

# SUHAS SOMNATH

## EDUCATION

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- Ph. D., Mechanical Engineering** July 2014  
University of Illinois at Urbana-Champaign Urbana, IL  
Dissertation: “Fundamentals of Heat Transfer and Thermal-Mechanical Control for Improved Atomic Force Microscopy”  
Advisor: Dr. William P. King
- M. S., Mechanical Engineering** May 2011  
University of Illinois at Urbana-Champaign Urbana, IL  
Dissertation: “Improved Nanotopography Sensing via Temperature Control of a Heated Atomic Force Microscope Cantilever”  
Advisor: Dr. William P. King
- B. S., Mechanical Engineering** July 2009  
Rutgers University, New-Brunswick Piscataway, NJ
- B. S., Computer Science** July 2009  
Rutgers University, New-Brunswick Piscataway, NJ

## RESEARCH EXPERIENCE

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- Postdoctoral Research Associate, Oak Ridge National Laboratory** Oct 2014 - Present  
Scanning Probe Microscopy Group, Center for Nanophase Materials Sciences
- Developing new experimental and analytical scanning probe microscopy techniques.
  - Patent pending – Developed a novel voltage spectroscopy technique that is 10,000x faster than current state-of-art techniques for improved spatial, voltage, and spectroscopic resolution in studying polarization switching behavior in ferroelectric materials.
  - Developing a cross-divisional software platform using high performance computing and storage resources at ORNL to bring together the data and expertise of experimentalists, theoreticians, and data scientists together to dramatically improve the quality and speed of materials research.
    - Developing instrumentation software to stream data from atomic force microscopes directly to supercomputers for analysis <https://www.youtube.com/channel/UCHb03ifYC5QdAisaBh67qJQ>
    - Developing software for analysis of scientific microscopy data that will be released to the open-source community soon (<https://pypi.python.org/pypi/pySPM> and <https://github.com/ssomnath/PySPM>)
  - Regularly teach and help fellow researchers and users in programming and instrumentation
- Graduate Research Assistant, University of Illinois,** Sep 2009 – Jul 2014  
Nanoengineering Lab, Mechanical Science & Engineering,
- Designed, microfabricated, and characterized cantilevers with integrated solid-state heater-thermometers.
  - Developed new thermal microscopy and lithography techniques for thermal AFM probes using custom hardware, software, and electronics.
  - Implemented inexpensive, autonomous, closed-loop temperature control of heated cantilever probes for higher sensitivity in microscopy and precision in microlithography
  - Developed instrumentation and analysis software, signal processing, and hardware to improve microscopy throughput by 1000x through use of arrays of probes in parallel.

- Developed finite element models to characterize behavior of thermal AFM probes.
- Mentored graduate students for their master's theses.

## RESEARCH AND TECHNICAL SKILLS

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- **Programming:**
  - 10 years' experience in numerous programming languages and database systems:
 

<i>Python</i>	<i>Java</i>	<i>Matlab</i>	<i>C / C++ / C#</i>
<i>R</i>	<i>Perl</i>	<i>MySQL</i>	<i>JSP / PHP</i>
  - Original software development:
    - Software for analyzing microscopy data on high-performance computing platforms: <https://github.com/ssomnath/PySPM>
    - Vocabulary building software for students preparing for SAT / ACT / GRE: [https://github.com/ssomnath/GRE\\_WordLookup](https://github.com/ssomnath/GRE_WordLookup)
- **Scanning Probe Microscopy & Lithography:**
  - 6 years' experience in developing new scanning probe microscopy and lithography techniques using custom software, signal processing, hardware, and electronics.
  - Experienced in following dynamic and contact mode SPM techniques:
 

<i>Piezoresponse Force Microscopy (PFM)</i>	<i>Force spectroscopy</i>
<i>Band excitation techniques</i>	<i>Dual AC Resonance Tracking (DART)</i>
<i>Switching Spectroscopy PFM</i>	<i>Lorentz Force cantilever actuation</i>
<i>Local Thermal Analysis (LTA)</i>	<i>Multi-cantilever imaging, lithography</i>
- **Modeling and Simulation:**
  - 4 years' experience in thermal, mechanical, electrical modeling of MEMS devices
    - Commercial finite element software – COMSOL Multiphysics, ANSYS
    - Developed simple models manually in languages like Matlab and Python
- **Microfabrication:**
  - 1 years' experience in fabricating samples and silicon cantilevers using:
 

<i>Photolithography</i>	<i>Thermal oxidation</i>
<i>Sputtering</i>	<i>Wet chemical etching</i>
<i>Reactive ion etching (RIE)</i>	<i>Plasma assisted etching</i>
<i>Thermal evaporation</i>	<i>Scanning electron microscopy</i>
- **Testing, characterization, and experimentation:**
  - Highly adept at instrumentation, testing, and data acquisition using LabVIEW
  - 6 years' experience in developing experimental setups using equipment such as:
 

<i>NI DAQ</i>	<i>Lock-in amplifiers</i>	<i>Oscilloscopes</i>	<i>Function generators</i>
<i>Source-meters</i>	<i>Multimeters</i>	<i>Wire-bonders</i>	<i>Probe stations</i>
  - 4 years' experience in developing analog circuitry for research experiments.
- **Engineering and design software:**
  - 6 years' experience using the following engineering design software:
 

<i>Solidworks</i>	<i>Pro Engineer</i>	<i>Autocad</i>	<i>Blender</i>
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  - 5 years' experience in following simulation and engineering software:
 

<i>Igor Pro</i>	<i>Simulink</i>	<i>Fortran</i>	<i>Mathematica</i>
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## JOURNAL PUBLICATIONS

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1. **Somnath, S.**, A. Belianinov, S. V. Kalinin, and S. Jesse, "Full information acquisition in piezoresponse force microscopy," vol 107, 263102, *Applied Physics Letters*, 2015.

2. Liam Collins, A. Belianinov, **S. Somnath**, B. Rodriguez, N. Balke, S. V. Kalinin, S. Jesse, "Multifrequency spectrum analysis using fully digital G Mode-Kelvin probe force microscopy," *Accepted for publication at Nanotechnology*, 2016.
3. **Somnath, S.**, J. O. Liu, M. Bakir, C. B. Prater, and W. P. King, "Multifunctional Atomic Force Microscope Cantilevers with Lorentz Force Actuation and Self-heating Capability," *Nanotechnology*, vol. 25, 395501, 2014.
4. **Somnath, S.** and W. P. King, "An Investigation of Heat Transfer between a Microcantilever and a Substrate for Improved Thermal Topography Imaging," *Nanotechnology*, vol. 25, 365501, 2014.
5. Seong, M. H., **S. Somnath**, H. J. Kim, and W. P. King, "Parallel Nanoimaging using an Array of 30 Heated Cantilevers," *RSC Advances*, vol 4., 24747-54, 2014.
6. Hu, Huan, H. Cho, **S. Somnath**, A. F. Vakakis, W. P. King, "Silicon Nano-Mechanical Resonators Fabricated using Tip-based Nanofabrication," *Nanotechnology*, 25 275301, 2014.
7. **Somnath, S.**, H. Hu, H. J. Kim, and W. P. King, "Parallel Nanoimaging and Nanolithography using a Heated Microcantilever Array," *Nanotechnology*, vol. 25, 014001, 2013.
8. Carroll, K. M, X. Lu, S. Kim, Y. Gao, H. J. Kim, **S. Somnath**, L. Polloni, R. Sordan, W. P. King, J. E. Curtis, E. Riedo, "Parallelization of Thermochemical Nanolithography," *Nanoscale*, vol. 6, 1299-1304, 2014.
9. Hu H., P. K. Mohseni, L. Pan, **S. Somnath**, J. R. Felts, M. A. Shannon, W. P. King, "Fabrication of arbitrarily-shaped silicon and silicon oxide nanostructures using tip-based nanofabrication," *Journal of Vacuum Science & Technology B.*, vol. 31, 06FJ01, 2013.
10. Liu, J. O., **S. Somnath**, and W. P. King, "Heated Atomic Force Microscope Cantilever with High Resistivity for Improved Temperature Sensitivity," *Sensors and Actuators A-Physical*, vol. 201, pp. 141-147, 2013.
11. King, W. P., B. Bhatia, J. R. Felts, H. J. Kim, B. Kwon, B. Lee, **S. Somnath**, and M. Rosenberger, "Heated Atomic Force Microscope Cantilevers and their Applications," *Annual Review of Heat Transfer*, vol. 12, 287-326, 2013.
12. Lee, B., **S. Somnath**, and W. P. King, "Fast Nanotopography Imaging Using a High Speed Cantilever with Integrated Heater-Thermometer," *Nanotechnology* 24, 135501, 2013.
13. **Somnath, S.** and W. P. King, "Heated Atomic Force Cantilever Closed Loop Temperature Control and Application to High Speed Nanotopography Imaging," *Sensors and Actuators A-Physical*, 192, 27-33, 2013.
14. Kim, H. J, N. Moldovan, J. R Felts, **S. Somnath**, Z. Dai, T. D. B. Jacobs, R. W. Carpick, J. A. Carlisle, and W. P. King "Ultranancrystalline Diamond Tip Integrated onto a Heated Atomic Force Microscope Cantilever," *Nanotechnology* 23, 495302, 2012
15. Felts, J. R., **S. Somnath**, R. H. Ewoldt, and W. P. King, "Nanometer-Scale Flow of Molten Polyethylene from a Heated Atomic Force Microscope Tip," *Nanotechnology* 23, 215301, 2012.
16. **Somnath, S.**, E. A. Corbin and W. P. King, "Improved Nanotopography Sensing via Temperature Control of a Heated Atomic Force Microscope Cantilever," *IEEE Sensors Journal* 11, 2664-2670, 2011.

## CONFERENCE PRESENTATIONS

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1. **Somnath, S.**, A. Belianinov, S. V. Kalinin, and S. Jesse, "A Novel Spectroscopy Technique for Ultrafast Polarization Switching in Ferroelectrics," *Materials Research Society Fall 2015 Meeting*, Boston, MA, Dec 2015.
2. **Somnath, S.**, S. Jesse, G. J. Van Berkel, S. V. Kalinin, and O. S. Ovchinnikova, "Tailored Heating Functions in Heated AFM Probes for Submicron Spatial Resolutions in Thermal Desorption Mass Spectrometry," *Materials Research Society Fall 2015 Meeting*, Boston, MA, Dec 2015.

3. **Somnath, S.**, A. Belianinov, S. V. Kalinin, and S. Jesse, "Big Data in Nanoscience: Improved Measurement Speed and Spatial Resolution by Streaming the Complete Information from the Detector," *Materials Research Society Fall 2015 Meeting*, Boston, MA, Dec 2015.
4. Belianinov, A., **S. Somnath**, S. V. Kalinin, and S. Jesse, "Data driven Dynamic Force-Distance Curve reconstruction in G-mode tapping Atomic Force Microscopy," *Materials Research Society Fall 2015 Meeting*, Boston, MA, Dec 2015.
5. **Somnath, S.**, S. Jesse, G. J. Van Berkel, S. V. Kalinin, and O. S. Ovchinnikova, "Improved submicron spatial resolution of thermal desorption mass spectrometry via short tailored pulse heating with thermal AFM probes," *63<sup>rd</sup> American Society of Mass Spectrometry Conference on Mass Spectrometry and Allied Topics*, St. Louis, MO, June 2015.
6. **Somnath, S.**, and W. P. King, "An Investigation of Heat Transfer between a Microcantilever and a Substrate for Improved Thermal Nanoimaging," *International Conference on Nanoscience + Technology (ICN+T)*, Vail, July 2014.
7. **Somnath, S.**, J.O. Liu, M. Bakir, C. B. Prater, and W.P. King, "Multifunctional Atomic Force Microscope Cantilever with Lorentz Force Actuation and Self-Heating for Nanomechanical Measurements in Air and Water," *Hilton Head Workshop 2014: A Solid-State Sensors, Actuators and Microsystems Workshop*, Hilton Head, USA, June 2014.
8. Curtis, J. E, K. Carroll, X. Lu, S. Kim, Y. Gao, H. J. Kim, **S. Somnath**, L. Polloni, R. Sordan, W. P. King, and E. Riedo, "Parallelization of Thermochemical Nanolithography," *APS March Meeting 2014*, Denver, Colorado, March 2014.
9. **Somnath, S.**, H.J. Kim, H. Hu, and W.P. King, "High Speed and Parallel Nanoimaging using an Array of Heated Atomic Force Microscope Cantilevers," *Transducers 2013 and Eurosensors XXVII The 17th International Conference on Solid-State Sensors, Actuators, and Systems*, Barcelona, Spain, June 2013.
10. Kim, H.J., N. Moldovan, J.R. Felts, **S. Somnath**, Z. Dai, T.D.B. Jacobs, R.W. Carpick, J.A. Carlisle, and W.P. King, "Heated Atomic Force Microscope Cantilevers with Wear-Resistance Ultrananocrystalline Diamond Tips," *Proceedings of the IEEE MEMS Conference*, Taiwan, 2013.
11. Ewoldt, R., J.R. Felts, **S. Somnath**, and W.P. King, "Nanometer-Scale Free Surface Flow of Molten Polyethylene from a Heated Atomic Force Microscope Tip," *2012 Meeting of the American Physical Society, Division of Fluid Dynamics*, San Diego, CA, November 2012.
12. Kim, H.J., Z. Dai, **S. Somnath**, H. Hu, and W.P. King, "Thermal Crosstalk in Heated Microcantilever Arrays," *American Society of Mechanical Engineers International Mechanical Engineering Congress and Exposition*, Houston TX, November 2012.
13. Kim, H.J., J.R. Felts, **S. Somnath**, Z. Dai, T.D. Jacobs, N. Moldovan, J.A. Carlisle, R.W. Carpick, and W.P. King, "Heated AFM Microcantilevers with Ultrananocrystalline Diamond Tips," *International Conference on Nanoscience + Technology (ICN+T)*, Paris, July 2012.
14. **Somnath, S.**, H. Hu, H. J. Kim, and W. P. King, "Parallel Nano Imaging and Lithography using a Cantilever Probe Array in a Commercial AFM System," *International Conference on Nanoscience + Technology (ICN+T)*, Paris, July 2012.
15. **Somnath, S.**, Z. Dai, and W. P. King, "Parallel Nanotopography Imaging with a Heated Microcantilever Array," *Technologies for Future Micro-Nano Manufacturing Workshop*, Napa, California, 214-217, August 2011.
16. Felts, J.R., L. Thompson, **S. Somnath**, C. Murphy, and W.P. King, "Rapid Nanofabrication of Gold Nanorod Raman Enhancing Nanostructures using Heated Probe Lithography," *Technologies for Future Micro-Nano Manufacturing Workshop*, Napa, California, 246-249, 2011.
17. Felts, J.R., P.C. Fletcher, **S. Somnath**, J. Pikul, Z. Dai, W.K. Lee, P.E. Sheehan, and W.P. King, "Nanofabrication Using Heated Probe Tips," *Proceedings of the SPIE - The International Society for Optical Engineering* 8031, 803105, Orlando, FL, 2011.

18. Felts, J. R., P. C. Fletcher, **S. Somnath**, J. Pikul, B. Bhatia, N. Maniscalco, Z. Dai, and W. P. King, "Advances in Nanometer Scale Manufacturing Using Heated Atomic Force Microscope Probes," *Materials Research Society Symposium Fall Meeting*, Boston MA, November 2010.
19. **Somnath, S.**, E. A. Corbin and W. P. King, "Six-Fold Improvement in Nanotopography Sensing via Temperature Control of a Heated Atomic Force Microscope Cantilever," *IEEE Sensors Conference*, Honolulu, Hawaii, 2010.

## TEACHING EXPERIENCE

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- Undergraduate Teaching Assistant, Introduction to Computer Science** Aug '08-May '09  
Computer Science Department, Rutgers University, New Brunswick Piscataway, NJ
- Conducted recitation sessions to revisit topics taught in lectures, answered questions regarding concepts and homework problems
  - Prepared weekly list of representative problems and walked students through solving the problems

- Peer Mentor, Calculus II** Aug 2007 – Dec 2008  
Mathematics Department, Rutgers University, New Brunswick Piscataway, NJ
- Assisted a graduate teaching assistant in weekly recitation sessions
  - Graded homeworks and posted solutions

## AWARDS & HONORS

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- Best Poster Award, *Center For Nanoscale Science and Technology (CNST) 10<sup>th</sup> Annual Nanotechnology Workshop, University of Illinois, Urbana-Champaign, May 2-3, 2012*
- Best Presentation Award – Senior Design Project, *Department of Mechanical Engineering, Rutgers University, Spring 2009*
- School of Engineering Scholarship, Rutgers University, Aug 2006 – May 2007
- Dean's List –Handpicked by the School of Engineering dean for high academic merit, *Rutgers University, Aug 2005 – May 2009*

## PROFESSIONAL MEMBERSHIPS

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- Materials Research Society
- American Society of Mechanical Engineers
- Tau Beta Pi
- Sigma Pi Tau

## LIST OF REFERENCES

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**Dr. Sergei V. Kalinin**  
*Senior R&D Staff and Group Leader*  
Scanning Probe Microscopy Group  
Center for Nanophase Materials Science  
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**Dr. William P. King**

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