Christopher Charles Bowland, Ph.D.

1 Bethel Valley Rd., Oak Ridge National Laboratory, Oak Ridge, TN 37831-6053
Office: (865) 574-6622 Mobile: (865) 748-8355 bowlandcc@ornl.gov

Education

Ph.D. August 2016 in Materials Science and Engineering
University of Florida
Advisor: Dr. Henry A. Sodano
Dissertation Title: *Conformal Growth Method of Ferroelectric Materials for Multifunctional Composites*

M.S. December 2013 in Materials Science and Engineering
University of Florida
Advisor: Dr. Henry A. Sodano

B.S. May 2012 in Materials Science and Engineering
Concentration: Nanomaterials
Minor: Business Administration
University of Tennessee

Professional Experience

Wigner Fellow – *Oak Ridge National Laboratory*, Materials Science and Technology Division, Carbon and Composites Group, Oak Ridge, TN — Aug. 2016-Present

- Conducting research on novel approaches to creating multifunctional fibers
- Researching multifunctional composites and 3D printed structures

Graduate Research Assistant – *University of Florida*, Materials Science and Engineering Department, Gainesville, Florida — Aug. 2012-Aug. 2016

- Performed M.S. and Ph.D. research
- Synthesized ferroelectric nanowires and textured films on carbon fiber to create multifunctional fibers
- Utilized X-ray diffraction, scanning electron microscopy, differential scanning calorimetry and atomic force microscopy to characterize the microstructure and electromechanical properties of the ferroelectric materials
- Fabricated and tested single fiber power harvesters and sensors
- Developed multifunctional composites via conventional carbon fiber resin molding techniques

Visiting Scholar – *University of Michigan*, Aerospace Engineering Department, Ann Arbor, Michigan — Aug. 2015-July 2016

- Completed Ph.D. research on multifunctional fibers for multifunctional composites

Applications Engineering Intern – *Nanomechanics, Inc*, Oak Ridge, TN Jan. 2012-July 2012

- Performed nanoindentation tests on thin films and polymers for elastic modulus and hardness measurements
- Primary focus on sample preparation and contract laboratory testing
- Wrote two white papers pertaining to the nanoindentation research

Summer Intern – *Oak Ridge National Laboratory*, Oak Ridge, TN June 2011-Aug. 2011

- Characterized, stabilized, and carbonized polyethylene (PE) fiber to produce low-cost carbon fiber
- Studied the thermal degradation kinetics of the PE fibers using a dynamic mechanical analyzer and thermomechanical analyzer

Professional Memberships

Materials Research Society, member (2017-present)
SPIE, member and conference session chair (2018-present)

Publications

Journal Articles in Print

1) Nguyen, N.A., **Bowland, C.C.,** Naskar, A.K. (2018). A General Method to Improve 3D-Printability and Inter-Layer Adhesion in Lignin-Based Composites. *Applied Materials Today*, 12, 138-152.
2) Nguyen, N.A., **Bowland, C.C.**, Naskar, A.K. (2018). Mechanical, thermal, morphological, and rheological characteristics of high performance 3D-printing lignin-based composites for additive manufacturing applications. *Applied Materials Today: Data in Brief*, 18, 936-950.
3) Nguyen, N.A., Meek, K.M., **Bowland, C.C.,** Barnes, S.H., Naskar, A.K. (2018). An Acrylonitrile–Butadiene–Lignin Renewable Skin with Programmable and Switchable Electrical Conductivity for Stress/Strain-Sensing Applications. *Macromolecules*, 51(1), 115-127.
4) **Bowland, C.C.**, Malakooti, M.H., Sodano, H.A. (2017). Barium Titanate Film Interfaces for Hybrid Composite Energy Harvesters. *ACS Applied Materials and Interfaces*, 9(4), 4507-4065.
5) **Bowland, C.C.** and Sodano, H.A. (2017). Hydrothermal Synthesis of Tetragonal Phase $BaTiO_3$ on Carbon Fiber with Enhanced Electromechanical Coupling. *Journal of Materials Science*, 52(13), 7893-7906.
6) Nafari, A., **Bowland, C.C.**, Sodano, H.A. (2017). Ultra-Long Vertically Aligned Lead Titanate Nanowire Arrays for Energy Harvesting in Extreme Environments. *Nano Energy*, 31, 168-173.
7) Bauer, M.J., Snyder, C.S., **Bowland, C.C.**, Uhl, A.M., Budi, M. AK, Villancio-Wolter, M., Sodano, H.A., Andrew, J.S. (2016). Structure–Property Relationships in Aligned Electrospun Barium Titanate Nanofibers. *Journal of American Ceramic Society*, 99(12), 3902-3908.
8) Zhou, Z., **Bowland, C.C.**, Patterson, B.A, Malakooti, M.H., Sodano, H.A. (2016). Conformal $BaTiO_3$ Films with High Piezoelectric Coupling through an Optimized Hydrothermal Synthesis. *ACS Applied Materials and Interfaces*, 8(33), 21446-21453.
9) Zhou, Z., **Bowland, C.C.**, Malakooti, M.H., Tang, H., Sodano, H.A. (2016). Lead-Free $0.5Ba(Zr_{0.2}Ti_{0.8})O_3$-$0.5(Ba_{0.7}Ca_{0.3})TiO_3$ Nanowires for Energy Harvesting. *Nanoscale*, 8(9), 5098-5105.

10) Tang, H., Zhou, Z., **Bowland, C.C.**, Sodano, H.A. (2015). Growth of Highly Textured $PbTiO_3$ Films on Conductive Substrate under Hydrothermal Conditions. *Nanotechnology*, 26(34), 345602.
11) **Bowland, C. C.**, Malakooti, M.H., Zhou, Z., & Sodano, H. A. (2015). Highly Aligned Arrays of High Aspect Ratio Barium Titanate Nanowires via Hydrothermal Synthesis. *Applied Physics Letters*, 106(22), 222903.
12) Tang, H., Zhou, Z., **Bowland, C.C.**, Sodano, H.A. (2015). Synthesis of Calcium Copper Titanate ($CaCu_3Ti_4O_{12}$) Nanowires with Insulating SiO_2 Barrier for Low Loss High Dielectric Constant Nanocomposites. *Nano Energy*, 17, 302-307.
13) **Bowland, C.C.**, Zhou, Z., & Sodano, H. A. (2014). Multifunctional Barium Titanate Coated Carbon Fibers. *Advanced Functional Materials*, 24(40), 6303-6308.

Journal Articles Under Review

1) **Bowland, C.C.**, Nguyen, N.A., Naskar, A.K. Roll-to-Roll Processing of Silicon Carbide Nanoparticle Deposited Carbon Fiber for Multifunctional Composites.
2) Nguyen, N.A., Sietske H. Barnes, **Bowland, C.C.,** Meek, K.M., Littrell, K.C., Keum, J.K. and Naskar, A.K. A Path for Lignin Valorization via Additive Manufacturing of High-Performance Sustainable Composites with Enhanced 3D-Printability
3) Nguyen, N.A., Meek, K.M., **Bowland, C.C.**, and Naskar, A.K., Thermo-Responsive Lignin for Shape Memory Applications.

Conference Manuscripts Accepted by Peer Review

1) Nafari, A., **Bowland, C.C.**, Sodano H.A. (2015). "Vertically Aligned Lead Titanate Nanowire Arrays for High Temperature Energy Harvesting," ASME 2015 Conference on Smart Materials, Adaptive Structures and Intelligent Systems, September 21-23, Colorado Springs, CO.

Conference Manuscripts Accepted by Abstract

1) **Bowland, C.C.**, Nguyen, N.A., Naskar, A.K. (2018). "The Effect of Nanoparticle Enhanced Sizing on the Structural Health Monitoring Sensitivity and Mechanical Properties of Carbon Fiber Composites," SPIE Smart Structures/NDE 2018, March 4-8, Denver, CO.
2) **Bowland, C.C.**, Wang, Y., Naskar, A.K. (2017). "Development of Nanoparticle Embedded Sizing for Enhanced Structural Health Monitoring of Carbon Fiber Composites," SPIE Smart Structures/NDE 2017, March 25-29, Portland, Oregon.
3) Malakooti, M.H, Patterson, B.A, **Bowland, C.C.**, Hwang, H-S, Sodano, H.A. (2017). "Piezoelectric Interfaces Enabled Energy Harvesting and Tailored Damping in Fiber Composites," SPIE Smart Structures/NDE 2017, March 25-29, Portland, Oregon.
4) Zhou, Z., **Bowland, C.C.**, Patterson, B.A, Malakooti, M.H, Sodano, H.A. (2016). "Conformal Growth of Textured Barium Titanate Films on Patterned Silicon Wafer," ASME 2016 Conference on Smart Materials, Adaptive Structures and Intelligent Systems.
5) Zhou, Z., **Bowland, C.C.**, Patterson, B.A, Malakooti, M.H, Sodano, H.A. (2016). "Optimized Parameters for Synthesis of $BaTiO_3$ Films with High Electromechanical Coupling," ASME 2016 Conference on Smart Materials, Adaptive Structures and Intelligent Systems.
6) Zhou, Z., **Bowland, C.C.**, Patterson, B.A, Malakooti, M.H, Sodano, H.A. (2016). "Hydrothermal Synthesis of Conformal Textured $BaTiO_3$ Films with Enhanced Ferroelectric Properties," E-MRS Spring 2016, Symposium on Solution Processing and Properties of Functional Oxide Thin Films and Nanostructures, May 3-5, Lille, France.

7) **Bowland, C.C.**, Malakooti, M.H., Hwang, H-S, Sodano, H.A. (2015). "Fiber Reinforced Piezoelectric Composites," 20th International Conference on Composite Materials, Symposium on Composites – Energy Storage and Harvesting, July 19-24, Copenhagen, Denmark.
8) Zhou, Z., Patterson, B., **Bowland, C.**, and Sodano, H.A. (2014). "Conformal Growth of Textured $BaTiO_3$ Film on Si and its Piezoelectric Property," MRS Fall Meeting & Exhibit, Nov. 30 – Dec. 5, Boston, MA.
9) **Bowland, C.**, Zhou, Z., and Sodano, H.A. (2014). "Barium Titanate Nanowire Film Coated Carbon Fibers for Power Harvesting," The Composites and Advanced Materials Expo, Oct. 13-16, 2014, Orlando, FL.
10) **Bowland, C.**, Zhou, Z., and Sodano, H.A. (2013). "Electromechanical Characterization of Barium Titanate Coated Carbon Fibers," 19th International Conference on Composite Materials, Symposium on Composites with Sensing, Actuation, and Energy Transduction Capabilities, July 28-Aug. 2, Montreal, Canada.

Journal Article Reviewer: *Carbon*

Patents

Invention Disclosure 201703972 "Composites with Electromechanical Properties and Their Methods of Manufacturing" (ORNL ID 3972) **Bowland C.C.** and Naskar A.K.