**MAX O. BLOOMFIELD**

## RESEARCH INTERESTS

Formation and evolution of microstructure in thin films, numerical approaches to modeling of multiscale/multiphysics phenomena. Specific interests include methods for linking macro- and meso-scale simulations to nano-scale evolution models, models of electrochemical and electroless deposition in complex solutions, discrete-to-continuum techniques, and advanced interface tracking techniques.

## EDUCATION

- August 2007 Ph.D., Howard P. Isermann Department of Chemical and Biological Engineering, Rensselaer Polytechnic Institute, Troy, NY, 12190.
- May 1998 B.S. Chemistry, State University of New York at Albany, Albany, NY.

## PUBLICATIONS

**Refereed Journal Articles**

1. “Extension Velocities for Efficient Level Set Based Surface Profile Evolution”, D.F. Richards, M.O. Bloomfield, S. Sen, and T.S. Cale, *Journal of Vacuum Science and Technology A,* **19**(4)**,** 1630-1635 (2001).

2. “Multiscale Process Modeling for Integrated Circuit Fabrication”, T. S. Cale, M.O. Bloomfield, D.F. Richards, K.E. Jansen and M.K. Gobbert, *Computational Material Science,* **23**, 3-14 (2002).

3. “Modeling and Simulation of Plasma Enhanced Processing for Integrated Circuit Fabrication”, V. Prasad, M.O. Bloomfield, D.F. Richards, H. Liang and T.S. Cale, *Vacuum,* **65**, 443-455 (2002).

4. “Modeling Pattern Density Dependent Bump Formation in Copper Electrochemical Deposition”, Y.-H. Im, M.O. Bloomfield, S. Sen, and T.S. Cale, *Electrochemical and Solid State Letters,* **6**(3), C42-C46 (2003).

5. “A computational framework for modeling grain structure evolution in three-dimensions”, M.O. Bloomfield, D.F. Richards, and T.S. Cale, *Philosophical Magazine,* **83**(31-34), 3549-3568 (2003).

6. “Formation and Evolution of Grain Structure in Thin Films”, M.O. Bloomfield and T S. Cale, *Microelectronics Engineering,* **76**(1-4), 195-204 (2004).

7. “Thermal Stresses in 3D IC Interwafer Interconnects”, J. Zhang, M.O. Bloomfield, J.-Q. Lu, R.J. Gutmann, and T.S. Cale, *Microelectronics Engineering, **82***, 534-547 (2005).

8. “Modeling Thermal Stresses in 3D IC Inter-Wafer Interconnects”, J. Zhang, M.O. Bloomfield, J.-Q. Lu, R.J. Gutmann, and T.S. Cale, *IEEE Transactions on Semiconductor Manufacturing*, **19**(4), 437-448 (2006)

9. "Influences of Grain Structure on Thermally Induced Stresses in 3D IC Inter-wafer Vias," D.N. Bentz, M.O. Bloomfield, J.-Q. Lu, R.J. Gutmann, and T.S. Cale, *Journal of Computational Electronics*, **5**(4), 327-331 (2006).

10. “Stress Induced Grain Boundary Migration in Polycrystalline Copper,” D.N. Bentz, M.O. Bloomfield, and T.S. Cale, *Journal of Electronic Materials*, accepted April 2007.

11. “Thermally Induced Stresses in 3D-IC Inter-wafer Interconnects: A Combined Grain-Continuum and Continuum Approach”, M.O. Bloomfield, D.N. Bentz, J.-Q. Lu, R.J. Gutmann and T.S. Cale, *Microelectronics Engineering*, accepted June 2007.

12. “Two Deterministic Approaches to Topography Evolution,” M.O. Bloomfield, T.S Cale and M.K Gobbert, *Surface and Coatings Technology*, to appear September 2007.

**Books**

1. (invited chapter) “Integrated Multiscale Process Simulation for Microelectronics”, T.S. Cale, M.O. Bloomfield, D.F. Richards, S. Soukane, K.E. Jansen, J.A. Tichy and M.K. Gobbert, in *Dispersive Transport Equations and Multiscale Models,* IMA Volumes in Mathematics and its Applications, N.B. Abdallah, A. Arnold, P. Degond, I. Gamba, R.T. Glassey, C.D. Levermore, and C. Ringhofer, eds., Springer, 2003, pp. 51-76.

2. (invited chapter) “Grain Continuum Modeling and the Virtual Wafer Fab”, M.O. Bloomfield and T.S. Cale, in *Multiscale Materials Modelling in Structural Engineering*, Z.X. Guo, ed., Woodhead Publishing, to appear in Autumn 2007.

**Proceedings**

1. “Microloading During Electrochemical Deposition: Integrated Multiscale Process Simulation”, M. O. Bloomfield, S. Soukane, K.E. Jansen, and T. S. Cale, in *Proceedings of the First International Conference on Semiconductor Technology (ISTC 2001),* Ming Yang, ed., ECS, PV 2001-17, Vol. 1, 2001, pp. 94-102.

2. “Integrated Multiscale Simulation of Copper Electrochemical Deposition Processes”, M. Bloomfield, K.E. Jansen, and T. Cale, in *Morphological Evolution in Electrodeposition and Electrochemical Processing in ULSI Fabrication IV*, P.C. Allongue, P.C. Andricacos, F. Argoul, D.P Barkey, J.C. Bradley, K. Kondo, P.C Searson, C. Reidsma-Simpson, J.L Stickney, G.M. Oleszek, eds. ECS, PV 2001-8, 2001.

3. “Integrated Multiscale Simulation of Copper Electrochemical Deposition”, M.O. Bloomfield, S. Sen, K.E. Jansen, and T.S. Cale, in *Proceedings of the Eighteenth International VLSI Multilevel Interconnection Conference,* T. Wade, ed., IMIC, 2001, pp. 397-406.

4. “Modeling and Simulation Opportunities for 3D Integrated Circuits”, V. Prasad, M.O. Bloomfield, J. Lu, A. Maniatty, R.B. Iverson, Y. Le Coz, and T.S. Cale, in *Proceedings of the Eighteenth International VLSI Multilevel Interconnection Conference*, T. Wade, ed., IMIC, 2001, pp. 421-425.

5. "Integrated Multiscale Process Simulation: Reactor Scale to Grain Scale", M.O. Bloomfield, K.E. Jansen and T.S. Cale, in *Thin Film Materials, Processes, and Reliability in Microelectronics*, G.S. Mathad, M. Yang, M. Engelhardt, H.S. Rathore, B.C. Baker, R.L. Opila, eds., ECS, PV 2001-24, 2001, pp. 77-84.

6. "Feature Scale Modeling of Transient Processes in Copper ECD", S. Sen, M.O. Bloomfield, S. Soukane and T.S. Cale, in *Thin Film Materials, Processes, and Reliability in Microelectronics*, G. S. Mathad, M. Yang, M. Engelhardt, H.S. Rathore, B.C. Baker, R.L. Opila, eds., ECS, PV 2001-24, 2001, pp. 85-94.

7. (refereed) "Modeling and Simulation Opportunities for 3D Integrated Circuits", M.O. Bloomfield, V. Prasad, J. Lu, O. Klaas, A.M. Maniatty, M.S. Shephard, T.S. Cale, in *Advanced Metallization Conference 2001*, S. Zaima and T. Ohba, eds, MRS, 2002, pp. 411-415.

8. "Integrated Multiscale Process Simulation," T.S. Cale, M.O. Bloomfield, J. Seok, C.P. Sukam, and J.A. Tichy, in *2002 Proceedings of the Nineteenth International VLSI Multilevel Interconnection Conference (VMIC)*, T. Wade, ed., IMIC, 2002, pp. 213-222.

9. "Grain Formation During Polycrystalline Thin Film Growth", M.O. Bloomfield, Y.H. Im, and T.S. Cale, in *Semiconductor Technology (ISTC2002), Proceedings of the 2nd International Conference on Semiconductor Technology*, M. Yang, ed., ECS PV 2002-17, ECS, 2002, pp. 333-341.

10. "Pattern Density Effects on Film Profile Evolution During ECD", Y.H. Im, M.O. Bloomfield, S. Sen, and T.S. Cale, in *Semiconductor Technology (ISTC2002), Proceedings of the 2nd International Conference on Semiconductor Technology*, M. Yang, ed., ECS PV 2002-17, ECS, 2002, pp. 285-294.

11. (refereed) "Improving Pulse Protocols in Atomic Layer Deposition", V.Prasad, M.K. Gobbert, M.O. Bloomfield, and T.S.. Cale, in *Advanced Metallization Conference 2002*, B.M. Melnick, T.S. Cale, S. Zaima, and T. Ohta, eds., MRS, 2003, pp. 709-715.

12. (refereed) "Pattern density effects on film profile evolution during ECD", Y.H. Im, M.O. Bloomfield, S. Sen, and T.S. Cale, in *Advanced Metallization Conference 2002*, B.M. Melnick, T.S. Cale, S. Zaima, and T. Ohta, eds., MRS, 2003, pp. 367-371.

13. (refereed) "Grain Formation during Polycrystalline Thin Film Growth", M.O. Bloomfield, Y.H. Im, Hanchen Huang, and Timothy S. Cale, in *Advanced Metallization Conference 2002*, B.M. Melnick, T.S. Cale, S. Zaima, and T. Ohta, eds., MRS, 2003, pp. 321-327.

14. "Coalescence and Evolution of Nanoscale Islands During Polycrystalline Thin Film Growth", M.O. Bloomfield, Y.H. Im, H. Huang, and T.S. Cale, *IUTAM Symposium on Multi-Scale Modeling and Characterization of Elastic-Inelastic*

*Behavior of Engineering Materials,* S. Ahzi, M. Cherkaoui , M.A. Khaleel, H.M. Zbib, M.A. Zirkry, and B. LaMatina, eds., Kluwer Academic Publishers, 2004, pp. 67-74.

15. "Integrated Multiscale and Multistep Process Simulation", M.O. Bloomfield, Y.H. Im, J. Seok, C.P. Sukam, J.A. Tichy, and T.S. Cale, in *Proceedings of the Eighth International Chemical-Mechanical Planarization for ULSI Multilevel Interconnection Conference (CMP-MIC)*, Tom Wade, ed., IMIC, 2003, pp. 463-472.

16. "Development of Microstructure in Nanostructures and Thin Films", M.O. Bloomfield, Y.H. Im, J. Wang, H. Huang, and T.S. Cale, in *Nanotechnology*, R. Vajtai, X. Aymerich, L.B. Kish, A. Rubio, eds., Proceedings of SPIE Vol. 5118, SPIE, 2003, pp. 378-389.

17. "Integrated Multiscale Process Simulation of Damascene Structures", M.O. Bloomfield, Y.H. Im, J. Seok, C.P. Sukam, J.A. Tichy, and T.S. Cale, in *ULSI Process Integration III,* C. Claeys, F. Gonzalez, J. Murota, P. Fazan, and R. Singh, eds., ECS PV 2003-6, ECS, 2003, pp. 455-466.

18. "The Evolution of Metal Grain Size Distributions" M.O. Bloomfield and T.S. Cale in *Proceedings of the Twentieth International VLSI Multilevel Interconnection Conference*, T. Wade, ed., IMIC, 2003, pp. 455-463.

19. "Integrated Multiscale Multistep Process Simulation", Y.H. Im, M.O. Bloomfield, J. Seok, C.P. Sukam, J.A. Tichy and T.S. Cale, in *2003 IEEE International Conference on Simulation of Semiconductor Processes and Devices (SISPAD)*, IEEE, 2003, pp. 307-310.

20. "Microstructure Development and Evolution", M.O. Bloomfield, Y.H. Im, and T.S. Cale, in *2003 IEEE International Conference on Simulation of Semiconductor Processes and Devices (SISPAD)*, IEEE, 2003, pp. 19-22.

21. (refereed) "Integrated Multistep Process Simulation with Chip-Scale Structures" M.O. Bloomfield, L.J. Borucki, Y.H. Im, and T.S. Cale, in *Advanced Metallization Conference 2003 (AMC 2003)*, G.W. Ray, T.J. Smy, T. Ohta, M. Tsujimara, eds., MRS, 2004, pp. 775-779.

22. (refereed) "Grain Boundary Migration in Metallic Interconnects", M.O. Bloomfield and T.S. Cale, in *Advanced Metallization Conference 2003 (AMC 2003)*, G.W. Ray, T.J. Smy, T. Ohta, M. Tsujimara, eds., MRS, 2004, pp. 231-235.

23. (refereed) "Simulation of Etching and Sealing of Porous Dielectrics" M.O. Bloomfield, Y.H. Im, and T.S. Cale, in *Advanced Metallization Conference 2003 (AMC 2003)*, G.W. Ray, T.J. Smy, T. Ohta, M. Tsujimara, eds., MRS, 2004, pp. 651-655.

24. “Multiscale Modeling for Interconnects: Status and Opportunities”, T.S. Cale, M.O. Bloomfield, X.-Y. Liu and H. Huang, J.E. Raynolds, C. Wells, J.T. Welch, and A.E. Kaloyeros, *2004 Proceedings of the 21st International VLSI Multilevel Interconnection Conference (VMIC)*, T. Wade, ed., IMIC, 2004, pp. 343-350.

25. “Multiscale Transport and Thin Film Microstructure Development”, M.O. Bloomfield, T.S. Cale and H. Huang, in *Proceedings of the Second International Conference on Multiscale Materials Modeling*, N.M. Ghoniem, ed., UCLA, 2004, p. 577.

26. “Simulation of Microstructure Formation during Thin Film Deposition”, M.O. Bloomfield and T.S. Cale, in *Simulation of Semiconductor Processes and Devices 2004* (SISPAD), G. Wachutka and G. Schrag, eds., Springer, 2004, pp. 232-236.

27. (refereed) “The Use of Conformal Voxels for Consistent Extractions from Multiple Level-Set Fields”, M.O. Bloomfield, D.F. Richards, and T.S. Cale, in *Lecture Notes in Computer Science Vol. 3516,*V.S. Sunderam, G.D. van Albada, P.M.A. Sloot, and J.J. Dongarra, eds., Springer, 2005, pp. 49 -56.

28. “Thermal Stresses in 3D IC Interwafer Vias”, .D.N. Bentz, J. Zhang, M.O. Bloomfield, J.-Q. Lu, R.J. Gutmann and T.S. Cale, in *Proceedings of the Twenty Second International VLSI Multilevel Interconnect Conference (VMIC)*, T. Wade (ed.), IMIC, 2005, pp. 89-96.

29. (refereed) “Thermally Induced Stresses in 3D ICs”, M. Bloomfield, J. Zhang, D.N. Bentz, J.-Q. Lu, R.J. Gutmann and T.S. Cale, in *Advanced Metallization Conference (AMC 2005)*, MRS, 2006, pp. 649-654.

30. “Modeling Thermal Stresses of Copper Interconnects in 3D IC Structures”, D.N. Bentz, J. Zhang, M.O. Bloomfield, J.-Q. Lu, R.J. Gutmann and T.S. Cale, in *Proceeding of the COMSOL Multiphysics Conference 2005*, J. Hiller (ed.), COMSOL, 2005, pp. 321-326.

31. “Grain-focused Microstructure Simulations: Stress-Induced Evolution of Polycrystalline Films,” D.N. Bentz, M.O. Bloomfield, and T.S. Cale, in *11th International Ceramics Congress Advances in Science and Technology*, Trans Tech Pub., 2006, pp. 1178-1183.

32. “Grain Based Modeling of Stress-Induced Copper Migration for 3D-IC Interwafer Vias,” D.N. Bentz, M.O. Bloomfield, H. Huang, J.-Q Lu, R. J. Gutmann, and T.S. Cale, in *2006 International Conference on Simulation of Semiconductor Processes and Devices (SISPAD),* IEEE, 2006, pp. 345-348.

33. “Stress Induced Grain Boundary Migration in Polycrystalline Cu Lines,” D.N. Bentz, M.O. Bloomfield, J.-Q Lu, R.J. Gutmann and T.S. Cale, in *Proceedings of International Conference on Multiscale Materials Modeling (MMM),* P. Gumsch (ed.), Fraunhofer IRB Verlag, 2006, pp. 404-407.

34. (refereed) “Mechanical Models of Polycrystalline 3D-IC Interwafer Vias,” D.N. Bentz, M.O. Bloomfield, J.-Q. Lu, R.J. Gutmann, and T.S. Cale, in *Advanced Metallization Conference (AMC 2006)*, MRS, 2007, in press.

35. “Stress Induced Migration in Polycrystalline Films: a Time-Scale Analysis,” M.O. Bloomfield, D.N. Bentz, J.-Q. Lu, R.J. Gutmann, and T. S. Cale, in , in *Proceedings Twenty Third International VLSI Multilevel Interconnection Conference,* T. Wade (ed.), IMIC, 2006, pp. 234-239.

36. “Applying Grain Continuum Models to Stress Induced Grain Evolution in Next Generation Integrated Circuit Interconnects,” D.N. Bentz, M.O. Bloomfield, J.-Q. Lu, R.J. Gutmann and T.S. Cale, in *Comsol Users Conference Proceedings*, J. Hiller (ed.), Comsol, 2006, pp. 309-317.

Journal of Vacuum Science & Technology B: Microelectronics Processing and â€¦, 1990. 42. 1990.Â  Journal of Vacuum Science & Technology B: Microelectronics and Nanometer â€¦, 1993. 36. 1993. Loop-based interconnect modeling and optimization approach for multigigahertz clock network design. X Huang, P Restle, T Bucelot, Y Cao, TJ King, C Hu. IEEE Journal of Solid-State Circuits 38 (3), 457-463, 2003. 34. 2003. CPAM: A common power analysis methodology for high-performance VLSI design. JS Neely, HH Chen, SG Walker, J Venuto, TJ Bucelot. IEEE 9th Topical Meeting on Electrical Performance of Electronic Packaging â€¦, 2000. 33. 2000. Enhanced performance of accumulation mode 0.5 mu m CMOS/SOI SCI Journal. Impact Factor Database. Vacuum. Basic Journal Info. Country.Â  A journal impact factor is frequently used as a proxy for the relative importance of a journal within its field. Normally, journals with higher impact factors are often deemed to have more influence than those with lower ones. However, the science community has also noted that review articles typically are more citable than research articles. (Read More: What is a good impact factor?) See what other people are reading. Discover. Vacuum. Impact Factor History.Â  Any journal impact factor or scientometric indicator alone will not give you the full picture of a science journal. Thatâ€™s why every year, scholars review current metrics to improve upon them and sometimes come up with new ones.