Daan Hein Alsem - Curriculum Vitae

Materials Sciences Division
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Education:

- Ph.D. in Materials Science and Engineering, University of California, Berkeley
  Advisor: Prof. Robert O.Ritchie 01/2003 – 12/2006
  Dissertation: *Mechanisms for Fatigue and Wear of Polysilicon Structural Thin Films*. Special focus on (analytical) electron microscopy techniques. Minors: Mechanical Engineering (focus: MEMS) and Electrical Engineering. GPA: 3.96/4.00.
- M.S. in Applied Physics, University of Groningen, The Netherlands (includes B.S.)
  Advisor: Prof. Jeff Th.M. de Hosson 09/1996 – 08/2002
  Projects: *Characterization of magnetic properties of nano-crystalline materials using transmission electron microscopy (TEM)* and *In-situ quantitative characterization of morphological evolution in q = 2 Potts model aluminum thin films using TEM*

Research interests:

- Mechanical behavior – deformation (elastic/plastic), fracture, fatigue, friction/adhesion and wear – of materials:
  - Micron- and nano-scale (structural) thin films and structures
  - Alternative energy generation/storage materials
  - Nature-inspired structural materials
- Developing and using advanced analytical and *in-situ* transmission electron beam characterization techniques to relate (changes in) microstructure to mechanisms governing physical behavior of functional and structural materials.

Research experience:

- *Post-doctoral researcher*, Materials Sciences Division / National Center for Electron Microscopy, Lawrence Berkeley National Laboratory, Berkeley, 01/2007 - Present
  Projects:
  - *Designing highly toughened nature-inspired hybrid composites*
  - *Nano-scale tribology of polysilicon structural films*
  - *In-situ TEM study of fracture and fatigue in polysilicon structural films*
  - *TEM study of cyclic torsional strain effects in NiTi shape-memory alloy*
  - *Fatigue crack growth in nano-grained Pt thin films*
  - *In-situ TEM EBIC study of Ag/Si contacts in silicon solar cells*
- *Graduate student researcher*, Materials Science and Engineering Department at the University of California at Berkeley / Materials Sciences Division at Lawrence Berkeley National Laboratory (LBNL), Berkeley, 01/2003 – 12/2006
- *Visiting research scholar*, National Center for Electron Microscopy at the Lawrence Berkeley National Laboratory, Berkeley, 03/2002 – 08/2002
- *Graduate student researcher*, Department of Applied Physics, University of Groningen, The Netherlands, 02/2001 – 08/2002.
- *Undergraduate research intern*, Department of Applied Physics, University of Groningen, the Netherlands, 01/1999 – 07/1999

Teaching and mentoring experience:

- *Substitute lecturer* for undergraduate course "Mechanical Properties of Engineering Materials", Department of Materials Science and Engineering, University of California, Berkeley, 09/2008 – 11/2008.
- *Guest lecturer* for graduate course "Tribology", Department of Mechanical Engineering, University of California, Berkeley, 02/2008.
- *Mentor for visiting graduate students* during internships in Materials Sciences Division, Lawrence Berkeley National Laboratory, 02/2005 - 08/2005 and 09/2007 – 02/2008.
- *Graduate student instructor* for "Mechanical Properties of Engineering Materials", Department of Materials Science and Engineering, University of California, Berkeley, 08/2006 – 12/2006 (weekly discussion sessions and also taught several main lectures).
- *Mentor for high school intern* during summer internship in Materials Sciences Division, Lawrence Berkeley National Laboratory, 06/2004 - 08/2004.
- *University student tutor for junior/senior high school students* in courses: physics, mathematics and chemistry, 09/1996 – 06/2001.

Professional services and synergistic activities:

- *Peer reviewer* for: Acta Materialia, Nanotechnology, Journal of Microelectromechanical Systems, Journal of Materials Science, Journal of Micromechanics and Microengineering, Journal of Physics D: Applied Physics, International Journal of Fracture, Microscopy Research & Technique, Sensors, MRS Proceedings, TMS Proceedings, Department of Energy – Office of Basic Energy Sciences.
- *Co-organizer* of joint National Center for Electron Microscopy and Molecular Foundry 2008 Users' Meeting at LBNL November 10-11, 2008.
- *Member* of National Center for Electron Microscopy User Association Executive Committee at Lawrence Berkeley National Laboratory, 02/08 – Present.
- *Co-chair of session* "Adhesion" at MicroNanoReliability 2007 conference, Berlin, Germany, September 5, 2007.
- *Treasurer and co-organizer* of Embedded Software Conference ('ESCAPE') at the University of Groningen, The Netherlands, October 16-17, 2001.
- *Public relations commissioner* on the board of the student association for students in Physics, Mathematics and Computer Science ('FMF') at the University of Groningen, The Netherlands, 09/1999 – 09/2000.
- *Chief-editor and designer* of the FMF magazine 'Periodiek*' 09/1999 – 10/2000

Scholarships:

- Travel scholarships: UC Berkeley Graduate Fellowships Office Conference Travel Grant (07/2007), Groningen University Fund Grant (03/2002 – 08/2002), Marco Polo Fund Grant (03/2002 – 08/2002).
- Royal Dutch Shell Scholarship ('Shell-studietoelagen beurs'), 08/1996 - 08/2002.

Society memberships:

- Materials Research Society (MRS)
- The Minerals, Metals & Materials Society (TMS)
- SPIE

Publications:

Refereed journal papers

J13. *Designing Highly Toughened Hybrid Composites Through Nature-Inspired Hierarchical Complexity,* M.E. Launey, E. Munch, **D.H. Alsem**, H.B. Barth, E. Saiz, A.P. Tomsia and R.O. Ritchie, *Acta Materialia, accepted, March 2009.*

J12. *Sliding Wear Mechanisms Of Polysilicon Surface Micromachines Operated In High Vacuum,* S.J. Timpe, **D.H. Alsem**, D.A. Hook, M.T. Dugger and K. Komvopoulos, *Journal of Microelectromechanical Systems, in press, February 2009.*

J11. *Wear Mechanisms And Friction Parameters For Sliding Wear Of Micron-Scale Polysilicon Sidewalls,* **D.H. Alsem**, R. van der Hulst, E.A. Stach, M.T. Dugger, J.Th.M. De Hosson and R.O. Ritchie, *Journal of Micromechanics and Microengineering, submitted, January 2009.*

J10. *Tough, Bio-Inspired Hybrid Materials,* E. Munch, M.E. Launey, **D.H. Alsem**, E. Saiz, A.P. Tomsia, R.O. Ritchie, *Science, vol. 322, 2008, pp. 1516-1520.*

J9. *Micron-Scale Friction And Sliding Wear Of Polycrystalline Silicon Thin Structural Films In Ambient Air,* **D.H. Alsem**, E.A. Stach, M.T. Dugger and R.O. Ritchie, *Journal of Microelectromechanical Systems, vol. 17, 2008, pp. 1144-1154.*

J8. *Further Considerations On The High-Cycle Fatigue Of Micron-Scale Polycrystalline Silicon,* **D.H. Alsem**, C.L. Muhlstein, E.A. Stach and R.O. Ritchie, *Scripta Materialia, vol. 59, 2008, pp. 931-935, (Invited paper).*

J7. *Effect Of Post-Release Sidewall Morphology On The Fracture And Fatigue Properties Of Polycrystalline Silicon Structural Films,* **D.H. Alsem**, B.L. Boyce, E.A. Stach and R.O. Ritchie, *Sensors and Actuators A, vol. 147, 2008, pp. 553-560.*

J6. *Mechanisms For Fatigue Of Micron-Scale Silicon Structural Films,* **D.H. Alsem**, O.N. Pierron, E.A. Stach, C.L. Muhlstein and R.O. Ritchie, *Advanced Engineering Materials, vol 9, no 1-2, 2007, pp. 15-30, (Invited review).*

J5. *Very High-Cycle Fatigue Failure In Micron-Scale Poly-Crystalline Silicon Films: Effects Of Environment And Surface Oxide Thickness,* **D.H. Alsem**, R. Timmerman, B.L. Boyce, E.A. Stach, J.Th.M. de Hosson and R.O. Ritchie, *Journal of Applied Physics, vol 101, Jan 2007, pp. 013515.*

J4. *An Electron Microscopy Study Of Wear In Polysilicon Microelectromechanical Systems In Ambient Air,* **D.H. Alsem**, E.A. Stach, M.T. Dugger, Marius Enachescu and R.O. Ritchie, *Thin Solid Films, vol 515, 2007, pp. 3259–3266.*

J3. *Quantitative Characterization Of The Growth And Morphological Evolution Of Bicrystalline Aluminum Thin Films,* **D.H. Alsem**, J.Th.M. de Hosson and E.A. Stach, *Journal of Materials Science, vol 40, 2005, pp. 5033-5036.*

J2. *Fatigue Failure In Thin-Film Polycrystalline Silicon Is Due To Subcritical Cracking Within The Oxide Layer*, **D.H. Alsem**, E.A. Stach, C.L. Muhlstein and R.O. Ritchie, *Applied Physics Letters, vol 86, Jan 2005, pp. 41914-1-3.*

J1. *Ultra-Soft Magnetic Films Investigated With Lorentz Transmissie Electron Microscopy And Electron Holography*, J.Th.M. De Hosson, N.G. Chechenin, **D.H. Alsem**, T. Vystavel, B.J. Kooi, A.R. Chezan and D.O. Boerma, *Microscopy & Microanalysis, vol 8, no 4, Aug 2002, pp.274-87.*

Conference papers

C9. *Effect Of Sidewall Morphology On The Fracture And Fatigue Properties Of Polysilicon Structural Films*, **D.H. Alsem**, B.L. Boyce, E.A. Stach and R.O. Ritchie, *Proceedings of the 12th International Conference on Fracture (ICF 12), Ottawa, Canada, July 2009 (submitted October 2008).*

C8. *Tribological Behavior Of Micron-Scale Polycrystalline Silicon Films In Ambient Air*, **D.H. Alsem**, R. van der Hulst, E.A. Stach, M.T. Dugger, J.Th.M. de Hosson and R.O. Ritchie, *Proceedings of SPIE MOEMS-MEMS: Micro- and Nanofabrication - Reliability, Packaging, Testing, and Characterization of MEMS/MOEMS and Nanodevices VIII, San Jose, CA, January 2009.*

C7. *Nano-Scale Tribological Behavior Of Polycrystalline Silicon Structural Films In Ambient Air*, **D.H. Alsem**, R. van der Hulst, E.A. Stach, M.T. Dugger, J.Th.M. de Hosson and R.O. Ritchie, *Materials Research Society Spring Meeting Proceedings (T1.4), San Francisco, CA, March 2008.*

C6. *Wear And Fatigue In Silicon Structural Films For MEMS Applications*, **D.H. Alsem**, R. Timmerman, E.A. Stach, M.T. Dugger and R.O. Ritchie, *Proceedings of the European Conference on Fracture 2006 (ECF 16), Alexandroupolis, Greece, July 2006.*

C5. *Utilizing On-Chip Testing And Electron Microscopy To Obtain A Mechanistic Understanding Of Fatigue And Wear In Polysilicon Structural Films*, **D.H. Alsem**, E.A. Stach, C.L. Muhlstein, M.T. Dugger, and R.O. Ritchie, *Materials Research Society Spring Meeting Proceedings (P2.5), San Francisco, CA, April 2004.*

C4. *Very High-Cycle Fatigue Of Micron-Scale Polysilicon Films For MEMS*, R.O. Ritchie, **D.H. Alsem**, C.L. Muhlstein and E.A. Stach, *Very High Cycle Fatigue*, T. Sakai and Y. Ochi, eds., *Society of Materials Science, Japan, 2004.*

C3. *Quantitative Characterization Of Morphological Evolution In Q = 2 Potts Model Aluminum Thin Films*, **D.H. Alsem**, E.A. Stach and J.Th.M. de Hosson, *Materials Research Society Fall Meeting Proceedings (W12.1), Boston, MA, December 2002.*

C2. *Magnetic structures of nano-crystalline FeZr(N) films*, T. Vystavel, **D.H. Alsem**, N.G. Chechenin, A.R. Chezan and J.Th.M. De Hosson, *15th International Congress on Electron Microscopy (ICEM 15) Vol. 1: Physics and Materials (313 - 315), Durban, South Africa, September 2002.*

C1. *Characterisation Of Magnetic Ripple Structures With Lorentz Microscopy*, **D.H. Alsem**, T. Vystavel, N.G. Chechenin and J.Th.M. de Hosson, *Proceedings of the Dutch Microscopy Society Fall Meeting, December 13th – 14th 2001, Papendal, The Netherlands, Editor: H.K. Koerten.*

Presentations:

Invited oral conference presentations

I2. *Correlating Mechanical Properties And Microstructure In Structural Thin Films,* **D.H. Alsem**, *International MEMS Workshop at SEMICON West 2008, San Francisco, CA, July 2008.*

I1. *High-Cycle Fatigue Of Micron-Scale Silicon Structural Films For MEMS Applications,* **D.H. Alsem**, B.L Boyce, E.A. Stach and R.O. Ritchie, *MicroNanoReliability 2007, Berlin, Germany, September 2007, (Plenary presentation).*

Oral conference presentations

O15. *Effect Of Sidewall Morphology On The Fracture And Fatigue Properties Of Polysilicon Structural Films,* **D.H. Alsem**, B.L. Boyce, E.A. Stach and R.O. Ritchie, *12th International Conference on Fracture (ICF 12), Ottawa, Ontario, Canada, July 2009.*

O14. *Nanotribology Of Sidewall Contact Interfaces of Polycrystalline Silicon Microdevices Operated In High Vacuum,* **D.H. Alsem,** H. Xiang, K. Komvopoulos and R.O. Ritchie, *Materials Research Society Spring Meeting, San Francisco, CA, April 2009.*

O13. *On The Use Of Analytical Transmission Electron Microscopy To Discern The Role Of Microstructure In Influencing The Physical Mechanisms Of Fatigue And Wear In Micron-Scale Polysilicon,* **D.H. Alsem**, E.A. Stach and R.O. Ritchie, *Materials Research Society Spring Meeting, San Francisco, CA, April 2009.*

O12. *Nano-Scale Tribology Of Polycrystalline Silicon Structural Films In Ambient Air,* **D.H. Alsem**, R. van der Hulst, E.A. Stach, M.T. Dugger, J.Th.M. de Hosson and R.O. Ritchie, *2009 TMS annual meeting, San Francisco, CA, February 2009.*

O11. *Tribological Behavior Of Micron-Scale Polycrystalline Silicon Films In Ambient Air,* **D.H. Alsem**, R. van der Hulst, E.A. Stach, M.T. Dugger, J.Th.M. de Hosson and R.O. Ritchie, *SPIE MOEMS-MEMS: Micro- and Nanofabrication - Reliability, Packaging, Testing, and Characterization of MEMS/MOEMS and Nanodevices VIII, San Jose, CA, January 2009.*

O10. *Effect Of Sidewall Morphology On The Fracture And Fatigue Properties Of Micron-Scale Polycrystalline Silicon,* **D.H. Alsem**, B.L. Boyce, E.A. Stach and R.O. Ritchie, *Materials Research Society Fall Meeting, Boston, MA, December 2008.*

O9. *Nano-Scale Tribological Behavior Of Polycrystalline Silicon Structural Films In Ambient Air,* **D.H. Alsem**, R. van der Hulst, E.A. Stach, M.T. Dugger, J.Th.M. de Hosson and R.O. Ritchie, *Materials Research Society Spring Meeting, San Francisco, CA, March 2008.*

O8. *Nano-Scale Tribology Of Polycrystalline Silicon Structural Films,* **D.H. Alsem**, E.A. Stach, M.T. Dugger and R.O. Ritchie, *Workshop on In-Situ Methods in Nanomechanics, Lawrence Berkeley National Laboratory, Berkeley, CA, August 2007.*

O7. *Nano-Scale Wear Mechanisms in Polysilicon for MEMS Applications,* **D.H. Alsem**, E.A. Stach, M.T. Dugger and R.O. Ritchie, *Materials Research Society Spring Meeting, San Francisco, CA, April 2007.*

O6. *Wear And Fatigue In Silicon Structural Films For MEMS Applications,* **D.H. Alsem**, R. Timmerman, E.A. Stach, M.T. Dugger and R.O. Ritchie, *European Conference of Fracture (ECF 16), Alexandroupolis, Greece, July 2006.*

O5. *Fatigue In Polycrystalline Silicon Structural Films - Influence Of Initial Oxide Thickness,* **D.H.Alsem**, R. Timmerman, E.A. Stach, B.L. Boyce, J.Th.M. De Hosson and R.O. Ritchie, *Materials Research Society Spring Meeting, San Francisco, CA, April 2006.*

O4. *Sliding Wear In Polysilicon Microelectromechanical Systems,* **D.H.Alsem**, E.A. Stach, C.L. Muhlstein, M. Enachescu and R.O. Ritchie, *Materials Research Society Spring Meeting, San Francisco, CA, March 2005.*

O3. *An Electron Microscopy Study Of Wear In Polysilicon Microelectromechanical Systems,* **D.H. Alsem**, E.A. Stach, M.T. Dugger, M. Enachescu and R.O. Ritchie, *2005 TMS annual meeting, San Francisco, CA, February 2005.*

O2. *Utilizing On-Chip Testing And Electron Microscopy To Obtain A Mechanistic Understanding Of Fatigue And Wear In Polysilicon Structural Films,* **D.H. Alsem**, E.A. Stach, C.L. Muhlstein, M.T. Dugger and R.O. Ritchie, *Materials Research Society Spring Meeting, San Francisco, CA, April 2004.*

O1. *Combining Micromechanical Testing And Electron Microscopy To Obtain A Mechanistic Understanding Of Fatigue And Wear In Microelectromechanical Systems,* **D.H. Alsem**, E.A. Stach, C.L. Muhlstein, M.T. Dugger and R.O. Ritchie, *Deformation and Stresses in Small Volumes, 2004 TMS Annual Meeting, Charlotte, NC, March 2004.*

Contributed oral conference presentations

CO13. *Nature-Inspired Design Of Highly Toughened Materials,* M.E. Launey, E. Munch , **D.H. Alsem**, E. Saiz, A.P. Tomsia and R. O. Ritchie, *Materials Research Society Spring Meeting, San Francisco, CA, April 2009.*

CO12. *Nature-Inspired Structural Materials,* R.O. Ritchie, E. Munch, M.E. Launey, **D.H Alsem**, E. Saiz and A.P Tomsia, *Materials Research Society Fall Meeting, Boston, MA, December 2008, (Invited talk).*

CO11. *Nature-Inspired Hybrid Structural Materials,* R.O. Ritchie, **D.H. Alsem**, M. Launey, E. Munch, E. Saiz, and A.P. Tomsia, *7th International Workshops on Interfaces, R.M. Cannon Memorial Workshop, New Materials via Interfacial Control, Santiago, Spain, June 2008, (Invited talk).*

CO10. *Nature-Inspired Hybrid Structural Materials,* **D.H. Alsem**, M. Launey, E. Munch, E. Saiz, A.P. Tomsia and R.O. Ritchie, *Materials Research Society Spring Meeting, San Francisco, CA, March 2008, (Invited talk).*

CO9. *Further Considerations On The Mechanisms For Fatigue Failure In Micron-Scale Silicon Structural Films,* R.O. Ritchie, **D.H. Alsem** and E.A. Stach, *Materials Science & Technology 2007 Conference, Detroit, MI, September 16-20 2007, (Invited talk).*

CO8. *An Assessment Of Very High Cycle Fatigue Failure In Micron-Scale Polycrystalline Silicon For MEMS,* R.O. Ritchie and **D.H. Alsem**, *Fourth International Very High Cycle Fatigue Conference (VHCF-4), Ann Arbor, MI, August 19-22 2007, (Invited talk).*

CO7. *A Comprehensive Assessment Of Fatigue Failure In Micron-Scale Silicon Structural Films For MEMS,* R.O. Ritchie, **D.H. Alsem**, *International Workshop on Micromaterials, Tokyo, Japan, November 6 2006, (Invited talk).*

CO6. *A Mechanistic Understanding Of Fatigue In Polysilicon Structural Films*, R.O. Ritchie, **D.H. Alsem**, E.A. Stach and C.L. Muhlstein, *2005 TMS annual meeting, San Francisco, CA, 2005, (Invited talk).*

CO5. *Very High-Cycle Fatigue Of Micron-Scale Polysilicon Films For MEMS,* R.O. Ritchie, **D.H. Alsem**, C.L. Muhlstein and E.A. Stach, *International Conference on Very High Cycle Fatigue (VHCF-3), Japan, 2004, (Invited talk).*

CO4. *Using The Electron Microscope To Explore Reliability In Microelectromechanical Systems And Nanostructured Materials,* E.A. Stach, V. Gopal, M. Jin, **D.H. Alsem**, M.J. Williamson, A. Minor, V. Radmilovic, C.L Muhlstein, J.W. Morris, Jr., and R.O. Ritchie, *Microscopy and Microanalysis 2004, Savannah, GA, August 2004, (Invited talk).*

CO3. *Magnetic Structure Of Nanocrystalline Of FeZr(N) Films,* T. Vystavel, **D.H. Alsem**, N.G. Chechenin, A.R. Chezan, *The 15th International Congress on Electron Microscopy (ICEM 15), Durban, South Africa, September 2002.*

CO2. *Characterisation Of Magnetic Properties With Lorentz Microscopy And Electron Holography: A Novel Approach*, J.Th.M. de Hosson, **D.H. Alsem**, T. Vystavel, N.G. Chechenin, *6th International Conference on Nanostructured Materials (Nano 2002), Orlando, FL, USA, June 2002.*

CO1. *Relation between Observed Micromagnetic Ripple and FMR Width in Ultrasoft Magnetic Films*, N.G. Chechenin, A.R. Chezan, C.B. Craus, T. Vystavel, **D.H. Alsem**, D.O. Boerma, J.Th.M. de Hosson and L. Niesen, *Intermag Europe 2002, IEEE International Magnetics Conference, Amsterdam, The Netherlands, April/May 2002.*

Poster presentations

P4. *Using Electron Microscopy To Correlate Mechanical Behavior And Microstructure Of Micron-Scale Polysilicon*, **D.H. Alsem**, E.A. Stach and R.O. Ritchie, *Molecular Foundry and National Center for Electron Microscopy Users' Meeting 2008, Berkeley, CA, November 2008.*

P3. *Nature Inspired Model Hybrid Composites*, E. Munch, M.E. Launey, **D.H. Alsem**, U.G. K. Wegst, E. Saiz, A.P. Tomsia and R.O. Ritchie, *7th International Workshops on Interfaces, R.M. Cannon Memorial Workshop, New Materials via Interfacial Control, Santiago de Compostela, Spain, June 2008.*

P2. *Quantitative Characterization Of Morphological Evolution In Q = 2 Potts Model Aluminum Thin Films*, **D.H. Alsem**, E.A. Stach and J. Th. M. De Hosson, *Materials Research Society Fall Meeting, Boston, MA, December 2002.*

P1. *Characterisation of Magnetic Ripple Structures With Lorentz Microscopy*, **D.H. Alsem**, T. Vystavel, N.G. Chechenin, J.Th.M. de Hosson, *Dutch Microscopy Society Fall Meeting, Papendal, The Netherlands, December 2001*.

Seminars

S8. *Fracture, Fatigue And Microstructure Of "New" Ceramic Structural Materials,* Department of Applied Physics, University of Groningen, De Hosson Group Meeting, Groningen, The Netherlands, *January 2009*.

S7. *Using The Electron Microscope To Correlate Mechanical Properties And Microstructure In Micron- And Nano-Scale Systems,* Center for Nanoscale Science and Technology, National Institute of Standards and Technology, Gaithersburg MD, *August 2008.*

S6. *Nano And Micro-Machines,* Lawrence Hall of Science, University of California at Berkeley, Nanotechnology Teacher Workshop, Berkeley CA, *June 2008.*

S5. *Correlating Mechanical Properties And Microstructure In Micron- And Nano-Scale Systems,* Department of Materials Science and Engineering, University of Pennsylvania, Philadelphia PA, *February 2008*.

S4. *Fatigue Of Micron-Scale Polycrystalline Silicon Structural Films,* Department of Mechanical Engineering, University of California at Berkeley, Komvopoulos Group Meeting, Berkeley CA, *February 2007*.

S3. *A Mechanistic Understanding Of Wear And Fatigue In Polysilicon Structural Films,* Department of Chemical Engineering, University of California at Berkeley, Maboudian Group Meeting, Berkeley CA, *June 2005*.

S2. *A Mechanistic Understanding Of Fatigue And Wear In Polysilicon Structural Films - Utilizing On-Chip Testing And Electron Microscopy,* University of Groningen, De Hosson Group Meeting, Groningen, The Netherlands, *January 2005*.

S1. *Combining On-Chip Testing And Electron Microscopy To Obtain A Mechanistic Understanding Of Fatigue And Wear In Microelectromechanical Systems*, Lawrence Berkeley National Laboratory, National Center for Electron Microscopy Seminar, Berkeley CA, *October 2003*.