detection in Preparing TEM Cross-Sections of Micro-Electronic Devices, with R. Jamison**,** Proceedings, 14 International Congress on Electron Microscopy, 1998, p. 403.

Transmission Electron Microscopy of Semiconductor Based Products, with David Susnitzky, MRS Symposium Proceedings, Electron Microscopy of Semiconducting Materials and ULSI Devices, Vol. 523, pp. 3-12, 1998.

Imaging and Analytical Challenges for Nanoscale Semiconductor Technology: Breakthrough Needs for Development and Manufacturing, with Robert McDonald and David Susnitzky, Proceedings, Electron Microscopy Society of America, 1997, p. 449.

Preparation of Cross-section TEM Specimens of Semiconductors Containing Tungsten Interconnects using Chemical Mechanical Polishing and Chemically Assisted Ion Beam Milling, and Use of AFM to Evaluate the Success of these Procedures, with Robert Jamison, David Susnitzky, Jian Duan, Carmen Matos and Sharon Darknell, MRS Symposium Proceedings Vol. 480, Specimen Preparation for Transmission Electron Microscopy of Materials IV, pp.201-206, 1997.

STANFORD UNIVERSITY SYMPOSIUM, Invited Speaker, 1991 “***Applications of Contemporary Electron Microscopy”***

The Microstructural Evolution in Nanocrystalline Alumina Made by Reactive Sputtering Deposition, with T.C. Chou, D. Adamson, and T.G. Nieh, Thin Solid Films, 1991.

Post-Ion Milling Chemical Polishing, and Enhancement of Interface View by Transverse Polishing During Dimpling, Proceedings of the XIIth International Congress for Electron Microscopy, San Francisco Press, (1990) 750-751.

MeV Ion Implantation Studies on LPE Films Grown on InP, with T.T. Bardin, J.G. Pronko, and C.R. Wie, Nuclear Instruments and Methods in Physics Research B40/41 (1989) 533-536.

Aluminum-Samarium Alloy for Interconnections in Integrated Circuits, with A. Joshi, D. Gardner, H.S. Hu, and T.G. Nieh, American Vacuum Society, 1989.

Precipitation of Impurities in GaAs Amorphized by Ion Implantation, with W.G. Opyd and J.F. Gibbons, Applied Physics Letters, **53** (16), 17 October, 1988

MacTransferFunction, Computer Program. Presentation-and Publication in, Proceedings, Electron Microscopy Society of America, 1988.

Inverse Pole Figure Generator, Computer Program and Presentation, Electron Microscopy Society of America, 1988.

A Series of JEOL 2000 FX Vacuum System Upgrades to Provide Substantial Improvements at Modest Cost, Proceedings, Electron Microscopy Society of America, 1988, pp. 660.

Identification of Nodules in Dual-Layer Aluminum-Copper Metallization on a Programmable Read-Only Memory (Prom), with Annette S. Marstiller and Esther H. Williams, Proceedings, ISTFA 1987, pp. 251-257.

Electrical and Structural Changes in GaAs Crystals from High-Energy, Heavy-Ion Implants, with T.T. Bardin, J.G. Pronko, F.A. Junga, W.G. Opyd, F. Xiong, and T.A. Tombrello, Nuclear Instruments and Methods in Physics Research B24/25, (1987) 548-553.

Analytical Electron Microscopy of Extraterrestrial Materials: Results from Microtome Sections of Carbonaceous Chondrites and Interplanetary Dust Particles, with D.F. Blake and T.E. Bunch, Proceedings, Microbeam Analysis Society, 1987, pp. 335-338.

A TEM Study of Microstructural Features of a Super-Plastically Deformed Fine Grained 7475 Aluminum Alloy, with R.B. Vastava, presentation to the TMS-AIME Fall Meeting, Philadelphia, PA 1983.

Crystallography and Microstructure of Manganese Sulphide Inclusions in Steel, Ph.D. Dissertation, University Microfilms, Ann Arbor, Michigan, 1982.

Crystallography and Microstructure of Manganese Sulphide Inclusions in Steel, presentation to the TMS-AIME Fall Meeting, Louisville, KY, 1981.

TEM-STEM Analysis of Inclusions in Steel, Microbeam Analysis 1980, p. 176, San Francisco Press.

Micro-Crystallography of Manganese Sulphide Inclusions in Steel, Proceedings, Electron Microscopy Society of America, 1979, p. 660, Claitors.

Accurate Quantitative Analysis of Oxy-Nitrides Using SIALON as a Standard, Proceedings of the 8th International Conference on X-ray Optics and Microanalysis and the 12th Annual Conference of the Microbeam Analysis Society,
p. 155A, 1977, San Francisco Press.

Reducing Background at the Short Wavelength End of ARL Crystal Spectrometers, with W.C. Bigelow, L.F. Allard, and F. Bleicher, Proceedings of the 8th National Conference on Electron Probe Analysis, p. 80A, 1973, San Francisco Press.