

# Henry Angelo Sodano, Ph.D.

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## EDUCATION

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- Ph.D.** May 2005 in Mechanical Engineering, Virginia Polytechnic Institute and State University (Virginia Tech), Advisor Dr. Daniel J. Inman  
Dissertation Title: *Development of Novel Eddy Current Damping Mechanisms for the Suppression of Structural Vibrations*
- M.S.** July 2003 in Mechanical Engineering, Virginia Polytechnic Institute and State University (Virginia Tech), Advisor Dr. Daniel J. Inman  
Thesis Title: *Macro-Fiber Composites for Sensing, Actuation and Power Generation*
- B.S.** May 2002 in Mechanical Engineering, Virginia Polytechnic Institute and State University (Virginia Tech)  
Passed Fundamentals of Engineering Exam (EIT), October 2001

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## PUBLICATIONS AND PATENTS

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- 2 published book chapters, 24 refereed journal papers published or submitted and 29 conference papers – *See list of publications for references*
- Three patent disclosures for work in power harvesting and chemical sensors
- Most downloaded paper published in the Journal of Intelligent Materials Systems and Structures in 2006

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## PROFESSIONAL EMPLOYMENT

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**Assistant Professor** – Department of Mechanical Engineering – Engineering Mechanics, *Michigan Technological University*, Houghton, MI, August 2005 – Present

**Research Scientist** – *Center for Intelligent Material Systems and Structures, Virginia Tech*, Blacksburg, VA, May 2005 – August 2005

**Graduate Research Assistant** – *Center for Intelligent Material Systems and Structures, Virginia Tech*, Blacksburg, VA, August 2002 – May 2005

**Undergraduate Student Intern** - *Center for Intelligent material Systems and Structures, Virginia Tech*, Blacksburg, VA, May 2002 – August 2002

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## PROFESSIONAL AWARDS AND SERVICE ACTIVITIES

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- Professional Awards
  - Selected to participate in the 2007 Air Vehicles Directorate Summer Faculty Program with Dr. Brian Sanders

- Los Alamos National Lab Directors Funded Post Doc, 2005 (Not Accepted to teach at MTU)
- NASA Graduate Student Researcher Program Fellowship, 2003-2005
- Paul E. Torgersen Research Excellence Poster Award, 2005
- Paul E. Torgersen Research Excellence Award, 2004
- Conference Activities
  - Co-Organizer Symposium on Micro/Nano Vibration-based Sensors and Energy Scavengers, ASME International Design Engineering Technical Conference, IDETC 2007
  - Session Chair
    - o 2005 & 2006 SPIE's International Conference on Smart Structures and Materials
    - o 2005 & 2006 SEM's Annual International Modal Analysis Conference
- Manuscript Reviewer for the following Journals:  
Journal of Intelligent Materials Systems and Structures, Smart Materials and Systems, ASME Journal of Vibration and Acoustics, ASME Journal of Dynamic Systems, Measurement and Control, Mechanical Systems and Signal Processing, Journal of Sound and Vibration, Shock and Vibration Digest, Journal of Infrastructure Systems, and International Journal of Structural Health Monitoring.
- Technical Committees
  - Adaptive Structures Technical Committee (Member)
- Professional Societies
  - American Society of Mechanical Engineers (ASME)
  - American Institute of Aeronautics and Astronautics (AIAA)
  - Society for Experimental Mechanics (SEM)
- Short Courses and Workshops
  - Invitee and participant in the Los Alamos National Laboratory 2005 power harvesting workshop

## TEACHING EXPERIENCE

Taught the following course at Michigan Tech

- MEEM 3700 – Mechanical Vibrations, Fall 2005, Spring 2006, and Spring 2006

Co-taught the following graduate course at Virginia Tech

- ME 5514 – Advanced Mechanical Vibrations, Spring 2005

## RESEARCH AND TEACHING INTERESTS

- **Research Interests**
  - Smart Structures
  - Structural Health Monitoring
  - Multifunctional Materials
  - Vibration Control
  - Energy Harvesting
  - Autonomous Structures
  - Biologically Inspired Systems
  - MEMS/NEMS Sensors

- **Teaching Interests**

- Mechanical Vibrations and Structural Dynamics
- Smart Materials and Adaptive Structures
- Dynamics
- Controls
- Signal Processing and Instrumentation
- Aerospace Structures

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## CURRENT RESEACH SUPPORT

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National Science Foundation, "Biologically Inspired Autonomic Structural Materials with Controlled Toughening and Healing," Aug. 2007 – July 2010, PI: Henry Sodano (Grant # CMMI-0700309).

State of Michigan – 21<sup>st</sup> Century Job Fund, "Optimizing Chemo-Mechanical Structure for MEMS Chemical Vapor Sensor Arrays," PI: Michele Miller, Nov. 2006 - Oct. 2009

NanoSonic Inc. (Phase 1 Navy STTR), "Harvesting Electric Power through an Instrumented PVDF Backpack Harness," Aug. 2006 – March 2007.

State of Michigan – Research Excellence Fund, "Multifunctional Piezoelectric Carbon Fibers," Aug. 2006 – July 2007, PI: Henry A Sodano

Honeywell Space Systems, "Active Thin Films for Antenna Applications," December 2003, PI: Daniel J. Inman, Co-PI: Henry Sodano and Eric J. Ruggiero

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## LIST OF PUBLICATIONS

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### Book Chapters:

1. Inman, D.J., Grisso, B.L. and Sodano, H.A., 2006, "Smart Structures in Structural Health Monitoring," *Mechanical Vibrations: Where do we stand?*, Springer, New York, USA.
2. Ruggiero, E., Sodano, H.A., Park, G. and Inman, D.J., 2002, "Active Vibration Suppression of a Gossamer Spacecraft," *Mechanics of Electromagnetic Material Systems and Structures*, WIT Press, South Hampton, UK, pp. 287-293.

### Journal Papers in Print:

1. Sodano, H.A., Simmers, G.E., Dereux, R., and Inman, D.J., 2007, "Recharging Batteries using Energy Harvested from Thermal Gradients," *Journal of Intelligent Material Systems and Structures*, Vol. 18, No. 1, pp. 3-10.
2. Simmers, G.E., Sodano, H.A., Park, G., and Inman, D.J., 2006, "Detection of Corrosion using Piezoelectric Impedance Based Structural Health Monitoring," *AIAA Journal*, Vol. 44, No. 11, pp 2800-2803.
3. Sodano, H.A., 2006, "Non-Contact Eddy Current Excitation Method for Vibration Testing," *Experimental Mechanics*, Vol. 46, No. 5, pp. 627-635.
4. Sodano, H.A., Lloyd, J. and Inman, D.J., 2006, "An Experimental Comparison between Several Active Composite Actuators for Power Generation," *Smart Materials and Structures*, Vol. 15, pp. 1211-1216.
5. Sodano, H.A., Inman, D.J., and Belvin, W.K., 2006, "Development of a New Passive-Active Magnetic Damper for Vibration Suppression," *ASME Journal of Vibration and Acoustics*, Vol. 128, pp. 318-327.

6. Sodano, H.A., Bae, J.S., Inman, D.J. and Belvin, W.K., 2006, "Improved Concept and Model of Eddy Current Damper," *ASME Journal of Vibration and Acoustics*, Vol. 128, pp. 295-302.
7. Sodano, H.A., Bae, J.S., Inman, D.J. and Belvin, W.K., 2006, "Modeling and Application of Passive Eddy Current Damper for the Suppression of Membrane Vibrations," *AIAA Journal*, Vol. 44, No. 3, pp 541-549.
8. Sodano, H.A., Bae, J.S., Inman, D.J. and Belvin, W.K., 2005, "Concept and Model of Eddy Current Damper for Vibration Suppression of a Beam," *Journal of Sound and Vibration*, Vol. 288, pp. 1177-1196.
9. Sodano, H.A., Park, G., and Inman, D.J., 2005, "Comparison of Piezoelectric Energy Harvesting Devices for Recharging Batteries," *Journal of Intelligent Material Systems and Structures*, Vol. 16, No. 10, pp. 799-807.
10. Sodano, H.A., Park, G. and Inman, D.J., 2005, "Multiple Sensors and Actuators for Vibration Suppression of an Inflated Torus," *AIAA Journal of Spacecraft and Rockets*, Vol. 42, No. 2.
11. Sodano, H.A., Park, G. and Inman, D.J., 2005, "Generation and Storage of Electricity from Power Harvesting Devices," *Journal of Intelligent Material Systems and Structures*, Vol. 16, No. 1, pp. 67-75.
12. Sodano, H.A., Park, G. and Inman, D.J., 2004, "Estimation of Electric Charge Output for Piezoelectric Energy Harvesting," *Journal of Strain*, Vol. 40, pp. 49-58.
13. Sodano, H.A. and Bae, J.S., 2004, "Eddy Current Damping in Structures," *Shock and Vibration Digest*, Vol. 36, No. 6, pp. 469-478.
14. Sodano, H.A., Park, G. and Inman, D.J., 2004, "A Review of Power Harvesting Using Piezoelectric Materials," *Shock and Vibration Digest*, Vol. 36, No. 3, pp. 197-206.
15. Sodano, H.A., Park, G. and Inman, D.J., 2003, "An Investigation into the Performance of Macro-Fiber Composites for Sensing and Structural Vibration Applications," *Mechanical Systems and Signal Processing*, Vol. 18, No. 3, pp. 683-697.

#### **Journal Papers in Press:**

16. Sodano, H.A., 2007, "Development of an Automated Eddy Current Structural Health Monitoring Technique with Extended Sensing Region," *International Journal of Structural Health Monitoring*, In Press.
17. Sodano, H.A. and Inman, D.J., 2007, "Closure: Improved Concept and Model of Eddy Current Damper," *ASME Journal of Vibration and Acoustics*, In Press.
18. Sodano, H.A., and Inman, D.J., 2007, "Experimental Validation of a New Active Eddy Current Vibration Control System," *Journal of Sound and Vibration*, In Press.
19. Sodano, H.A. and Inman, D.J., 2007, "Modeling of a New Active Eddy Current Vibration Control System," *ASME Journal of Dynamic Systems, Measurement and Control*, In Press.

#### **Journal Papers in Review:**

20. Anton, S.R. and Sodano, H.A., 2007, "A Review of Power Harvesting Using Piezoelectric Materials (2003-2006)," *Smart Materials and Structures*, In Review.

21. Simmers, G.E., Sodano, H.A., Park, G. and Inman, D.J., 2007, "Thermal Protection for a Self-Sensing Piezoelectric Control System," *Smart Materials and Structures*, In Review.
22. Sodano H.A. and Cheah, S.-K., 2007, "Novel Eddy Current Damping Mechanism for Passive Magnetic Bearings," *Journal of Vibration and Control*, In Review.
23. Granstrom, J., Feenstra, J., Sodano, H.A. and Farinholt, K., 2007, Energy Harvesting from a Backpack Instrumented with Piezoelectric Shoulder Straps, *Smart Materials and Structures*, In Review.
24. Feenstra, J., Granstrom, J. and Sodano, H.A., 2007, Mechanically Amplified Piezoelectric Stack Actuators for Harvesting Electrical Energy from a Backpack," *Smart Materials and Structures*, In Review.

**Conference Papers Accepted by Peer Review:**

1. Feenstra, J., Granstrom, J. and Sodano, H.A., 2007 "Amplified Piezoelectric Stack Actuators for Harvesting Electrical Energy from a Backpack," Proceedings of the International Design Engineering Technical Conference, Sept. 4-7, Las Vegas, Nevada, USA.
2. Wells, L., Lin, Y., Sodano, H.A. and Youn, B., 2007, "Geometric Optimization of a Piezoelectric Power Harvesting Plate for Increased Bandwidth," Proceedings of the International Design Engineering Technical Conference, Sept. 4-7, Las Vegas, Nevada, USA.
3. Sodano, H.A. and Chaeh, S.K., 2007, "Novel Eddy Current Damping Mechanism for Passive Magnetic Bearings," Proceedings of the 46<sup>th</sup> AIAA/ASME/ASCE/AHS Structures, Structural Dynamics and Materials Conference (SDM), April 22-26<sup>th</sup>, Honolulu HI.
4. Sodano, H.A. and Kneeland, P., 2006, "Small Thermoelectric Energy Source using Various Fuels," Proceedings of 2006 ASME International Mechanical Engineering Congress and Exposition, November 5-10, Chicago, IL.
5. Sodano, H.A., Bae, J.S., Inman, D.J. and Belvin, W.K., 2005, "Model of Eddy Current Damper for the Suppression of Transverse Membrane Vibrations," Proceedings of the 46<sup>th</sup> AIAA/ASME/ASCE/AHS Structures, Structural Dynamics and Materials Conference (SDM), April 18-21<sup>st</sup>, Austin, TX.
6. Sodano, H.A., Bae, J.S., Inman, D.J. and Belvin, W.K., 2004, "Model of Eddy Current Damping mechanism for the Suppression of Beam Vibrations," Proceedings of ASME's International Mechanical Engineering Congress and Exposition, November 13-19<sup>th</sup>, Anaheim, CA.
7. Sodano, H.A., Park, G., Leo, D. and Inman, D.J., 2003, "Model of Piezoelectric Power Harvesting Beam," Proceedings of ASME's International Mechanical Engineering Congress and Exposition, November 16-21<sup>st</sup>, Washington D.C.
8. Sodano, H.A., Park, G. and Inman, D.J., 2003, "Vibration Testing and Control of an Inflatable Torus Using Multiple Sensors/actuators," Proceedings of the 44<sup>th</sup> AIAA/ASME/ASCE/AHS Structures, Structural Dynamics and Materials Conference (SDM), April 7-10<sup>th</sup>, Norfolk, VA, AIAA Paper 2003-1644.

**Conference Papers Accepted by Abstract:**

9. Sodano, H.A., Granstrom, J., Feenstra, J. and Farinholt, K., 2007, "Harvesting of Electrical Energy from an Backpack with a Piezoelectric Strap," SPIE's 13<sup>th</sup> annual International Symposium on Smart Structures and Materials, February 26<sup>th</sup> – March 2<sup>nd</sup>, San Diego, CA.

10. Van Karsen, C., Avitabile, P. Sodano, H., Blough, J. and Evensen, H., 2006 "Implimentation of Some Dynamic Systems Material into the Mechanical Engineering Curriculum," 2006 ASEE Annual Conference & Exposition, June 18-21, Chicago, IL.
11. Sodano, H.A. and Inman, D.J., 2006, "Experimental Validation of an Active Eddy Current Vibration Control Scheme," SPIE's 13<sup>th</sup> annual International Symposium on Smart Structures and Materials, February 26<sup>th</sup> – March 2<sup>nd</sup>, San Diego, CA.
12. Sodano, H.A. and Inman, D.J., 2006, "Model of an Active Eddy Current Vibration Control System," SPIE's 13<sup>th</sup> annual International Symposium on Smart Structures and Materials, February 26<sup>th</sup> – March 2<sup>nd</sup>, San Diego, CA.
13. Sodano, H.A., 2006, "New Non-Contact Excitation Method for Vibration Testing," Proceedings of the 24<sup>th</sup> annual International Modal Analysis Conference (IMAC), Jan. 30 - Feb. 2, St. Louis, MO.
14. Sodano, H.A., 2006, "Design of Automated Eddy Current Structural Health Monitoring Techniques with Extended Sensing Region," Proceedings of the 24<sup>th</sup> annual International Modal Analysis Conference (IMAC), Jan. 30 - Feb. 2, St. Louis, MO.
15. Simmers, G.E., Sodano, H.A., and Inman, D.J., 2005, "Self-Sensing Active Control in the Presence Temperature Changes," Proceeding of the 15<sup>th</sup> International Conference on Adaptive Structures and Technologies (ICAST), October 9-12th, Paris, France.
16. Sodano, H.A., Bae, J.S., Inman, D.J. and Belvin, W.K., 2005, "Passive-Active Eddy Current Damper," SPIE's 12<sup>th</sup> annual International Symposium on Smart Structures and Materials, March 7-10<sup>th</sup>, San Diego, CA.
17. Simmers, G.E., Sodano, H.A., Park, G., and Inman, D.J., 2005, "Impedance Based Corrosion Detection" SPIE's 12<sup>th</sup> annual International Symposium on Smart Structures and Materials, March 7-10<sup>th</sup>, San Diego, CA.
18. Sodano, H.A., Bae, J.S., Inman, D.J. and Belvin, W.K., 2005, "Improved Eddy Current Damping Model for Transverse Vibrations," Proceedings of the 23<sup>rd</sup> annual International Modal Analysis Conference (IMAC), Jan. 31 - Feb. 3, Orlando, FL.
19. Simmers, G.E., Sodano, H.A., Park, G., and Inman, D.J., 2005, "Impedance Based Structural Health Monitoring to Detect Corrosion," Proceedings of the 23<sup>rd</sup> annual International Modal Analysis Conference (IMAC), Jan. 31 - Feb. 3, Orlando, FL.
20. Inman, D.J., Sodano, H.A. and Park, G., 2004, "Piezoelectric Materials for Structures: A State of the Art and Future of Harvesting," The Air Force/Army/NSF Joint Workshop on Multifunctional Structures for Energy Harvesting & Storage, Dec., Palo Alto, CA.
21. Sodano, H.A., Dereux, R., Simmers, G.E. and Inman, D.J., 2004, Power Harvesting Using Thermal Gradients for Charging Batteries," Proceeding of the 15th International Conference on Adaptive Structures and Technologies (ICAST), October 25-27<sup>th</sup>, Bar Harbor, ME.
22. Sodano, H.A., Bae, J.S., Inman, D.J. and Belvin, W.K., 2004, "Improved Eddy Current Damping Mechanism for Transverse Vibrations," Proceeding of the 15th International Conference on adaptive Structures and Technologies (ICAST), October 25-27<sup>th</sup>, Bar Harbor, ME.
23. Sodano, H.A., Lloyd, J. and Inman, D.J., 2004, "An Experimental Comparison between Several Active Composite Actuators for Power Generation," SPIE's 11<sup>th</sup> annual International Symposium on Smart Structures and Materials, March 14-18<sup>th</sup>, San Diego, CA.

24. Salehian, A., Sodano, H. A., Cliff, E. M., Herdman, T.L., Burns, J. A. and Inman, D. J., 2004, "Slewing Issues in LSS/ISAT (Integration of Smart Materials)," presented in *NASA-LaRC*, Hampton, VA.
25. Sodano, H.A., Park, G., and Inman, D.J., 2004, "Review of Power Harvesting Advances and Applications," Proceedings of the 22<sup>st</sup> annual International Modal Analysis Conference (IMAC), January 26-29<sup>th</sup>, Dearborn, MI.
26. Sodano, H.A., Park, G., Leo, D.J. and Inman, D.J., 2003, "Use of Piezoelectric Energy Harvesting Devices for Charging Batteries," SPIE's 10<sup>th</sup> annual International Symposium on Smart Structures and Materials, March 2-6<sup>th</sup>, San Diego, CA.
27. Sodano, H.A., Magliula, E.A., Park, G. and Inman, D.J., 2002, "Electric Power Generation Using Piezoelectric Devices," Proceeding of the 13th International Conference on adaptive Structures and Technologies (ICAST), October 7-9<sup>th</sup>, Potsdam/Berlin, Germany.
28. Sodano, H.A., Peairs, D.M., Magliula, E.A., Park, G. and Inman, D.J., 2003, "The Use of Macro-Fiber Composites in Structural Vibration Applications," Proceeding of the 21<sup>st</sup> International Modal Analysis Conference (IMAC), February 3-6<sup>th</sup>, Kissimmee, FL.
29. Ruggiero, E., Sodano, H.A., Park, G. and Inman, D.J., 2002, "Active Vibration Suppression of a Gossamer Spacecraft," Proceedings of the 14th U.S. National Congress of Theoretical and Applied Mechanics, Blacksburg, VA.

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## INVITED LECTURES AND PRESENTATIONS

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1. Sodano, H.A., 2007, "Multifunctional Materials for Enhanced Safety and Performance of Mechanical Systems, Department of Mechanical and Aerospace Engineering, Arizona State University, Tempe, AZ.
2. Sodano, H.A., 2006, "Harvesting of Ambient Energy for the Development of Self-Power Sensors, Department of Mechanical Engineering, Virginia Tech, Blacksburg, VA.
3. Sodano, H.A., 2005, "Development of Eddy Current Damping Mechanisms for the Suppression of Structural Vibrations" Department of Aerospace Engineering, University of Colorado, Boulder, CO.
4. Sodano, H.A., 2005, "Development of Eddy Current Damping Mechanisms for the Suppression of Structural Vibrations" Department of Mechanical Engineering – Engineering Mechanics, Michigan Technological University, Houghton, MI.

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## GRADUATE AND UNDERGRADUATE STUDENTS SUPERVISED

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### Current Students

- Yirong Lin, (August 2006 – Present) Ph.D. Student
- Jonathan Granstrom (August 2006 – Present) M.S. Student
- Joel Feenstra (August 2006 – Present) M.S. Student

### Graduated Student

- Sze Kwan Cheah (July 2006) M.S. in Mechanical Engineering, Michigan Tech, "Modeling and Application of an Eddy Current Damper for a Rotating System"

Undergraduate Research:

- Phil Kneeland (December 2004 – August 2006) B.S. from Michigan Tech
- Steve Anton (December 2004 – August 2006) B.S. from Michigan Tech
- Scott M. Heibel (May 2005 – August 2005) B.S. from Virginia Tech
- Hunter Moore (Jan. 2005 – May 2005) B.S. from Virginia Tech
- Justin Green (May 2004 – August 2004) B.S. from Virginia Tech
- Remi Dereux (Aug. 2004 – Jan. 2005) B.S. Institut Catholique d'Arts et Metiers, Toulouse, France
- Garnett E. Simmers (Sept. 2003 – Aug. 2004) B.S. from Virginia Tech
- Andrew Wallace (June – Aug. 2003) B.S. from Virginia Tech
- Richard Grudet (Aug-Dec. 2002) B.S. from Institut Catholique d'Arts et Metiers, France
- Philip Gabler (May – Aug. 2003) B.S. from Virginia Tech
- Elizabeth Magliula (May-Aug. 2002) B.S. from Cooper Union University, NY