Curriculum Vitae

Randall L. Headrick
Associate Professor
Department of Physics
The University of Vermont
Burlington, VT 05405
Office: 802-656-0048
E-mail: rheadrick@uvm.edu

Education

PhD,	Materials Science and Engineering, University of Pennsylvania, 1988
BS,	Physics, Carnegie-Mellon University, 1982.

Professional interests

Kinetics of thin-film growth, and etching. Real-time x-ray and electron diffraction studies of materials growth and surface evolution.

Professional record

2005-present	Associate Professor, Department of Physics, The University of Vermont, Burlington, VT. Secondary appointment: Materials Science. Director of the Materials Science Program since 9/06. Research interests in the dynamics of sputter deposition, molecular beam epitaxy, and pulsed laser deposition; growth and characterization of organic semiconductor thin films.
2001-2005	Department of Physics, University of Vermont, Assistant Professor Secondary appointment: Materials Science. Research in the area of kinetics of thin-film growth, and etching; real-time x-ray and electron diffraction studies of materials growth and surface evolution.
1991-2001	Cornell University, Ithaca, N.Y., Senior Staff Scientist, Cornell High Energy Synchrotron Source. Developed in-situ growth and surface processing capabilities on the 24-pole wiggler station, A2.
1989-1991	AT&T Bell Laboratories, Murray Hill, NJ. Postdoctoral Member of Technical Staff, with Dr. Leonard Feldman. Studied ordered delta-doping of silicon, using x-ray scattering to probe ordered buried layers in silicon.
1982-1988	University of Pennsylvania, Philadelphia, PA. Graduate Research Associate Department of Materials Science and Engineering, with Professor William R. Graham. PhD Thesis title: “Geometric structure of adsorbate covered surfaces determined by medium energy ion scattering”.

Honors, awards, and activities

Nominated for the Kroepsch-Maurice Excellence in Teaching Award, 2005.
NSF CAREER grant, 2004.
Visiting Assistant Professor, Department of Applied and Engineering Physics, Cornell University, 2001-2002.
Consultant, AT&T Bell Laboratories, Murray Hill, NJ., 1991-1993
IBM Corporation Graduate Fellowship, 1985, 1986
University of Pennsylvania Graduate Fellowship, 1982

Synergistic Activities

1. Mentored three undergraduate students during the last five years.
2. Supervised seven Ph.D. students and sponsored three postdoctoral students during the last five years.
3. Currently supervising five Ph.D. students, one Postdoc., and one undergraduate student.
4. Member of the American Physical Society and the Materials Research Society.
5. NSLS Soft Condensed Matter Proposal Review Panel, since 2007.
6. Reviewer of manuscripts for Reviews of Scientific Instruments, Journal of Applied Physics, Applied Surface Science, and Physical Review B.
7. Research has been continuously funded by external sources (DOE, NSF) since 2002.

Refereed Publications

1. "Non-Registered Silicon Produced at Metal-Silicon Interfaces by 14 MeV Oxygen Ions", R.L. Headrick and L.E. Seiberling, Appl. Phys. Lett. **45**, 288 (1984).
2. "MeV Ion Induced Modification of the Native Oxide of Silicon", R.L. Headrick and L.E. Seiberling, Mat. Res. Soc. Symp. Proc. **51**, 363 (1986).
3. "A UHV-Compatible DE-E Gas Telescope for Depth Profiling and Surface Analysis of Light Elements", A.M. Behrooz, R.L. Headrick, L.E. Seiberling, and R.W. Zurmuhle, Nucl. Instrum. Meth. B **28**, 108 (1987).
4. "Medium-energy ion scattering study of the Si(111):As-1×1 surface", R.L. Headrick and W.R. Graham, J. Vac. Sci. Technol. A, **6** (3), 637 (1988).
5. "Geometric Structure of the Si(111):As-1x1 Surface", R.L. Headrick and W.R. Graham, Phys. Rev. B **37**, 1051 (1988).
6. "Medium-energy Ion Scattering Study of the Initial Stage of Oxidation of Fe(001)", R.L. Headrick, P. Konarski, S.M. Yalisove, and W.R. Graham, Phys. Rev B **39**, 9 (1989).
7. "Stability of Boron- and Gallium- Induced Surface Structures on Si(111) During Deposition and Epitaxial Growth of Silicon", R.L. Headrick, L.C. Feldman, and I.K. Robinson, Appl. Phys. Lett., **55**, 442 (1989).
8. "Structure Determination of the Si(111):B ($\sqrt{3}\times\sqrt{3}$) Surface: Subsurface Substitutional Doping", R.L. Headrick, I.K. Robinson, E. Vlieg, and L.C. Feldman, Phys. Rev. Lett., **63**, 1253 (1989).
9. "Influence of Surface Reconstruction on the Orientation of Homoepitaxial Silicon Films", R.L. Headrick, B.E. Weir, J. Bevk, B.S. Freer, and L.C. Feldman, Phys. Rev. Lett., **65**, 1128, (1990).
10. "Secondary Ion Mass Spectroscopy on delta-doped GaAs grown by Molecular Beam Epitaxy", E.F. Shubert, H.S. H.S. Luftman, R.F. Kopf, R.L. Headrick, and J.M. Kuo, Appl. Phys. Lett., **57**, 1799 (1990).
11. "Surface States and Alkalai-to -Semiconductor Charge Transfer of the K/Si(111) ($\sqrt{3}\times\sqrt{3}$) R30°-B System", Y. Ma, J.E. Rowe, E.E. Chaban, C.T. Chen, R.L. Headrick, G.M. Meigs, S. Modesti, and F. Sette, Phys. Rev. Lett., 65, 2173 (1990).
12. "The Si(100)-(2x1) Boron Reconstruction: Self-Limiting Monolayer Doping", R.L. Headrick, B.E. Weir, A.F.J. Levi, D.J. Eaglesham, and L.C. Feldman, Appl. Phys. Lett. **57**, 2779 (1990).
13. "Energy Dependent Vibrational Spectra of the Si(111)-B Surface", J.E. Rowe, R.A. Malic, E.E. Chaban, R.L. Headrick, and L.C. Feldman, Journal of Electron Spectroscopy and Related Phenomena, **54**, 1115 (1990).
14. "Electrical Conduction in the Si(111):B-($\sqrt{3}\times\sqrt{3}$)R30° Interface Reconstruction", R.L. Headrick, A.F.J. Levi, H.S. Luftman, J. Kovalchick, and L.C. Feldman, Phys. Rev. B, **43**, 14711, (1991).
15. "Low Temperature Homoepitaxy on Si(111)", B.E. Weir, R.L. Headrick, J. Bevk, B.S. Freer, and L.C. Feldman, Appl. Phys. Lett., **59**, (2), 204 (1991).
16. "Mechanically and Thermally Stable Si-Ge Films and Heterojunction Bipolar Transistors Grown by RapidThermal Chemical Vapor Deposition (RTCVD) at 900°C", M.L. Green, B.E. Weir, D. Brasen, Y.F. Hseih, G. Higashi, A. Feygenson, L.C. Feldman, and R.L. Headrick, J. Appl. Phys. **69** (2), 745 (1991).
17. "Ordered Monolayer Structures of boron in Si(111) and Si(100)", R.L. Headrick, B.E. Weir, A.F.J. Levi, B. Freer, J. Bevk, and L.C. Feldman, J. Vac. Sci. and Technol., A **9** (4), 2269 (1991).
18. "Buried, ordered structures: boron in Si(111) and Si(100)", R.L. Headrick, B.E. Weir, A.F.J. Levi, D.J. Eaglesham, and L.C. Feldman, Journal of Crystal Growth **111**, 838 (1992).
19. "High-flux x-ray undulator radiation from proposed B factory storage rings at Cornell University", D.H. Bilderback, B.W. Batterman, M.J. Bedzyk, J. Brock, K. Finkelstein, R. Headrick, and Q. Shen, Rev. Sci. Instrum. **63** (1), 1590 (1992).

20. "Boron-Silicon Alloy Delta Layer" , B.E Weir, R.L. Headrick, Q. Shen, L.C. Feldman, M. Needels, M.S. Hybertsen, M. Schlüter, and T.R. Hart, Phys. Rev. B **46**, 12861 (1992).
21. "X-ray and Raman Scattering Characterization of Ge/Si Buried Layers", R.L. Headrick, J.-M. Baribeau, D.J. Lockwood, T.E. Jackman, and M.J. Bedzyk, Appl. Phys. Lett. **62**, 687 (1993).
22. "Influence of Annealing on the Interface Structure and Strain Relief in Si/Ge Heterostructures", D.J. Lockwood, J.-M. Baribeau, T.E. Jackman, P. Aebi, T. Tyliszczak, A.P. Hitchcock, and R.L. Headrick, Scanning Microscopy, **7**, 457 (1993).
23. "Interface Roughness in Ge/Si Superlattices", R.L. Headrick and J.-M. Baribeau, J. Vac. Sci. and Technol. B, **11**, 1514 (1993).
24. "Correlated Roughness in $(Ge_mSi_n)_p$ Superlattices", R.L. Headrick and J.-M. Baribeau, Phys. Rev. B, **48**, 9174 (1993).
25. "Interfacial Studies in Semicondutor Heterostructures by X-Ray Diffraction Techniques", J.-M. Baribeau, R.L. Headrick and P. Maigné, Scanning Microscopy, **8**, 751 (1994).
26. "Electrical characterization of an ultrahigh concentration boron delta-doping layer", B.E. Weir, L.C. Feldman, D. Monroe, H.-J. Gossmann, R.L. Headrick, T.R. Hart, Applied Physics Letters, **65**, (6), 737 (1994).
27. "Redesigned front end for the upgrade at CHESS", R.L. Headrick and K.W. Smolenski, Rev. Sci. Instrum. **67**, 1 (1995).
28. "Roughness in $Si_{1-x}Ge_x$/Si Superlattices: Growth Temperature Dependence", R.L. Headrick and J.-M. Baribeau, J. Vac. Sci. Technol. A **13**, 782 (1995).
29. "Nature and Evolution of Interfaces in $Si/Si_{1-x}Ge_x$ Superlattices", J.-M. Baribeau and R.L. Headrick, Journal of Electronic Materials, **24**, 341 (1995).
30. "Anisotropic Roughness in $Si_{1-x}Ge_x$/Si Superlattices", R.L. Headrick, J.-M. Baribeau, and Y.E. Strausser, Appl. Phys. Lett., **66**, 96, (1995).
31. "Critical Fluctuations in Membranes", Ruitian Zhang, Wenjun Sun, Stephanie Tristram-Nagle, R.L. Headrick, Robert M. Suter and John F. Nagle, Phys. Rev. Lett. **74**, 2832 (1995).
32. "Electron microscopy of the ordered boron 2×1 structure buried in crystalline silicon", B.E. Weir, D.J. Eaglesham, L.C. Feldman, H.S. Luftman and R.L. Headrick, Applied Surface Science, **84**, 413 (1995).
33. "Small-angle x-ray scattering from lipid bilayers is well described by modified Caille theory but not by paracrystalline theory", R. Zhang, S. Tristram-Nagle, W. Sun, R.L. Headrick, T.C. Irving, R.M. Suter, and J.F. Nagle, Biophys. J. **70**, 349 (1996).
34. "Real-time x-ray-scattering measurement of the nucleation kinetics of cubic gallium nitride on β-SiC(001)", R.L. Headrick, S. Kycia, Y.K. Park, A.R. Woll, and J.D. Brock, Phys. Rev. B **54**, 14686 (1996).
35. "X-ray scattering study of the surface morphology of Au(111) during Ar^+ ion irradiation", M.V. Ramana Murty, T. Curcic, A. Judy, B.H. Cooper, A.R. Woll, J.D. Brock, S. Kycia, and R.L. Headrick, Phys. Rev. Lett **80**, 4713 (1998).
36. "Ion-assisted nucleation and growth of GaN on Sapphire(0001)", R.L. Headrick, S. Kycia, A.R. Woll, J.D. Brock, M.V. Ramana Murty, Phys. Rev. B **58**, 4818 (1998).
37. "Nucleation and growth of GaN on sapphire (0001): incorporation and interlayer transport", A.R. Woll, R.L. Headrick, S. Kycia, and J.D. Brock, Physical Review Letters **83**, 4349 (1999).
38. "The effect of crystalline domain size on the photophysical properties of thin organic molecular films", A.J. Mäkinen, A.R. Melnyk, S. Schoemann, R.L. Headrick, Y. Gao, Physical Review B **60**, 14683 (1999).
39. "Real-time x-ray scattering study of surface morphology evolution during ion erosion and epitaxial growth of Au(111)", M.V.R. Murty, T. Curcic, A. Judy, B.H. Cooper, A.R. Woll, J.D. Brock, S. Kycia, and R.L. Headrick, Physical Review B **60**, 16956 (1999).
40. "Clarification of the ripple phase of lecithin bilayers using fully hydrated, aligned samples", J. Katsaras, S. Tristram-Nagle, Y. Liu, R.L. Headrick, E. Fontes, P.C. Mason, J.F. Nagle, Physical Review E **61**, 5668 (2000).
41. "Revisiting the ripple phase using fully hydrated, aligned DPPC multibilayers", J. Katsaras S. Tristram-Nagle, Y. Liu, R.L. Headrick, E. Fontes, P.C. Mason, J.F. Nagle, Biophysical Journal **78**, 116 (2000).
42. "Persistent layer-by-layer sputtering of Au(111)", M.V.R. Murty, A.J. Couture, B.H. Cooper, A.R. Woll, J.D. Brock, and R.L. Headrick, Journal of Applied Physics **88**, 597 (2000).
43. "Roughness in sputtered multilayers analyzed by transmission electron microscopy and X-ray diffuse scattering", A.T. Macrander, C. Liu, R. Csencsits, R. Cook, M. Kirk, and R. Headrick, Physica B **283**, 157 (2000).

44. "Orientation of pentacene films using surface alignment layers and its influence on thin film transistor characteristics", M.L. Swiggers, G. Xia, J.D. Slinker, A.A. Gorodetsky, G.G. Malliaras, R.L. Headrick, C. Dulcey and R.N. Shashidhar, Applied Physics Letters, **79**, 1300 (2001).
45. "Ion-induced pattern formation on Co surfaces: an x-ray scattering and Kinetic Monte Carlo study", O. Malis, J.D. Brock, R. L. Headrick, Min-Su Yi, and J.M. Pomeroy, Phys Rev. B **66**, art. no. 035408 (2002).
46. "Spontaneous Nanoscale corrugation of SiO_2: The role of ion-irradiation enhanced viscous flow", C.C. Umbach, R.L. Headrick, and K.-C. Chang, Phys. Rev. Lett. **87**, 246104 (2002).
47. "Multilayer optics for a wiggler beamline", R.L. Headrick, K.W. Smolenski, A. Kazimirov, C. Liu, and A.T. Macrander, Rev. Sci. Instrum. **73**, 1476 (2002).
48. "Si(100) surface morphology evolution during normal-incidence sputtering with 100-500 eV Ar^+ ions", K.F. Ludwig, C.R. Eddy, O. Malis, R.L. Headrick, Appl. Phys. Lett., **81**, 2770, (2002).
49. "Early stages of pentacene film growth on silicon oxide", A. Mayer, R. Ruiz, R.L. Headrick, A. Kazimirov, and G.G. Malliaras, Organic Electronics **5**, 257 (2004).
50. "Structure of pentacene thin films", R. Ruiz, G.G. Malliaras, B. Nickel, G. Scoles, A.K. Kazimirov, H. Kim, R.L. Headrick, and Z. Islam, Applied Physics Letters **85**, 4926 (2004).
51. "Pentacene thin film growth", R. Ruiz, D. Choudhary, B. Nickel, T. Toccoli, K.-C. Chang, A.C. Mayer, P. Clancey, R.L. Headrick, S. Iannotta, and G.G. Malliaras, *Chemistry of Materials* **16**, 4497 (2004).
52. "Real-time x-ray studies of Mo-seeded Si nanodot formation during ion bombardment," G. Ozaydin, A.S. Ozcan, Yiyi Wang, K.F. Ludwig, Hua Zhou, R.L. Headrick, and D.P. Siddons, *Applied Physics Letters* **87**, 163104 (2005).
53. "Growth dynamics of pentacene thin films," A.C. Mayer, R. Ruiz, H. Zhou, R.L. Headrick, A. Kazimirov, and G.G. Malliaras, *Physical Review B* **73**, 205307 (2006).
54. "Structure of a pentacene monolayer deposited on SiO_2: Role of trapped interfacial water," S.T. Wo, B.R. Wang, H. Zhou, Y.P. Wang, J. Bessette, R.L. Headrick, A.C. Mayer, G.G. Malliaras, and A. Kazimirov, *J. Appl. Phys.* **100**, 093504 (2006).
55. "Self-assembled and etched cones on laser ablated polymer surfaces," N.S. Murthy, R.D. Prabhu, J.J. Martin, L. Zhou, and R.L. Headrick, *J. Appl. Phys.* **100**, 023538 (2006).
56. "Interface roughness evolution in sputtered WSi_2/Si multilayers," Y.P. Wang, H. Zhou, L. Zhou, R.L. Headrick, A.T. Macrander, and A.S. Ozcan, *J. Appl. Phys.* **101**, 023503 (Jan 2007).
57. "Wavelength tunability of ion-bombardment induced ripples on sapphire," H. Zhou, Y.-P. Wang, L. Zhou, R.L. Headrick, A.S. Ozcan, Y.-Y. Wang, G. Ozaydin, and K.F. Ludwig, Jr., *Physical Review B*, **75**, 155416 (2007).
58. "Real-time X-ray studies of the growth of Mo-seeded Si nanodots by low-energy ion bombardment," G. Ozaydin, Y. Wang, K.F. Ludwig Jr., H. Zhou, and R.L. Headrick, *Nuclear Inst. and Methods in Physics Research, B*, **264**, 47 (2007).
59. "Anisotropic mobility in large grain size solution processed organic semiconductor thin films," R.L. Headrick, S. Wo, F. Sansoz, and J.E. Anthony, *Appl. Phys. Lett.* **92**, 063302, (2008).
60. "Mechanism of pattern formation and smoothing of oxide surfaces induced by ion beam erosion", H. Zhou, L. Zhou, G Ozaydin, K.F. Ludwig, and R .L. Headrick, *Phys. Rev. B* **78**, 165404 (2007)
61. "Ripple formation and smoothening on insulating surfaces," R.L. Headrick and H. Zhou, Invited review article for *Journal of Physics: Condensed Matter*. 21, 24005 (2009). Special issue on "Surface nanopatterns induced by ion beam sputtering."
62. "Working Model of an Atomic Force Microscope," K. Bonson, R.L. Headrick, D. Hammond, and M. Hamblin, American *Journal of Physics*, In press (2010).

Conference proceedings

1. "Disorder Production at Metal-Silicon Interfaces by MeV/amu Ion Irradiation", R.L. Headrick and L.E. Seiberling, Mat. Res. Soc. Symp. Proc. **35**, 539 (1985).
2. "Silicon Epitaxy and Silicon Surfaces", L.C. Feldman, R.L. Headrick, and B.E. Weir, in China Center of Advanced Science and Technology (World Laboratory) Symposium/Workshop Proceedings, Volume 9, (Gordon and Breach, Amsterdam, 1992).
3. "X-ray studies of low-temperature grown SiO_2 on Si", J.-M. Baribeau, D. Landheer, J.A. Bardwell, K.B. Clark, and R.L. Headrick, Interface Control of Electrical, Chemical, and Mechanical Properties Symposium, Mater. Res. Soc; Pittsburgh, PA, USA, p. 75 (1994).

4. “Interface phenomena in very thin Si-Ge heterostructures”, J.-M. Baribeau, D.J. Lockwood, Z.-H. Lu, and R.L. Headrick, Mechanisms of Thin Film Evolution. Symposium. Mater. Res. Soc; Pittsburgh, PA, USA, p. 77 (1994).
5. “Real-time X-ray scattering studies of thin-film growth and processing”, R.L. Headrick, AIP Conference Proceedings, **417**, 195 (1997).
6. “Specular and diffuse x-ray scattering from tungsten/carbon multilayers having a high reflectivity at 10 keV”, A. Macrander, R.L. Headrick, C. Lui, A. Khounsary, K. Smolenski, S. Krasnicki, J. Maj, and J. Erdmann, Proceedings of the SPIE, **3448**, 291 (1998).
7. “Water-cooled multilayer optics for a wiggler beamline”, K.W. Smolenski, R.L. Headrick, Q. Shen, B. Carroll, A. Khounsary, C. Liu, A. Macrander, Proceedings of the SPIE, **3448**, 27 (1998).
8. “Real-time x-ray scattering study of surface dynamics on Au(111) during Ar^+ ion irradiation”, M.V. Ramana Murty, T. Curcic, A. Judy, B.H. Cooper, A.R. Woll, J.D. Brock, S. Kycia, and R.L. Headrick, Mechanisms and Principles of Epitaxial Growth in Metallic Systems, Mater. Res. Soc; Warrendale, PA, USA, p.195 (1999).
9. “Roughening of Au(111) surfaces during ion beam erosion: a scanning tunneling microscope and X-ray diffraction study”, Judy, A.; Ramana Murty, M.V.; Butler, E.; Pomeroy, J.; Cooper, B.H.; Woll, A.R.; Brock, J.D.; Kycia, S.; Headrick, R.L., Epitaxial Growth-Principles and Applications, Mater. Res. Soc.; Warrendale, PA, USA, p.61 (1999)
10. “Sagittally focusing multilayers for wiggler beamlines”, K.W. Smolenski, R. L. Headrick, C. Liu, A.T. Macrander, Advances in X-ray Optics, San Diego, CA, USA, Aug. 2000, Proceedings of the SPIE (2001).
11. “Time-Resolved X-Ray Scattering Study of Co Surface Evolution during Low-Energy Ion Irradiation”, O. Malis, J. M. Pomeroy, R. L. Headrick, and J. D. Brock; Ion Beam Synthesis and Processing of Advanced Materials, Mater. Res. Soc. Symp. Proc. Vol 647: O.9.5.1; Warrendale, PA, USA. (2002)
12. “Development of a Compact System for In-situ X-ray Scattering Studies of Organic Thin Film Deposition”, R.L. Headrick, G.G. Malliaras, A.C. Mayer, A.K. Deyhim, and A.C. Hunt, Synchrotron Radiation Instrumentation: Eighth International Conference on Synchrotron Radiation Instrumentation, San Francisco, CA, American Institute of Physics Conference Proceedings **708**, 1150 (2004).

Book chapters

1. “Ordered Delta Doping”, R.L. Headrick, B.E. Weir, and L.C. Feldman, in Delta Doping of Semiconductors, E.F. Schubert, ed. (Cambridge University Press, 1996.)

Patents

1. “Process for fabricating a thin crystalline structure”, United States Patent US 7,351,283 B2, Randall L. Headrick, April 2008.