

BRIAN D. JENSEN

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Research Interests

Contact resistance of MEMS devices, including nanometer-scale tribology
Design and fabrication of MEMS
Multi-domain modeling of MEMS
Design of compliant mechanisms, especially bistable mechanisms

Education

Ph.D., University of Michigan, *Mechanical Engineering*, December 2004.

Dissertation: *Multi-Physics Modeling and Experimental Investigation of Low-Force MEMS Switch Contact Behavior*

Chair: Katsuo Kurabayashi.

M.S., University of Michigan, *Electrical Engineering*, Aug. 2004.

Emphasis in electromagnetic engineering. GPA 8.9/9.0

Advisor: John L. Volakis.

M.S., Brigham Young University, *Mechanical Engineering*, Aug. 1998.

Thesis: *Identification of Macro- and Micro-Compliant Mechanism Configurations Resulting in Bistable Behavior*. GPA 3.98/4.0

Chair: Larry L. Howell.

B.S., Brigham Young University, *Mechanical Engineering*, Aug. 1996.

Graduation Summa Cum Laude, Minor in Mathematics. GPA 3.98/4.0

Professional Experience

Assistant Professor, Jan. 2005–Present

Brigham Young University, Provo, UT

Teaching and research in the Mechanical Engineering Department. Focus on microscale contacts.

Postdoctoral Fellow, Oct. 2004–Dec. 2004

University of Michigan, Ann Arbor, MI

Research in adhesion of MEMS switch contacts and nanometer-scale modeling of insulating films covering the contact surfaces.

Research Assistant, June 2000–Oct. 2004

University of Michigan, Ann Arbor, MI

Research in tunable micro-resonators and reliability modeling and testing of RF MEMS switches, with focus on factors affecting contact resistance and contact adhesion.

Graduate Student Instructor, Sept. 2003–Dec. 2003

University of Michigan, Ann Arbor, MI

Taught about 90 undergraduates in mechanism and machine design. Scored 4.77/5.0 (median) in student evaluations for “instructor was an excellent teacher.”

Graduate Student Instructor, Jan. 2001–April 2001

University of Michigan, Ann Arbor, MI

Taught a graduate course on micro-electro-mechanical systems.

Micro-Mechanical Designer, May 1998–Aug. 1999

Sandia National Laboratories, Albuquerque, NM

Created novel MEMS designs for self-assembling pop-up mirrors, micro-tensile test systems, and tunable micro-resonators. Developed high-precision technique for measuring mechanical properties of micro-mechanical materials.

Research Assistant, Sept. 1996–May 1998

Brigham Young University, Provo, UT

Design of compliant bistable macro- and micro-mechanisms.

Honors and Awards

Second Place Nationally, ASME Graduate Mechanism Design Contest, Oct. 2002. Project title “A Fully-Compliant Bistable Micro-Mechanism”

National Defense Science and Engineering Graduate Fellowship, 2002. Tuition and stipend support for three years.

Dwight F. Benton Fellowship, College of Engineering, University of Michigan, Sept. 1999.

Horace H. Rackham Dean’s Fellowship, University of Michigan, Sept. 1999.

Third Place Nationally, ASME Graduate Mechanism Design Contest, Sept. 1998. Project title “The Design and Fabrication of a Bistable Micro-Mechanism.”

Design of Significant Merit Award, Eaton Mechanism Design Contest, 1997.

National Science Foundation Graduate Research Fellowship, 1997. Tuition and stipend support for three years.

Trustee Scholarship, Brigham Young University, 1989. Four-year, full-tuition scholarship.

Publications

Manuscripts in Archival Journals

B. D. Jensen, K. Huang, L. W. Chow, and K. Kurabayashi, "Adhesion effects on contact opening dynamics in micromachined switches," *J. Applied Physics*, vol. 97, 103536, 2005.

B. D. Jensen, K. Huang, L. W. Chow, and K. Kurabayashi, "Low-force contact heating and softening using micromechanical switches in diffusive-ballistic electron transport transition," *Appl. Phys. Lett.*, vol. 86, 023507, 2005.

B. D. Jensen and L. L. Howell, "Bistable configurations of compliant mechanisms modeled using four links and translational joints," *J. Mechanical Design*, vol. 126, no. 4, pp. 657–666, 2004.

B. D. Jensen and L. L. Howell, "Identification of compliant pseudo-rigid-body mechanism configurations resulting in bistable behavior," *J. Mechanical Design*, vol. 125, no. 4, pp. 701–708, 2003.

B. D. Jensen, K. Saitou, J. Volakis, and K. Kurabayashi, "Fully integrated electrothermal multidomain modeling of RF MEMS switches," *IEEE Microwave Wireless Compon. Lett.*, vol. 13, no. 9, pp. 364–366, Sept. 2003.

B. D. Jensen, S. Mutlu, S. Miller, K. Kurabayashi, and J. J. Allen, "Shaped comb fingers for tailored electro-mechanical restoring force," *J. Microelectromech. Syst.*, vol. 12, no. 3, pp. 373–383, June 2003.

B. D. Jensen and L. L. Howell, "The modeling of cross-axis flexural pivots," *Mechanism and Machine Theory*, vol. 37, no. 5, pp. 461–476, 2002.

B. D. Jensen, M. P. de Boer, N. D. Masters, F. Bitsie, and D. A. LaVan, "Interferometry of actuated microcantilevers to determine material properties and test structure nonidealities in MEMS," *J. Microelectromech. Syst.*, vol. 10, no. 3, pp. 336–346, Sept. 2001.

B. T. Edwards, B. D. Jensen, and L. L. Howell, "A pseudo-rigid-body model for initially-curved pinned-pinned segments used in compliant mechanisms," *J. Mechanical Design*, vol. 123, no. 3, pp. 464–468, 2001.

B. D. Jensen, L. L. Howell, and L. G. Salmon, "Design of two-link, in-plane, bistable compliant micro-mechanisms," *J. Mechanical Design*, vol. 121, no. 3, pp. 416–423, 1999.

S. C. Bromley, L. L. Howell, and B. D. Jensen, "Determination of maximum allowable strain for polysilicon micro devices," *Engineering Failure Analysis*, vol. 6, no. 1, pp. 27–41, 1999.

Manuscripts In Review for Archival Journals

B. D. Jensen, L.-W. Chow, K. Huang, K. Saitou, J. L. Volakis, and K. Kurabayashi, "Contact heating for control of contact resistance in RF MEMS switches," *J. Microelectromech. Syst.*, accepted for publication.

Z. Wang, B. Jensen, J. Volakis, K. Saitou, and K. Kurabayashi, "An efficient preconditioner (LESP) for hybrid matrices arising in RF MEMS switch analysis," *IEEE Trans. Antennas Propagation*, submitted for publication.

Manuscripts in Edited Books

N. D. Masters, M. P. de Boer, B. D. Jensen, M. S. Baker, and D. Koester, "Side-by-side comparison of passive MEMS residual strain test structures under residual compression," in *Mechanical Properties of Structural Films, ASTM STP 1413*, S. B. Brown and C. L. Muhlstein, Eds. American Society for Testing and Materials, 2001.

Manuscripts in Peer-Reviewed Conference Proceedings

B. D. Jensen, K. Saitou, J. Volakis, and K. Kurabayashi, "Impact of skin effect on thermal behavior of RF MEMS switches," in *Proc. 6th ASME/JSME Thermal Engineering Joint Conference*, Paper No. TED-AJ03-420, March 2003.

M. Parkinson, B. D. Jensen, and K. Kurabayashi, "Design of compliant force and displacement amplification micro-mechanisms," in *Proc. ASME 2001 Design Engineering Technical Conferences*, 2001, paper DETC2001/DAC-21089.

B. D. Jensen and L. L. Howell, "Identification of compliant pseudo-rigid-body mechanism configurations resulting in bistable behavior," in *Proc. ASME 2000 Design Engineering Technical Conferences*, 2000, paper DETC2000/MECH-14147.

M. Parkinson, B. D. Jensen, and G. M. Roach, "Optimization-based design of a fully-compliant bistable micromechanism," in *Proc. ASME 2000 Design Engineering Technical Conferences*, 2000, paper DETC2000/MECH-14119.

B. T. Edwards, B. D. Jensen, and L. L. Howell, "A pseudo-rigid-body model for functionally-binary pinned-pinned segments used in compliant mechanisms," in *Proc. 1999 ASME Design Engineering Technical Conferences*, 1999, paper DETC99/DAC-8644.

P. G. Opdahl, B. D. Jensen, and L. L. Howell, "An investigation into compliant bistable mechanisms," in *Proc. 1998 ASME Design Engineering Technical Conferences*, Atlanta, GA, 1998, paper DETC98/MECH-5914.

B. D. Jensen, L. L. Howell, and L. G. Salmon, "Introduction of two-link, in-plane bistable compliant MEMS," in *Proc. 1998 ASME Design Engineering Technical Conferences*, 1998, paper DETC98/MECH-5837.

B. D. Jensen, L. L. Howell, D. B. Gunyan, and L. G. Salmon, "The design and analysis of compliant MEMS using the pseudo-rigid-body model," in *Microelectromechanical Systems (MEMS) 1997*. Dallas, TX: 1997 ASME International Mechanical Engineering Congress and Exposition, Nov. 1997, pp. 119–126.

Manuscripts in Panel or Committee-Reviewed Conference Proceedings

B. D. Jensen, L. L.-W. Chow, J. L. Volakis, and K. Kurabayashi, "Adhesion effects on contact opening time in MEMS switches," in *Proc. ASME/STLE Int. Joint Tribology Conf.*, paper TRIB2004-64350, 2004.

Z. Wang, B. Jensen, L. Chow, J. Volakis, K. Saitou, and K. Kurabayashi, "Effects of dimple geometry on RF MEMS switch heating," in *ANTEM 2004/URSI Conf.*, July 2004.

B. D. Jensen, K. Huang, L. W. Chow, K. Saitou, J. L. Volakis, and K. Kurabayashi, "Asperity heating for repair of metal contact RF MEMS switches," in *2004 IEEE MTT-S International Microwave Symposium Digest*, paper THIF-28, 2004.

Z. Wang, B. Jensen, J. Volakis, K. Saitou, and K. Kurabayashi, "A preconditioner for hybrid matrices arising in RF MEMS switch analysis," in *2004 IEEE Antennas and Propagation Society Int. Symp.*, vol. 3, June 2004.

B. D. Jensen, L. W. Chow, R. F. Webbink, K. Saitou, J. L. Volakis, and K. Kurabayashi, "Force dependence of RF MEMS switch contact heating," in *Proc. 2004 17th IEEE Int. Conf. Micro Electro Mech. Systems*, 2004, pp. 137–140.

B. D. Jensen, Z. Wang, K. Saitou, J. L. Volakis, and K. Kurabayashi, "Simultaneous electrical and thermal modeling of a contact-type RF MEMS switch," in *Microelectromechanical Systems*. 2003 ASME Int. Mechanical Engineering Congress and Exposition, 2003, paper IMECE2003-41422.

B. D. Jensen, Z. Wang, L. Chow, K. Saitou, K. Kurabayashi, and J. L. Volakis, "Integrated electrothermal modeling of RF MEMS switches for improved power handling capability," in *IEEE Topical Conf. Wireless Communication Tech.*, Oct. 2003, pp. 10–11.

Z. Wang, B. D. Jensen, J. L. Volakis, K. Saitou, and K. Kurabayashi, "Analysis of RF-MEMS switches using finite element-boundary integration with moment method," in *2003 IEEE Antennas and Propagation Society International Symposium*, vol. 2, 2003, pp. 173–176.

B. D. Jensen, M. B. Parkinson, K. Kurabayashi, L. L. Howell, and M. S. Baker, "Design optimization of a fully-compliant bistable micro-mechanism," in *Microelectromechanical Systems (MEMS)*. 2001 ASME Int. Mechanical Engineering Congress and Exposition, 2001, paper IMECE2001/MEMS-23852.

B. D. Jensen, S. Mutlu, S. Miller, K. Kurabayashi, and J. J. Allen, "Design and simulation of shaped comb fingers for compensation of mechanical restoring force in tunable resonators," in *Microelectromechanical Systems (MEMS)*. 2001 ASME Int. Mechanical Engineering Congress and Exposition, 2001, paper IMECE2001/MEMS-23826.

M. S. Rodgers, S. Kota, J. Hetrick, Z. Li, B. D. Jensen, T. W. Krygowski, S. Miller, S. M. Barnes, and M. S. Burg, "A new class of high-force, low-voltage compliant actuation systems," in *Hilton Head Workshop 2000*, 2000.

M. S. Rodgers, J. J. Allen, B. D. Jensen, S. L. Miller, and K. S. Meeks, "Microelectromechanical high-density energy storage/rapid release system," in *Proc. 1999 Micromachined Devices and Components V*. Santa Clara, CA: SPIE Vol. 3876, Sept. 1999, pp. 212–222.

M. P. de Boer, B. D. Jensen, and F. Bitsie, “A small area in-situ MEMS test structure to measure fracture strength by electrostatic probing,” in *Proc. 1999 Materials Device Characterization in Micromachining II*. Santa Clara, CA: SPIE Vol. 3875, Sept. 1999, pp. 97–103.

B. D. Jensen, F. Bitsie, and M. P. de Boer, “Interferometric measurement for improved understanding of boundary effects in micromachined beams,” in *Proc. 1999 Materials Device Characterization in Micromachining II*. Santa Clara, CA: SPIE Vol. 3875, Sept. 1999, pp. 61–72.

B. D. Jensen, M. P. de Boer, and S. L. Miller, “IMaP: Interferometry for material properties in MEMS,” in *Tech. Proc. Second Int. Conf. Modeling and Simulation of Microsystems*, San Juan, Puerto Rico, April 1999, pp. 206–209.

Patents

Patents Granted

“High-Performance Fully-Compliant Micro-Mechanisms for Force/Displacement Amplification,” Jensen, B. D., Farina, M., and Kurabayashi, K., U.S. Patent #6,748,818, issued June 15, 2004.

“Method and System for Automated On-Chip Material and Structural Certification of MEMS Devices,” Sinclair, M. B., de Boer, M. P., Smith, N. F., Jensen, B. D., and Miller, S. L., U.S. Patent #6,567,715, issued May 20, 2003.

“Electrostatic Apparatus for Measurement of Microfracture Strength,” de Boer, M. P., Bitsie, F., and Jensen, B. D., U.S. Patent #6,424,165, issued July 23, 2002.

“Microelectromechanical Ratcheting Apparatus,” Barnes, S. M., Miller, S. L., Jensen, B. D., Rodgers, M. S., and Burg, M. S., U.S. Patent #6,313,562, issued November 6, 2001.

“Bistable Compliant Mechanism,” Jensen, B. D., Howell, L. L., and Roach, G. M., U.S. Patent #6,215,081, issued April 20, 2001.

“Compact Electrostatic Comb Actuator,” Rodgers, M. S., Burg, M. S., Jensen, B. D., Miller, S. L., and Barnes, S. M., U.S. Patent #6,133,670, issued Oct. 17, 2000.

Patents Pending

“Compliant Apparatus and Method,” Jensen, B. D., Parkinson, M. B., Roach, G. M., Howell, L. L., U.S. Patent Pending.

Memberships

ASME International

IEEE

Tau Beta Pi

Service

Mechanical Engineering representative for the University of Michigan Graduate Student Forum, a graduate student organization that works to improve the educational experience of graduate students at the university, Sept. 2002–April 2004..

Secretary of University of Michigan Family Housing Residents' Council, a community forum representing the interests of residents, May 2002–Aug. 2004.

President of Family Housing Residents' Council, May 2000–May 2002.

Missionary, South Africa Johannesburg Mission, for the Church of Jesus Christ of Latter-day Saints, 1991–1993.

References

Dr. Katsuo Kurabayashi. Assistant Professor, Dept. of Mechanical Engineering, University of Michigan. 2250 GG Brown Lab, 2350 Hayward St., Ann Arbor, MI 48109-2125. (734) 615-5211. katsuo@umich.edu.

Dr. Larry L. Howell Associate Professor, Dept. of Mechanical Engineering, Brigham Young University, 435 CTB, Brigham Young University, Provo, UT 84602. (801)378-8037. lhowell.et.byu.edu.

Dr. Maarten P. de Boer. Principal Member of Technical Staff, Sandia National Laboratories, MS 1080, P.O. Box 5800, Albuquerque, NM 87185-1808. (505)844-2991. mpdebo@sandia.gov.

Dr. Samuel L. Miller. Principal Member of Technical Staff, Sandia National Laboratories, MS 1217, P.O. Box 5800, Albuquerque, NM 87185-1808. (505)844-3001. millersl@sandia.gov.