

BRUCE W. WESSELS

06.30.16

POSITION

W. P. Murphy Professor of Materials Science and Engineering;
Northwestern University, Evanston, Illinois 60208

RESEARCH INTERESTS

Electronic, magnetic and optical properties of materials and devices, thin film science, nanoelectronics and nanophotonics

EDUCATION

Ph.D. Materials Science 1973, M.I.T;
B.S. Metallurgy and Materials Science, 1968, University of Pennsylvania.

PROFESSIONAL SOCIETIES

TMS
ASM International
The Electrochemical Society
The Materials Research Society
American Physical Society
Optical Society of America

PROFESSIONAL APPOINTMENTS

Chair, Electrical Engineering and Computer Science, Northwestern University, Sept. 2005-2007
Walter P. Murphy Professor, September 1998-
Professor of Materials Science and Engineering, Northwestern University, Jan. 1984- ;
Electrical Engineering and Computer Science 1987- ; Applied Physics Program 2014-,
Electronic Materials Program, Director, 1980- 1990;
Associate Professor, 1980-83;
Assistant Professor, 1977-80;
Visiting Scientist, Argonne National Laboratory 1978;
Member of the Technical Staff, General Electric Research and Development Center 1972-77,
Acting Branch Manager 1976.

RECOGNITIONS

ASTM Warwick Memorial Award, Pennsylvania
Hugo Otto Wolf Award, Pennsylvania
Tau Beta Pi
Sigma Xi
American Men And Women in Science
Who's Who in Engineering
Who's Who in America
Fellow ASM
Fellow American Physical Society
Fellow Optical Society of America

Fellow TMS (The Minerals, Metals and Materials Society)

OTHER ACTIVITIES

TMS Electronic Materials Committee, 1977-2000:

Treasurer 1983-85

Vice-Chairman 1985-87

Chairman 1987-89

TMS-AIME Electronic Materials Conference Program Chairman, 1986-87

ASM Materials Science Committee, 1984;

Electrochemical Society, Local Section Chair, 1984

Key Reader, *Transactions of AIME*, 1985-91;

Editorial Board, *Journal of Electronic Materials*, 1981-89, 1997-

Letters Editor 1998-

1982-88; Program Committee of Third International Conference on Superlattices, Microdevices and Microstructures, 1987

TMS Electronic, Magnetic, and Photonic Materials Division Executive Council, Vice-Chair, 1991-92, Chair 1993-95

TMS Application to Practice, Educator and Leadership Award Committee 1993-95, Chair 1994-95

TMS Board of Directors, 1993-98

TMS Nominations Committee 1993-96

TMS Vice President 1995

TMS President 1996

TMS Foundation President 1997

TMS Matheson and Hardy Awards Committee Chair 2003

AIME Board of Directors 1996-98

MRS Symposium organizer: "Metalorganic Chemical Vapor Deposition of Electronic Ceramics", 1993;

MRS Symposium organizer: "Thin Films for Integrated Optic Applications", 1995.

MRS Symposium organizer: "Thin Films for Optical Waveguide Devices", 1999.

International Conference on Electroceramics, Advisory Board 2003-2005, 2006, 2016

Editorial advisory board, *Journal of Electroceramics*, 2006-2009

Program Committee WUN Spintronics Symposium 2010

Program Committee Electronic Materials Conference 2009-2010

PATENTS:

B. J. Baliga and B. W. Wessels, "Planar gate turn-off field controlled thyristors and planar junction gate field effect transistors, and method of making same" U.S. Patent 4,569,118, Issued Feb. 11, 1986

B. W. Wessels and P. J. Wang, "Vapor phase epitaxy of indium phosphide and other compounds using flow-rate modulation", U. S. Patent 4,801,557, Issued Jan. 31, 1989.

B. W. Wessels, T. J. Marks, D. S. Richeson, L. M. Tonge, J. Zhang, "Method of forming superconducting Tl-Ba-Ca-Cu-O Films" U. S. Patent 5,185,317, Issued Feb. 9, 1993.

B. W. Wessels and L. Q. Qian, "Scanning tunneling optical spectrometer" U. S. Patent 5,262,642, Issued Nov. 16, 1993.

B. W. Wessels, T. J. Marks, D. S. Richeson, L. M. Tonge and J. Zhang "CVD Method for forming bi-containing oxide superconductor thin films" U. S. Patent 5,296,460, Issued Mar, 22, 1994.

B. W. Wessels and B. A. Block, "Optoelectronic ferroelectric sensor and signal generating device" U.S. Patent 5,663,556, Issued Sept. 2, 1997.

B. W. Wessels and M. J. Nystrom, "Oriented niobate ferroelectric thin films for electrical and optical devices and method of making such films" U.S. Patent 5,753,300, Issued May, 1998.

B. W. Wessels, D. M. Gill, G. Ford and S. T. Ho, "Thin film electro-optic modulator for broadband applications" U. S. Patent 6,118,571, Issued September 12, 2000.

B. W. Wessels, B. A. Block, "Rare Earth Doped Barium Titanate Thin Film Optical Working Medium for Optical Devices" U.S. Patent 6,122,429, Issued September 19, 2000.

B. W. Wessels, M. J. Nystrom, "Oriented niobate ferroelectric thin films for electrical and optical devices" U.S. Patent 6,208,453, Issued March 27, 2001.

B. W. Wessels and Bruce Block " Method of Doping Barium Titanate" U. S. Patent 6,303,393, Issued Oct. 16, 2001

B. W. Wessels, B. Hoerman and F. Niu, "Oxide Thin Films and Composites and Related Methods of Deposition" US Patent 6,605,151 B1 Aug. 12, 2003.

B. W. Wessels, P. Tang, D. Towner and A. Meier, "BaTiO₃ thin film waveguides and related modulator devices" US Patent 7224878, May 29, 2007.

B. W. Wessels and Pao-tai Lin, "Apparatus and methods of broadband second harmonic generation" US Patent 7898730, Mar. 1, 2011.

B. W. Wessels and S. J. May, "Method of Using Group III-V Ferromagnetic/Non-Magnetic Semiconductor Heterojunctions and Magnetodiodes", US Patent 7956608, Issued June 7, 2011.

B. W. Wessels and N. Rangaraju, "Programmable logic based on a magnetic diode and applications of the same" US Patent 8552759, Issued Oct. 8, 2013.

Joseph S Friedman, Nikhil Rangaraju, Yehea Ismail, Bruce W Wessels, "Logic cells based on spin diode and applications of the same" US Patent 8912821 Issued Dec. 16, 2014.

B. W. Wessels and S.J. May, "Group III-V ferromagnetic/non-magnetic semiconductor heterojunctions and magnetodiodes" US Patent 9024370 B1 Issued May 5, 2015.

B. W. Wessels, N. Rangaraju and J. A. Peters, "Bipolar magnetic junction transistor with magnetoamplification and applications of same", US Patent 9136398, Sept. 15, 2015

J. Friedman, B. W. Wessels and A. V. Sahakian, "System and method for spin logic", US Patent 9,186,103 B2, Nov. 17, 2015.

PUBLICATIONS

Publications: 360 journal articles and refereed proceedings, editor of 5 books

Books: Advances in Electronic Materials, ed. with G. Y. Chin (American Society of Metals, Metals Park 1986).

Metal-organic Chemical Vapor Deposition of Electronic Ceramics, ed. with S. B. Desu, D. B. Beach and S. Gokoglu, (Materials Research Soc., Pittsburgh, PA 1994).

Annual Review of Materials Science, ed. with E. N. Kaufmann, J. A. Giordimaine and J. B. Wachtman Jr. (Annual Reviews Inc., Palo Alto CA 1995)

Thin Films for Integrated Optic Applications ed. with D. Walba and S. Marder, (Materials Research Soc., Pittsburgh PA 1995)

Thin Films for Optical Waveguide Devices and Materials for Optical Limiting ed with K. Nashimoto, J. Shmulovich, A. K. Y. Jen, K. Lewis, (Materials Research Society, Pittsburgh PA 2000).

Refereed Publications – Bruce W. Wessels

"Epitaxial Growth of Silicon Carbide by Chemical Vapor Deposition" in Silicon Carbide - 1973, U. of So. Carolina Press, 1974, p. 25, with H. C. Gatos and A. F. Witt.

"Vapor Deposition of GaP for High Efficiency Solid State Lamps", J. Electrochem. Soc., **122** 402 (1975).

"Temperature Dependence of Minority Carrier Lifetime in Vapor Crown GaP", J. Appl. Phys., **46** 2143 (1975).

"Determination of Deep Levels in Cu-Doped GaP using Transient Current Spectroscopy", J. Appl. Phys., **47** 1131 (1976).

"Electronic Properties of Epitaxial Silicon Carbide", Int. J. of Phys. and Chem. of Solids **38** 345 (1977), with H. C. Gatos.

"Background Deep-Level Defects in VPE GaP", J. Appl. Phys., **48** 1956 (1977).

"A High Gain Vertical Channel Field Controlled Thyristor", IEDM Digest (1977), with B. J. Baliga.

"Vertical Channel Field-Controlled Thyristors with High Gain and Fast Switching Speeds", IEEE Trans. on Electron Devices, ED-25, 1261 (1978), with B. J. Baliga.

"High Gain Structure for Power Junction Gate FET", IEDM Digest (1978) p. 661, with B. J. Baliga.

"Gettering of Epitaxial Gallium Phosphide Using Phosphosilicate Glass", Electronic Letters, **15** 748 (1979).

"Deep Level Defects in CdS/GaAs Heterojunctions", Thin Solid Films, **71** 33 (1980), with P. Besomi.

"Deep Level Defects in Polycrystalline CdS", J. Appl. Phys., **51** 4305 (1980), with P. Besomi.

"The Chemical Vapor Deposition of Polycrystalline InP", J. Electrochem. Soc., **127** 2747 (1980) with M. Inuishi.

"High Conductivity Heteroepitaxial ZnSe Films", Appl. Phys. Lett., **37** 955 (1980) with P. Besomi.

"Deep Level Defects in Au/ZnSe Schottky Diodes", Electronics Letters, **16** 794 (1980) with P. Besomi.

"Deep Hole Traps in VPE p-type InP", Electronics Letters **17** 685, (1981), with M. Inuishi.

"Growth and Characterization of Heteroepitaxial Zinc Selenide", J. of Cryst. Growth, **55** 477 (1981) with P. Besomi.

"Electronic Mobility and Carrier Concentration of Heteroepitaxial Zinc Selenide", J. Appl. Phys., **53** 532 (1982), with W. Leigh and P. Besomi.

"Photovoltaic Properties of Zinc Selenide/Gallium Arsenide Heterojunctions", Thin Solid Films, **87** 113 (1982), with P. Besomi and K. Christianson.

"Vapor Growth of Thin Heteroepitaxial InP on CdS", Thin Solid Films, **88** 195 (1982), with M. Inuishi.

"Growth and Characterization of Vapor Epitaxial Indium Phosphide", Semiconductor Growth Technology, ed. by E. Krikorian, (SPIE), **323** 55 (1982), M. Inuishi.

"Deep Level Defects in Heteroepitaxial Zinc Selenide", J. Appl. Phys., **53** 3076 (1982), with P. Besomi.

"High conductivity ZnSSe Thin Films", Appl. Phys. Lett., **41** 165 (1982), with W. Leigh.

"Vapor Growth and Properties of Thin Film Zinc Sulphoselenide", Thin Solid Films, **97** 221 (1982), with W. Leigh.

"Deep Level Transient Spectroscopy of Interface and Bulk-trap States in InP MOS Structures", Thin Solid Films, **103** 41 (1983), with M. Inuishi.

"Shallow and Deep Level Defect Centers in High Purity VPE Indium Phosphide", NATO in InP Symposium Proceedings, ed. B. Cockayne, J. of Crystal Growth, **64** 14 (1983), with S. W. Sun, A. P. Constant, and C. D. Adams.

"Growth and Characterization of High Purity VPE Indium Phosphide Prepared by the Hydride Process" in III-V Opto-electronics and Device Related Processes, ed. by V. G. Keramidas and S. Mahajan, (Electrochemical Society, Princeton, NJ, 1983), with S W Sun and C D. Adams.

"Optical Properties of Deep Centers in Semi-insulating ZnSe", Thin Solid Films, **102** 251 (1983), with E. Bawolek.

"Detection of Deep Traps in High Conductivity ZnSe by Optical Transient Capacitance Spectroscopy", J. Appl. Phys., **54** 4205 (1983), with K. A. Christianson.

"Zinc Sulphoselenide Thin Films for Photovoltaic Applications" in Materials and New Processing Technologies for Photovoltaics, ed. by J. A. Amick (Electrochemical Society, Princeton NJ, 1983), with W. Leigh and K. Christianson.

"Nitrogen Related Defect Centers in Zinc Selenide", J. Appl. Phys., **55** 1614 (1984), with W. B. Leigh.

"Heteroepitaxial Growth of High Mobility InAsP from the Vapor Phase", Appl. Phys. Lett., **44** 766 (1984), with P. J. Wang.

"Photocapacitance Spectroscopy of Surface States on Indium Phosphide Photoelectrodes", Appl. Phys. Lett., **44** 766 (1984), with C. Goodman.

"Identification of Deep Radiation Levels in VPE ZnSe", J. Luminescence, **31** and **32** 433, (1984), with K. A. Christianson.

"Investigation of Acceptors in As-Grown ZnSe by ODLTS and Photocapacitance Spectroscopy", J. Electronic Materials, **14a** 1229 (1985), with W. B. Leigh and K. A. Christianson.

"Deep Levels in Vapor Epitaxial Indium Phosphide Grown in the Presence of Ammonia", J. Appl. Phys., **57** 4616 (1985), with S. W. Sun.

"Electrical Properties of N-N Zinc Selenide/Gallium Arsenide Heterojunctions", Thin Solid Films, **131** 173 (1985), with E. J. Bawolek.

"Electronic Properties of InAsP-InP Strained Layer Superlattices", in Gallium Arsenide and Related Compounds", Inst. Phys. Conf. Ser. No. **79** (1985), with P. J. Wang.

"Vapor Phase Epitaxy of InP using Flow Modulation", Appl. Phys. Lett., **49** 564 (1986), with P. J. Wang.

"The Function of Cobalt and Platinum on p-InP in the Photoevolution of Hydrogen from Alkaline Solutions", Appl. Phys. Lett., **49** 829 (1986), with C. E. Goodman.

"Electronic and Optical Properties of the Fe Doped InP Prepared by Organometallic Vapor Phase Epitaxy", J. Appl. Phys., **60** 4342 (1986), with K. Huang.

"ENDOR study of Radiation Induced Defects in Epitaxial Gallium Phosphide", in Defects in Semiconductors, ed. H. J. von Bardeleben, **10-12**, 1063 (1986), with R. J. Gurbiel and B. M. Hoffman.

"Radiative Defects in Electron Irradiated InP" in Defects in Semiconductors, ed. H. J. von Bardeleben, **10-12**, 1027 (1986), with A. Constant.

"Epitaxial Growth of Mn-doped Indium Phosphide", J. Materials Science Letters, **6** 1310 (1987), with K. Huang.

"The Preparation of Advanced Multilayer III-V Semiconductor Structures by Hydride Vapor Phase Epitaxy Using Flow-rate Modulation", Proc. Int. Conference on Chemical Vapor Deposition X, ed. G. Cullen, (Electrochemical Society NJ 1987), with P. J. Wang.

"Photoluminescent Properties of ZnO Layers Prepared by Organometallic Chemical Vapor Deposition", in Epitaxy of Semiconductor Layered Structures, ed. R. T. Tung (Materials Research Society, Pittsburgh, PA 1987), **102** 149, with S. Bethke and H. Pan.

"Electronic Properties of InAsP/InAs Strained Layer Superlattices Prepared by Hydride Vapor Phase Epitaxy", Superlattices and Microstructures, **4** 251 (1988), with P. J. Wang.

"Photo and Electroluminescence of ZnSe Grown by OMVPE", J. of Luminescence, **40** 804 (1988), with B. Yang and Z. Jinying.

"Electron-beam-pumped Lasing in Epitaxial ZnSe Thin Films", J. of Cryst. Growth, **86** 935 (1988), with J. E. Potts, T. L. Smith, H. Cheng, and B. Yang.

"Growth and Characterization of Heteroepitaxial ZnO Thin Films by Organometallic Chemical Vapor Deposition", J. Crystal Growth, **86** 248 (1988), with P. Souletie, S. Bethke, and H. Pan.

"Luminescence of Heteroepitaxial Zinc Oxide", Appl. Phys. Lett., **52** 138 (1988), with S. Bethke and H. Pan.

"Growth Kinetics of ZnO Prepared by Organometallic Chemical Vapor Deposition", J. of Materials Research, **3** 740 (1988), with P. Souletie.

"Characterization of Mn-doped InAs_xP_{1-x} Grown by Organometallic Vapor Phase Epitaxy", Appl. Phys. Lett., **52** 1155 (1988), with K. Huang.

"Surface Photovoltage Spectroscopy of Surface States on Indium Phosphide", Appl. Phys. Lett., **52** 1352 (1988), with Y. Byun.

"Encapsulation, Diffusion and DIET in the Electron Microscope", Ultramicroscopy, **25** 253 (1988), with J. Strane, L. Marks, D. E. Luzzi, M. I. Buckett, and J. P. Zhang.

"Growth and Properties of InAsP Alloys Prepared by Organometallic Vapor Phase Epitaxy", J. Cryst. Growth, **92** 547 (1988), with K. H. Huang.

"Electronic and Optical Properties of Deep Levels in Iron-doped InAsP Alloys", J. Appl. Phys., **64** 6770 (1988), with K. H. Huang.

"Organometallic Chemical Vapor Deposition of High T_c Superconducting Films Using a Volatile Fluorocarbon-based Precursor", Appl. Phys. Lett., **53** 1750 (1988), with J. Zhao, K. Dahmen, H. Marcy, L. Tonge, T. Marks, and C. R. Kannewurf.

"High-Resolution Transmission Electron Microscopy of InAsP/InP Heterostructures, in Heteroepitaxial Approaches in Semiconductors, ed. A. Macrander, (Electro-chemical Society N.J. 1988), with D. X. Li and R. P. Schneider, Jr.

"Capture and Recombination Processes in Epitaxial Fe-doped InP", in Materials Science Forum, **38-41**, 881 (1989), with K. H. Huang.

"Low Pressure Organometallic Vapor Deposition of High T_c Superconducting YBa₂Cu₃O_{7-x} Films", Sol. State. Comm., **69** 187 (1989), with J. Zhao, K. Damen, H. Marcy, L. Tonge, T. Marks, and C. R. Kannewurf.

"Organometallic Chemical Vapor Deposition of Superconducting YBaCuO Films and Post-Deposition Processing", in Science and Technology of Thin Film Superconductors, ed. R. McConnell, (Academic Press N.Y. 1989), with J. Zhao, H. Marcy, L. Tonge, T. Marks, and C. R. Kannewurf.

"Structural and Optical Properties of Highly Strained InAsP/InP Hetero-structures", in Heteroepitaxial Approaches in Semiconductors, ed. A. Macrander, (Electrochemical Society N.J.) **136** 3490 (1989), with R. P. Schneider, Jr. and D.X. Li.

"Monolayer Abruptness in Highly Strained InAs_xP_{1-x}/InP Quantum Wells", Appl. Phys. Lett., **54** 1142 (1989), with R. P. Schneider, Jr.

"Organometallic Chemical Vapor Deposition of High T_c Superconducting Bi-Sr-Ca-Cu-O Films", Appl. Phys. Lett., **54** 1166 (1989), with J. Zhang, J. Zhao, H. Marcy, L. Tonge, T. J. Marks, and C. R. Kannewurf.

"Rapid Thermal Annealing of YBa₂Cu₃O_{7-x} Films Prepared by OMCVD Using a Highly Volatile Fluorocarbon-based Precursor", Physica, C **159** 710 (1989), with J. Zhao, H. Marcy, L. M. Tonge, T. J. Marks, and C. R. Kannewurf.

"Organometallic Chemical Vapor Deposition Routes To High T_c Superconducting Tl-Ba-Cu-O Films", Appl. Phys. Lett., **54** 2154 (1989).

"Electron Irradiation Damage in Oxides", Ultramicroscopy, **29** 217 (1989), with M. I. Buckett, J. Strane, D. E. Luzzi, J. P. Zhang, and L. D. Marks.

"Organometallic Chemical Vapor Deposition Approaches to Thin Films of High T_c Superconductors-Strategies and Progress", in (ACS Symposium Series), with L. M. Tonge, D. S. Richeson, T. J. Marks, J. Zhao, J. Zhang, H. O. Marcy, and C. R. Kannewurf.

"Optical Properties of InAsP/InP and InAs/InAsP Strained-Layer Superlattices and Heterostructures", Superlattices and Microstructures, **6** 287 (1989), with R. P. Schneider, Jr.

"Nitrogen Doping of ZnO Prepared by Organometallic Chemical Vapor Deposition in Optical Materials: Processing and Science, ed. C. Ortiz and D. B. Poker, Materials Research Society, Pittsburgh, PA, **152** 215 (1989), with H. C. Pan.

"Highly Strained InAsP/InP Quantum Wells Prepared by Flow Modulation Epitaxy", in III-V Heterostructures for Electronic/Photonic Devices, ed. C. W. Tu and V. Mattera, Materials Research Society, Pittsburgh, PA, **145** 145 (1989), with R. P. Schneider, Jr.

"Structural and Optical Properties of Highly Strained InAsP/InP Hetero-structures", J. Electrochem. Soc. **11** 3490 (1989), with R. P. Schneider, Jr.

"Organometallic Chemical Vapor Deposition of Superconducting High-T_c Pb-doped Bi-Sr-Ca-Cu-O Thin Films", Appl. Phys. Lett., **55** 1906 (1989), with J. M. Zhang, H. O. Marcy, L. M. Tonge, T. J. Marks, and C. R. Kannewurf.

"Yb-doped InP Grown by Metalorganic Vapor Phase Epitaxy Using a Beta-diketonate Precursor", Appl. Phys. Lett., **56** 566 (1990), with D. M. Williams.

"Electron Beam-enhanced Oxidation Processes in II-VI Compound Semiconductors Observed by High-Resolution Electron Microscopy", J. Appl. Phys., **67** 1535 (1990), with N. Thangaraj.

"Formation of Oriented High T_c Superconducting Bi-Sr-Ca-Cu-O Thin Films on Silver Substrates by Organometallic Chemical Vapor Deposition", *Appl. Phys. Lett.*, **56** 976 (1990), with J. M. Zhang, L. M. Tonge, and T. J. Marks.

"Organometallic Chemical Vapor Deposition of Strontium Titanate", *J. Appl. Phys.*, **67** 3858 (1990), with W. A. Feil, L. M. Tonge, and T. J. Marks.

"Deep Level Properties of Mn in InP", *J. Appl. Phys.*, **67** 6882 (1990), with K. Huang.

"Compensation in Ge-doped InP", *J. Appl. Phys.*, **68** 606 (1990), with S. W. Sun.

"Deposition of High T_c Superconducting YBaCuO Thin Films at Low Temperatures Using a Plasma-Enhanced Organometallic Chemical Vapor Deposition Approach", *Sol. State Comm.*, **74** 1091 (1990), with J. Zhao, H. O. Marcy, L. M. Tonge, T. J. Marks, and C. R. Kannewurf.

"Organometallic Chemical Vapor Deposition of Strontium Titanate Thin Films", in Chemical Vapor Deposition of Refractory Metals and Ceramics, ed. by T. M. Besmann and B. M. Gallois, (Materials Research Society, Pittsburgh PA 1990), with W. A. Feil, L. M. Tonge, and T. J. Marks.

"Preparation of YBaCuO High T_c Superconducting Films by Plasma-enhanced Organometallic Chemical Vapor Deposition" in High-temperature Superconductors: Fundamental Properties of Novel Materials Processing, ed. J. Narayen, P. Chu, L. Schneemeyer, and D. Christen, (Materials Research Soc., Pittsburgh PA 1990), with J. Zhao, L. M. Tonge, H. O. Marcy, T. J. Marks, and C. R. Kannewurf.

"Routes to High- T_c Superconducting Tl-Ba-Ca-Cu-O Films Using Organometallic Chemical Vapor Deposition", *ibid.*, with D. Richeson, L. M. Tonge, J. Zhao, J. Zhang, H. O. Marcy, T. J. Marks, and C. R. Kannewurf.

"High- T_c Undoped and Pb-doped Bi-Sr-Ca-Cu-O Thin Films Prepared by Organometallic Chemical Vapor Deposition", *ibid.*, with J. M. Zhang, H. O. Marcy, L. M. Tonge, T. J. Marks, and C. R. Kannewurf.

"Deposition of Ferroelectric $\text{Bi}_4\text{Ti}_3\text{O}_{12}$ Thin Films", in Chemical Vapor Deposition XI, ed. by K. E. Spear, (Electrochem. Soc. NJ 1990), with L. A. Wills.

"Chemically Vapor Deposited Strontium Titanate Thin Films and Their Properties", *ibid.*, with W. A. Feil, L. M. Tonge, and T. J. Marks.

"Microstructure and Superconducting Properties of BiSrCaCuO Thin Films", in Progress in High-Temperature Superconducting Transistors and Other Devices, SPIE Proc., **1934** 232 (1990), with J. M. Zhang, F. DiMeo, Jr., D. S. Richeson, T. J. Marks, D. C. DeGroot, and C. R. Kannewurf.

"Growth Studies of Ferroelectric Oxide Layers Prepared by Organometallic Chemical Vapor Deposition", J. of Crystal Growth, **107** 712 (1991), with L. A. Wills, W. A. Feil, L. M. Tonge, and T. J. Marks.

"Preparation and Properties of Superconducting Bi-Sr-Ca-Cu-O Thin Films on Ag Substrates", *ibid.*, with J. M. Zhang, L. M. Tonge, and T. J. Marks.

"InAs/InP Strained Single Quantum Wells Grown by Atmospheric Pressure Organometallic Vapor Phase Epitaxy", Appl. Phys. Lett., **57** 1998 (1990), with R. P. Schneider, Jr.

"Superconducting YBaCuO Thin Films on Silver Substrates by In-situ Plasma-Enhanced Metalorganic Chemical Vapor Deposition", Appl. Phys. Lett., **58** 88 (1991), with J. Zhao, Y. Q. Li, C. S. Chern, P. Norris, B. Gallois, and B. Kear.

"Preparation of High- T_c Superconducting Bi-Sr-Ca-Cu-O Films by Organometallic Chemical Vapor Deposition Using Second-generation Fluorocarbon-based Precursors", J. Appl. Phys., **69** 2743 (1991), with J. M. Zhang, D. S. Richeson, T. J. Marks, D. C. DeGroot, and C. R. Kannewurf.

"Scanning Tunneling Optical Spectroscopy of Semiconductors", Appl. Phys. Lett., **58** 1295 (1991), with L. Q. Qian.

"Scanning Tunneling Optical Spectroscopy of Semiconductor Quantum Well Structures", Appl. Phys. Lett., **58** 2538 (1991), with L. Q. Qian.

"Optical Properties of InAs/InP Strained Single Quantum Wells Grown by Organometallic Vapor-phase Epitaxy", J. Appl. Phys., **70** 405 (1991), with R. P. Schneider, Jr.

"Scanning Tunneling Optical Spectroscopy of InAsP/InP Quantum Well Structures", in Microscopy of Semiconductors, ed. by A. G. Cullis and N. J. Long, IOP, **117** 569 (1991), with L. Q. Qian.

"Photoluminescence Excitation Spectroscopy of InAs_{0.67}P_{0.33}/InP Quantum Wells", J. Electron. Mat., **20** 1117 (1991), with R. P. Schneider, Jr.

"Photoluminescent Properties of Er-doped InGaP Prepared by Metalorganic Vapor Phase Epitaxy", Appl. Phys. Lett., **59** 2317 (1991), with A. J. Neuhalfen.

"A New Route to High T_c Superconducting Bi-Sr-Ca-Cu-O Thin Films", J. Appl. Phys. **71** 2769 (1992), with J. M. Zhang, F. DiMeo, Jr., D. L. Schulz, T. J. Marks, J. L. Schindler, and C. R. Kannewurf.

"Thermal Quenching of Er³⁺ - Related Luminescence in InGaP", Appl. Phys. Lett., **60** 2657 (1992), with A. J. Neuhalfen.

"Photoluminescent Properties of Yb-doped InAsP Alloys", in Defects in Semiconductors, ed. G. Deleo, Materials Science Forum, **83-87**, 689 (1992), with A. J. Neuhalfen and D. M. Williams.

"Electronic and Photoluminescent Properties of InP Prepared by Flow Modulation Epitaxy", J. Appl. Phys., **71** 261 (1992), with A. J. Neuhalfen.

"BaTiO₃ Thin Films Prepared by Organometallic Chemical Vapor Deposition", MRS Proc. **243** (1992), with L. A. Wills, D. L. Schulz and T. J. Marks.

"Epitaxial Growth of BaTiO₃ Thin Films by Organometallic Deposition", Appl. Phys. Lett., **60** 41 (1992), with L. A. Wills, D. S. Richeson and T. J. Marks.

"Scanning Tunneling Optical Spectroscopy of Semiconductor Thin Films and Quantum Wells", J. Vac. Sci. and Tech., **B10** 1803 (1992), with L. Q. Qian.

"Rare-earth Doped InGaP Prepared by Metalorganic Vapor Phase Epitaxy", MRS Proc., **240** 195 (1992), with A. J. Neuhalfen.

"Heteroepitaxial Bi₂Sr₂CaCu₂O_x Superconducting Thin Films Deposited on LaAlO₃ by Solid Phase Epitaxy and OMCVD", in MRS Proc., **275** (1992), with J. Chen, H. A. Lu, F. DiMeo, Jr., D. L. Schulz, T. J. Marks, J. L. Schindler and C. R. Kannewurf.

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