

Stanford



John Bravman

Bing Centennial Prof, Freeman-Thornton Chair for Vice Provost for Undergrad Ed, & Dean of Fresh-Soph College, & Prof of Materials Sci & Eng, Emeritus

Materials Science and Engineering

Bio

BIO

<https://www.bucknell.edu/meet-bucknell/bucknell-leadership/meet-president-bravman>

ACADEMIC APPOINTMENTS

- Emeritus Faculty, Acad Council, Materials Science and Engineering
- Member, Cardiovascular Institute

ADMINISTRATIVE APPOINTMENTS

- President, Bucknell University, (2010- present)

Publications

PUBLICATIONS

- **Stress relaxation in free-standing aluminum beams** *THIN SOLID FILMS*

Lee, H. J., Zhang, P., Bravman, J. C.
2005; 476 (1): 118-124

- **White beam analysis of coupling between precipitation and plastic deformation during electromigration in a passivated Al(0.5wt.% Cu) interconnect** *METALLOFIZIKA I NOVEISHIE TEKHNOLOGII*

Barabash, R. I., Ice, G. E., Tamura, N., Valek, B. C., Bravman, J. C., Patel, J. R.
2005; 27 (1): 75-94

- **Quantitative characterization of electromigration-induced plastic deformation in Al(0.5wt%Cu) interconnect** *Symposium on Characterization and Mechanical Reliability of Advanced Electronic Materials at Nanoscale*

Barabash, R. I., Ice, G. E., Tamura, N., Valek, B. C., Bravman, J. C., Spolenak, R., Patel, J. R.
ELSEVIER SCIENCE BV.2004: 24–30

- **Study on the strength and elongation of free-standing Al beams for microelectromechanical systems applications** *APPLIED PHYSICS LETTERS*

Lee, H. J., Zhang, P., Bravman, J. C.
2004; 84 (6): 915-917

- **Important factors for silane adhesion promoter efficacy: surface coverage, functionality and chain length** *JOURNAL OF ADHESION SCIENCE AND TECHNOLOGY*

JENKINS, M. L., Dauskardt, R. H., Bravman, J. C.
2004; 18 (13): 1497-1516

- **Quantitative analysis of dislocation arrangements induced by electromigration in a passivated Al (0.5 wt % Cu) interconnect** *JOURNAL OF APPLIED PHYSICS*

Barabash, R. I., Ice, G. E., Tamura, N., Valek, B. C., Bravman, J. C., Spolenak, R., Patel, J. R.

2003; 93 (9): 5701-5706

• Local plasticity of Al thin films as revealed by X-ray microdiffraction *PHYSICAL REVIEW LETTERS*

Spolenak, R., Brown, W. L., Tamura, N., MacDowell, A. A., Celestre, R. S., Padmore, H. A., Valek, B., Bravman, J. C., Marieb, T., Fujimoto, H., Batterman, B. W., Patel, J. R.
2003; 90 (9)

• Scanning X-ray microdiffraction with submicrometer white beam for strain/stress and orientation mapping in thin films *JOURNAL OF SYNCHROTRON RADIATION*

Tamura, N., MacDowell, A. A., Spolenak, R., Valek, B. C., Bravman, J. C., Brown, W. L., Celestre, R. S., Padmore, H. A., Batterman, B. W., Patel, J. R.
2003; 10: 137-143

• Tensile failure by grain thinning in micromachined aluminum thin films *JOURNAL OF APPLIED PHYSICS*

Lee, H. J., Zhang, P., Bravman, J. C.
2003; 93 (3): 1443-1451

• Electromigration-induced plastic deformation in passivated metal lines *APPLIED PHYSICS LETTERS*

Valek, B. C., Bravman, J. C., Tamura, N., MacDowell, A. A., Celestre, R. S., Padmore, H. A., Spolenak, R., Brown, W. L., Batterman, B. W., Patel, J. R.
2002; 81 (22): 4168-4170

• Effect of interface conditions on yield behavior of passivated copper thin films *JOURNAL OF MATERIALS RESEARCH*

Vinci, R. P., Forrest, S. A., Bravman, J. C.
2002; 17 (7): 1863-1870

• Subcritical debonding of polymer/silica interfaces under monotonic and cyclic loading *Symposium on Computational Thermodynamics and Materials Design*

Snodgrass, J. M., Pantelidis, D., JENKINS, M. L., Bravman, J. C., Dauskardt, R. H.
PERGAMON-ELSEVIER SCIENCE LTD.2002: 2395-2411

• High spatial resolution grain orientation and strain mapping in thin films using polychromatic submicron x-ray diffraction *APPLIED PHYSICS LETTERS*

Tamura, N., MacDowell, A. A., Celestre, R. S., Padmore, H. A., Valek, B., Bravman, J. C., Spolenak, R., Brown, W. L., Marieb, T., Fujimoto, H., Batterman, B. W., Patel, J. R.
2002; 80 (20): 3724-3726

• Stress-induced and electromigration voiding in aluminum interconnects passivated with silicon nitride *JOURNAL OF APPLIED PHYSICS*

Lee, S. H., Bravman, J. C., Doan, J. C., Lee, S., Flinn, P. A., Marieb, T. N.
2002; 91 (6): 3653-3657

• Studies of silane adhesion promoters on silica filler particles for use in microelectronic packaging *Symposium on Polymer Interfaces and Thin Films held at the 2001 MRS Fall Meeting*

Jenkins, M., DeVries, G., Dauskardt, R. H., Bravman, J. C.
MATERIALS RESEARCH SOCIETY.2002: 159-164

• Formation of titanium silicide on narrow gates using laser thermal processing *IEEE TRANSACTIONS ON ELECTRON DEVICES*

Verma, G., Gelatos, C., Talwar, S., Bravman, J. C.
2002; 49 (1): 42-47

• Miniature Nernstian oxygen sensor for deposition and growth environments *REVIEW OF SCIENTIFIC INSTRUMENTS*

van Setten, E., Gur, T. M., Blank, D. H., Bravman, J. C., Beasley, M. R.
2002; 73 (1): 156-161

• Submicron X-ray diffraction *7th International Conference on Synchrotron Radiation Instrumentation (SRI 2000)*

MacDowell, A. A., Celestre, R. S., Tamura, N., Spolenak, R., Valek, B., Brown, W. L., Bravman, J. C., Padmore, H. A., Batterman, B. W., Patel, J. R.
ELSEVIER SCIENCE BV.2001: 936-943

• Effects of dielectric materials on electromigration failure *JOURNAL OF APPLIED PHYSICS*

Doan, J. C., Lee, S., Lee, S. H., Flinn, P. A., Bravman, J. C., Marieb, T. N.
2001; 89 (12): 7797-7808

• Use of angle resolved x-ray photoelectron spectroscopy for determination of depth and thickness of compound layer structures *JOURNAL OF VACUUM SCIENCE & TECHNOLOGY A*

Spruytte, S., Coldren, C., Harris, J., Pantelidis, D., Lee, H. J., Bravman, J., Kelly, M.

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● **Creating process margin in laser thermal processing: Application to formation of titanium silicide** *APPLIED PHYSICS LETTERS*

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2001; 78 (7): 925-927

● **Mechanical tests of free-standing aluminum microbeams for MEMS application** *Symposium on Mechanical Properties of Structural Films*

Zhang, P., Lee, H. J., Bravman, J. C.

AMERICAN SOCIETY TESTING AND MATERIALS.2001: 203–213

● **Differential thermal budget in laser processing: Application to formation of titanium silicide** *IEEE ELECTRON DEVICE LETTERS*

Verma, G., Talwar, S., Bravman, J. C.

2000; 21 (10): 482-484

● **A high-voltage scanning electron microscopy system for in situ electromigration testing** *REVIEW OF SCIENTIFIC INSTRUMENTS*

Doan, J. C., Lee, S., Lee, S. H., Meier, N. E., Bravman, J. C., Flinn, P. A., Marieb, T. N., Madden, M. C.

2000; 71 (7): 2848-2854

● **Stress relaxation of free-standing aluminum beams for microelectromechanical systems applications** *APPLIED PHYSICS LETTERS*

Lee, H. J., Cornell, G., Bravman, J. C.

2000; 76 (23): 3415-3417

● **The evolution of the resistance of aluminum interconnects during electromigration** *MICROELECTRONICS RELIABILITY*

Doan, J. C., Bravman, J. C., Flinn, P. A., Marieb, T. N.

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● **Study of crack propagation at an oxide/polymer interface under varying loading conditions** *Symposium V on Thin Films-Stresses and Mechanical Properties VIII held at the 1999 MRS Fall Meeting*

Pantelidis, D., Snodgrass, J., Dauskardt, R. H., Bravman, J. C.

MATERIALS RESEARCH SOCIETY.2000: 407–412

● **Void nucleation on intentionally added defects in Al interconnects** *APPLIED PHYSICS LETTERS*

Doan, J. C., Lee, S. H., Bravman, J. C., Flinn, P. A., Marieb, T. N.

1999; 75 (5): 633-635

● **The effects of environment and fatigue on the adhesion and subcritical debonding of dielectric polymers** *Symposium O: Low-Dielectric Constant Materials at the 1999 MRS Spring Meeting*

Snodgrass, J. M., Pantelidis, D., Bravman, J. C., Dauskardt, R. H.

MATERIALS RESEARCH SOCIETY.1999: 123–128

● **Electromigration voiding in argon-implanted interconnects** *Materials Reliability in Microelectronics IX Symposium at the 1999 MRS Spring Meeting*

Meier, N. E., Doan, J. C., Marieb, T. N., Flinn, P. A., Bravman, J. C.

MATERIALS RESEARCH SOCIETY.1999: 97–102

● **Experimental study of self-diffusion in silicon using isotopically enriched structures** *Symposium on Si Front-End Processing-Physics and Technology of Dopant-Defect Interactions*

Ural, A., Griffin, P. B., Plummer, J. D.

MATERIALS RESEARCH SOCIETY.1999: 97–102

● **The relationship between resistance changes and void volume changes in passivated aluminum interconnects** *37th Annual IEEE International Reliability Physics Symposium*

Doan, J. C., Bravman, J. C., Flinn, P. A., Marieb, T. N.

IEEE COMPUTER SOC.1999: 206–212

● **Direct measurement of nucleation times and growth rates of electromigration induced voids** *5th International Workshop on Stress Induced Phenomena in Metallization*

Doan, J. C., Bravman, J. C., Flinn, P. A., Marieb, T. N.

AIP PRESS.1999: 15–26

● **Thin film stress measurement with a tunneling sensor** *Symposium AA on Materials Science of Microelectromechanical Systems (MEMS) Devices at the 1998 MRS Fall Meeting*

- Zhang, P., Vinci, R. P., Bravman, J. C., Kenny, T. W.
MATERIALS RESEARCH SOCIETY.1999: 45–50
- **A detailed study of void motion in passivated aluminum interconnects** *Materials Reliability in Microelectronics IX Symposium at the 1999 MRS Spring Meeting*
Doan, J. C., Bravman, J. C., Flinn, P. A., Marieb, T. N.
MATERIALS RESEARCH SOCIETY.1999: 103–108
 - **Effect of microstructure and chemical bonding on the adhesion strength of a silicon/polymer interface for microelectronic packaging applications** *Symposium D on Integration of Dissimilar Materials in Micro- and Optoelectronics / Symposium I on III-V and SiGe Group IV Device/IC Processing Challenges for Commercial Applications, at the 1998 MRS Fall Meeting*
Pantelidis, D., Lee, H. J., Bravman, J. C.
MATERIALS RESEARCH SOCIETY.1999: 165–170
 - **Stress-induced and electromigration voiding in nitride passivated Al interconnects** *5th International Workshop on Stress Induced Phenomena in Metallization*
Lee, S. H., Lee, S., Bravman, J. C., Flinn, P. A., Marieb, T. N.
AIP PRESS.1999: 174–179
 - **Observations of low cycle fatigue of Al thin films for MEMS applications** *Symposium on Microelectromechanical Structures for Materials Research*
Cornella, G., Vinci, R. P., Iyer, R. S., Dauskardt, R. H., Bravman, J. C.
MATERIALS RESEARCH SOCIETY.1998: 81–86
 - **The effects of passivation thickness and initial aluminum line stress on electromigration behavior** *Symposium on Materials Reliability in Microelectronics VIII*
Lee, S., Bravman, J. C., Flinn, P. A., Marieb, T. N.
MATERIALS RESEARCH SOCIETY.1998: 249–254
 - **A quantitative study of void nucleation times in passivated aluminum interconnects** *Symposium on Materials Reliability in Microelectronics VIII*
Dean, J. C., Bravman, J. C., Flinn, P. A., Marieb, T. N.
MATERIALS RESEARCH SOCIETY.1998: 83–88
 - **Growth of single crystal YIG fibers by the laser heated pedestal growth method** *Symposium B on Phase Transformations and Systems Driven Far From Equilibrium at the Materials-Research-Society Fall Meeting*
Lim, H. J., DeMattei, R. C., Feigelson, R. S.
MATERIALS RESEARCH SOCIETY.1998: 83–88
 - **Determination of temperature dependent unstressed lattice spacings in crystalline thin films on substrates** *Symposium on Thin-Films - Stresses and Mechanical Properties VII at the MRS Fall Meeting*
Cornella, G., Lee, S., Kraft, O., Nix, W. D., Bravman, J. C.
MATERIALS RESEARCH SOCIETY.1998: 527–532
 - **High voltage scanning electron microscopy for in-situ electromigration studies** *14th International Congress on Electron Microscopy*
Bravman, J. C., Flinn, P. A., Marieb, T. N., Lee, S., Doan, J.
IOP PUBLISHING LTD.1998: 397–398
 - **Void phenomena in passivated metal lines: Recent observations and interpretation** *4th International Workshop on Stress Induced Phenomena in Metallization*
Flinn, P. A., Lee, S., Doan, J., Marieb, T. N., Bravman, J. C., Madden, M.
AMER INST PHYSICS.1998: 250–61
 - **Transient diffusion of beryllium and silicon in gallium arsenide** *ANNUAL REVIEW OF MATERIALS SCIENCE*
Haddara, Y. M., Bravman, J. C.
1998; 28: 185–214
 - **Comparisons of constraint effects on Al lines under various passivations** *4th International Workshop on Stress Induced Phenomena in Metallization*
Lee, S., Bravman, J. C., Flinn, P. A., Marieb, T. N.
AMER INST PHYSICS.1998: 277–82
 - **Comparison of electromigration behavior in passivated aluminum interconnects** *4th International Workshop on Stress Induced Phenomena in Metallization*
Lee, S., Doan, J., Bravman, J. C., Flinn, P. A., Marieb, T. N., Ogawa, S.
AMER INST PHYSICS.1998: 101–6

- **An analysis technique for extraction of thin film stresses from x-ray data** *APPLIED PHYSICS LETTERS*
Cornella, G., Lee, S. H., Nix, W. D., Bravman, J. C.
1997; 71 (20): 2949-2951
- **Finite element modeling of grain aspect ratio and strain energy density in a textured copper thin film** *Symposium on Thin Films - Stresses and Mechanical Properties VI, at the 1996 MRS Spring Meeting*
Vinci, R. P., Bravman, J. C.
MATERIALS RESEARCH SOCIETY.1997: 411-416
- **Comparison of stresses in Al lines under various passivations** *Symposium on Materials Reliability in Microelectronics, at the 1997 MRS Spring Meeting*
Lee, S., Bravman, J. C., Flinn, P. A., Marieb, T. N.
MATERIALS RESEARCH SOCIETY.1997: 415-420
- **Observation of electromigration voiding in Cu lines** *Symposium on Materials Reliability in Microelectronics, at the 1997 MRS Spring Meeting*
Lee, S. H., Bravman, J. C., Flinn, P. A., Arnaud, L.
MATERIALS RESEARCH SOCIETY.1997: 235-239
- **In-situ measurement of viscous flow of thermal silicon dioxide thin films at high temperature** *Symposium on Amorphous and Crystalline Insulating Thin Films, at the 1996 MRS Fall Meeting*
Yu, C. L., Flinn, P. A., Bravman, J. C.
MATERIALS RESEARCH SOCIETY.1997: 261-266
- **Stress and microstructural evolution of LPCVD polysilicon thin films during high temperature annealing** *Symposium on Thin Films - Structure and Morphology*
Yu, C. L., Flinn, P. A., Lee, S. H., Bravman, J. C.
MATERIALS RESEARCH SOCIETY.1997: 403-408
- **In-situ stress measurements during dry oxidation of silicon** *Symposium on Materials Reliability in Microelectronics, at the 1997 MRS Spring Meeting*
Yu, C. L., Flinn, P. A., Bravman, J. C.
MATERIALS RESEARCH SOCIETY.1997: 95-100
- **Effect of encapsulant material on the diffusion of beryllium in molecular beam epitaxy gallium arsenide** *APPLIED PHYSICS LETTERS*
Haddara, Y. M., Deal, M. D., Bravman, J. C.
1996; 68 (14): 1939-1941
- **Measurement and interpretation of strain relaxation in passivated Al-0.5% Cu lines** *JOURNAL OF MATERIALS RESEARCH*
Besser, P. R., Marieb, T. N., Lee, J., Flinn, P. A., Bravman, J. C.
1996; 11 (1): 184-193
- **Modeling the transient diffusion behavior of beryllium in gallium arsenide and the effect of encapsulant material on non-equilibrium point defect populations** *4th International Symposium on Process Physics and Modeling in Semiconductor Technology*
Haddara, Y. M., Deal, M. D., Bravman, J. C.
ELECTROCHEMICAL SOCIETY INC.1996: 142-48
- **Finite element modeling of grain aspect ratio and strain energy density in a textured copper thin film** *Symposium on Materials Reliability in Microelectronics VI, at the 1996 MRS Spring Meeting*
Vinci, R. P., Bravman, J. C.
MATERIALS RESEARCH SOCIETY.1996: 481-486
- **EFFECTS OF BARRIER LAYER AND PROCESSING CONDITIONS ON THIN-FILM CU MICROSTRUCTURE** *JOURNAL OF ELECTRONIC MATERIALS*
ZIELINSKI, E. M., Vinci, R. P., Bravman, J. C.
1995; 24 (10): 1485-1492
- **PSEUDO-QUATERNARY PHASE-RELATIONS NEAR BI₂SR₂CACU₂O₈+X IN REDUCED OXYGEN PRESSURES** *PHYSICA C*
MACMANUSDRISCOLL, J. L., Bravman, J. C., Beyers, R. B.
1995; 251 (1-2): 71-88
- **THE INFLUENCE OF STRAIN-ENERGY ON ABNORMAL GRAIN-GROWTH IN COPPER THIN-FILMS** *APPLIED PHYSICS LETTERS*
ZIELINSKI, E. M., Vinci, R. P., Bravman, J. C.

1995; 67 (8): 1078-1080

● **OBSERVATIONS OF ELECTROMIGRATION-INDUCED VOID NUCLEATION AND GROWTH IN POLYCRYSTALLINE AND NEAR-BAMBOO PASSIVATED AL LINES JOURNAL OF APPLIED PHYSICS**

Marieb, T., Flinn, P., Bravman, J. C., Gardner, D., Madden, M.

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● **THERMAL STRAIN AND STRESS IN COPPER THIN-FILMS THIN SOLID FILMS**

Vinci, R. P., ZIELINSKI, E. M., Bravman, J. C.

1995; 262 (1-2): 142-153

● **TRANSPORT CHARACTERIZATION OF CALCIUM-DOPED YBA₂CU₃O₇-DELTA THIN-FILMS PHYSICAL REVIEW B**

KUCERA, J. T., Bravman, J. C.

1995; 51 (13): 8582-8590

● **MODELING DIFFUSION IN GALLIUM-ARSENIDE - RECENT WORK MRS BULLETIN**

Haddara, Y. M., Lee, C. C., Hu, J. C., Deal, M. D., Bravman, J. C.

1995; 20 (4): 41-50

● **DIFFUSION OF IMPLANTED BE IN ALXGa1-XAS AS A FUNCTION OF AL CONCENTRATION AND ANNEAL TEMPERATURE APPLIED PHYSICS LETTERS**

Lee, C. C., Deal, M. D., Bravman, J. C.

1995; 66 (3): 355-357

● **PHASE-EQUILIBRIA IN THE Y-BA-CU-O SYSTEM AND MELT PROCESSING OF AG CLAD Y₁BA₂CU₃O₇-X TAPES AT REDUCED OXYGEN PARTIAL PRESSURES PHYSICA C-SUPERCONDUCTIVITY AND ITS APPLICATIONS**

MACMANUSDRISCOLL, J. L., Bravman, J. C., Beyers, R. B.

1995; 241 (3-4): 401-413

● **The influence of strain energy minimization on abnormal grain growth in copper thin films 5th Symposium on Materials Reliability in Microelectronics, at the 1995 MRS Spring Meeting**

ZIELINSKI, E. M., Vinci, R. P., Bravman, J. C.

MATERIALS RESEARCH SOC.1995: 103–108

● **Measurement of the dependence of stress and strain on crystallographic orientation in Cu and Al thin films Symposium on Thin Films - Stresses and Mechanical Properties V, at the 1994 Fall Meeting of the Materials-Research-Society**

ZIELINSKI, E. M., Vinci, R. P., Bravman, J. C.

MATERIALS RESEARCH SOCIETY.1995: 429–434

● **A simple analysis of average mechanical behaviour and strain energy density of misoriented grains in a textured film 5th Symposium on Materials Reliability in Microelectronics, at the 1995 MRS Spring Meeting**

Vinci, R. P., Weihs, T. P., ZIELINSKI, E. M., Barbee, T. W., Bravman, J. C.

MATERIALS RESEARCH SOC.1995: 97–102

● **The effects of processing on the microstructure of copper thin films on tantalum barrier layers 5th Symposium on Materials Reliability in Microelectronics, at the 1995 MRS Spring Meeting**

ZIELINSKI, E. M., Vinci, R. P., Bravman, J. C.

MATERIALS RESEARCH SOC.1995: 303–308

● **Effect of copper film thickness on stress and strain in grains of different orientation Symposium on Thin Films - Stresses and Mechanical Properties V, at the 1994 Fall Meeting of the Materials-Research-Society**

Vinci, R. P., ZIELINSKI, E. M., Bravman, J. C.

MATERIALS RESEARCH SOCIETY.1995: 459–464

● **PHASE-EQUILIBRIA AND MELT PROCESSING OF Bi₂SR₂CA₁Cu₂O₈+X TAPES AT REDUCED OXYGEN PARTIAL PRESSURES APPLIED PHYSICS LETTERS**

MACMANUSDRISCOLL, J. L., Wang, P. C., Bravman, J. C., Beyers, R. B.

1994; 65 (22): 2872-2874

● **STUDIES OF STRUCTURAL DISORDER IN REBa₂Cu₃O₇-X THIN-FILMS (RE = RARE-EARTH) AS A FUNCTION OF RARE-EARTH IONIC RADIUS AND FILM DEPOSITION CONDITIONS PHYSICA C-SUPERCONDUCTIVITY AND ITS APPLICATIONS**

MACMANUSDRISCOLL, J. L., Alonso, J. A., Wang, P. C., Geballe, T. H., Bravman, J. C.

1994; 232 (3-4): 288-308

• **EFFECTS OF BARRIER LAYER AND ANNEALING ON ABNORMAL GRAIN-GROWTH IN COPPER THIN-FILMS** *JOURNAL OF APPLIED PHYSICS*

ZIELINSKI, E. M., Vinci, R. P., Bravman, J. C.

1994; 76 (8): 4516-4522

• **EFFECTS OF SILVER AND LEAD ON THE PHASE-STABILITY OF BI₂SR₂CA₁CU₂O_{8+X} AND BI₂SR₂CA₂CU₃B_{10+X} ABOVE AND BELOW THE SOLIDUS TEMPERATURE** *JOURNAL OF THE AMERICAN CERAMIC SOCIETY*

MACMANUSDRISCOLL, J. L., Bravman, J. C., SAVOY, R. J., Gorman, G., Beyers, R. B.

1994; 77 (9): 2305-2313

• **EFFECT OF ION ENERGY ON THE DIFFUSION OF SI IMPLANTED INTO GAAS** *Meeting of the Electrochemical-Society*

Lee, C. C., Deal, M. D., Jones, K. S., Robinson, H. G., Bravman, J. C.

ELECTROCHEMICAL SOC INC.1994: 2245-49

• **ELIMINATING DOPANT DIFFUSION AFTER ION-IMPLANTATION BY SURFACE ETCHING** *APPLIED PHYSICS LETTERS*

Lee, C. C., Deal, M. D., Bravman, J.

1994; 64 (24): 3302-3304

• **OBSERVATION OF VOIDS INDUCED BY MECHANICAL-STRESS AND ELECTROMIGRATION IN PASSIVATED AL LINES DEPOSITED AT DIFFERENT PURITY LEVELS** *APPLIED PHYSICS LETTERS*

Marieb, T., Bravman, J. C., Flinn, P., Gardner, D. S., Madden, M.

1994; 64 (18): 2424-2426

• **ELASTIC STRAIN GRADIENTS AND X-RAY-LINE BROADENING EFFECTS AS A FUNCTION OF TEMPERATURE IN ALUMINUM THIN-FILMS ON SILICON** *JOURNAL OF MATERIALS RESEARCH*

Venkatraman, R., Besser, P. R., Bravman, J. C., Brennan, S.

1994; 9 (2): 328-335

• **AN X-RAY-METHOD FOR DIRECT DETERMINATION OF THE STRAIN STATE AND STRAIN RELAXATION IN MICRON-SCALE PASSIVATED METALLIZATION LINES DURING THERMAL CYCLING** *JOURNAL OF MATERIALS RESEARCH*

Besser, P. R., Brennan, S., Bravman, J. C.

1994; 9 (1): 13-24

• **MICROSTRUCTURAL CHARACTERIZATION OF COPPER THIN-FILMS ON METALLIC UNDERLAYERS** *4th Symposium on Materials Reliability in Microelectronics, at the 1994 MRS Spring Meeting*

ZIELINSKI, E. M., Vinci, R. P., Bravman, J. C.

MATERIALS RESEARCH SOC.1994: 307-312

• **X-RAY DETERMINATION OF STRAINS, STRESS, AND RELAXATION IN INTERCONNECT METALLIZATIONS** *2nd International Workshop on Stress-Induced Phenomena in Metallization*

Besser, P. R., Bravman, J. C.

AIP PRESS.1994: 46-61

• **THERMAL-STRESSES IN PASSIVATED COPPER INTERCONNECTS DETERMINED BY X-RAY-ANALYSIS AND FINITE-ELEMENT MODELING** *4th Symposium on Materials Reliability in Microelectronics, at the 1994 MRS Spring Meeting*

Vinci, R. P., ZIELINSKI, E. M., Bravman, J. C.

MATERIALS RESEARCH SOC.1994: 289-294

• **UNDERSTANDING AND ELECTROCHEMICAL CONTROL OF YBa₂Cu₃O_{7-X} THIN-FILM EPITAXY ON YTTRIUM STABILIZED ZIRCONIA** *JOURNAL OF APPLIED PHYSICS*

MACMANUSDRISCOLL, J., Geballe, T. H., Bravman, J. C.

1994; 75 (1): 412-422

• **IN-SITU OBSERVATIONS OF VOIDING IN METAL LINES UNDER PASSIVATION** *4th Symposium on Materials Reliability in Microelectronics, at the 1994 MRS Spring Meeting*

Marieb, T., Bravman, J. C., Flinn, P., Madden, M.

MATERIALS RESEARCH SOC.1994: 409-413

• **DIRECT OBSERVATION OF THE GROWTH AND MOVEMENT OF ELECTROMIGRATION VOIDS UNDER PASSIVATION** *2nd International Workshop on Stress-Induced Phenomena in Metallization*

Marieb, T. N., ABRATOWSKI, E., Bravman, J. C., Madden, M., Flinn, P.
AIP PRESS.1994: 1–14

• **FINITE-ELEMENT MODELING AND X-RAY-MEASUREMENT OF STRAIN IN PASSIVATED AL LINES DURING THERMAL CYCLING** *JOURNAL OF THE ELECTROCHEMICAL SOCIETY*

Besser, P. R., Mack, A. S., Fraser, D. B., Bravman, J. C.
1993; 140 (6): 1769-1772

• **NUCLEATION AND GROWTH MECHANISMS OF A,B-AXIS-ORIENTED YBA₂Cu₃O₇-DELTA FILMS ON LAAlO₃** *PHYSICAL REVIEW B*

Streiffer, S. K., Lairson, B. M., ZIELINSKI, E. M., Bravman, J. C.
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