Nicholas J. Ginga

EDUCATION

Ph.D. in Mechanical Engineering — 2014
College of Engineering, ***Georgia Institute of Technology***
Dissertation title: "On-chip dielectric cohesive fracture characterization and mitigation investigation through off-chip carbon nanotube interconnects"

M.S. in Mechanical Engineering — 2008
College of Engineering, ***Georgia Institute of Technology***

B.S. in Mechanical Engineering — 2005
School of Engineering, ***The College of New Jersey***

RESEARCH EXPERIENCE

01/07/19 – present — **Postdoctoral Research Fellow: Georgia Institute of Technology, CASPaR Lab with Dr. Suresh Sitaraman**

- Advisor – Dr. Suresh Sitaraman, Department of Mechanical Engineering
- Finite element modeling and testing of electronic packages and flexible electronics
- Developing small scale magnetic actuation test for interfacial adhesion measurement of dielectric thin film materials found near solder balls in electronic packages.
- Finite element modeling and mechanical testing of carbon nanotube infused polymers (Ecoflex®) for high level strain sensors.

06/01/15 – 06/30/19 — **Postdoctoral Research Fellow: Georgia Institute of Technology (10/01/2017- present) and University of Michigan (06/01/15 – 08/01/17), The Takayama Lab - Micro and Nanotechnology for Biomedical Analysis Lab**

Carrying out research focused on biomedical devices and organ-on-a-chip systems.

- Advisor – Dr. Shuichi Takayama, Department of Biomedical Engineering
- Investigating using fracture of oxidized PDMS, hPDMS, and polymer thin films to create micro/nano channels. These elastomeric channels can be used to manipulate nanoparticles, DNA, and chromatin in micro/nano flexible fluidic systems.
- Design and fabrication of biomedical devices to perform injection and withdrawal of liquid and bacteria into human intestinal organoids. This work investigates using such human intestinal organoids as bioreactors and to better understand the interaction of bacteria and the human intestine.
- Design and fabricate 3D printed mechanical devices to investigate the effect of capillary fluid forces on lung cells to mimic the fluid stresses exerted on lung cells during injury. The device prototype is a cyclic mechanical

plunger that can be used with multi-well cell culture plates with Transwell inserts for air/liquid culture of lung cells.
- Used soft lithography to make and test PDMS microfluidic devices.

09/01/2016 – 08/01/17 **Postdoctoral Research Fellow: University of Michigan, The Dasgupta Research Group**

Carrying out research focused on investigating nanoscale coatings by atomic layer deposition (ALD) to tune interphase mechanics in polymer nanostructured composites.

- Advisor – Dr. Neil Dasgupta, Department of Mechanical Engineering
- Design and fabrication of polymer (ex. PMMA) double cantilever beam test specimens to investigate improving interfacial toughness between epoxy matrix and composite filler material.
- Utilizing double cantilever beam test samples in monotonic tensile test configuration with digital image correlation (DIC) and also in a wedge test configuration to measure the interfacial fracture toughness of polymer/ALD/epoxy system.
- Atomic layer deposition (ALD) of films such as aluminum oxide (Al_2O_3) and zinc oxide (ZnO) at low temperatures on polymer substrates.

08/01/2008 – 06/01/2014 **Ph.D. Research: Georgia Institute of Technology, CASPaR Lab with Dr. Suresh Sitaraman**

Investigated CNTs as off-chip electrical interconnects for thermomechanical reliability of flip-chip packages.

- Developed process to selectively grow tall (~100 μm) vertically aligned carbon nanotube (CNT) forests on patterned copper films for use as electrical interconnects. Process utilizes clean room photolithography, sputter and evaporation metal deposition, plasma reactive ion etching, and thermal chemical vapor deposition.
- Developed process to assemble silicon flip-chips with patterned CNT interconnects (~100 μm diameter and ~200 μm pitch) to organic FR4 substrate using stencil patterned electrically conductive adhesive. Assembled electronic packages were thermal cycled to investigate thermomechanical reliability of CNT based off-chip interconnects.
- Conducted measurements of the effective mechanical modulus of carbon nanotube forests using several methods including a modified nanoindentation method, semi-insitu SEM based method with custom compression fixture and load cell, and a traditional uniaxial load frame method. Measurements were used in development of a material model for finite element analysis (FEA) of electronic packages with CNT interconnects (DARPA funded).
- Performed FEA of electronic packages utilizing CNT off-chip interconnects. The analysis demonstrated the mechanical decoupling of the silicon chip from the organic substrate by the CNTs, resulting in the reduction of thermal stresses in the silicon chip for improved reliability.

Developed new micro/nano-scale method to measure cohesive fracture toughness of thin films.

- Developed a cohesive fracture test which is fixtureless and utilizes a film with high intrinsic stress on top of the test material film to initiate and drive fracture of the test film. The test method was demonstrated with a thin film of SiO_2 (common dielectric material). The method utilizes clean room photolithography, sputter metal deposition, plasma reactive ion etching, and plasma enhanced chemical vapor deposition.
- Performed FEA of the newly developed thin film fracture toughness test to calculate fracture parameters and investigate effects of film thicknesses, crack length, and intrinsic stress.

09/1/2005 – 08/01/2008 **M.S. Research: Georgia Institute of Technology, CASPaR Lab with Dr. Suresh Sitaraman**

Investigated and demonstrated a previously published test method which utilizes a highly stressed film to measure the interfacial fracture toughness of thin film systems.

- A highly stressed film (Cr) was used to initiate and drive interfacial fracture between the substrate (Si) and test material (Ti). Gained experience and developed skill with many of the Georgia Tech clean room micro/nano fabrication equipment.
- Measured and characterized intrinsic stress in magnetron sputtered Cr thin films as a function of argon pressure to use for interfacial and cohesive fracture tests. Measured intrinsic stress using contact profilometry.

TEACHING EXPERIENCE

08/14/2019 – present **University of Alabama in Huntsville** (Full-time Lecturer, Fall 2020-present)

Course: MAE211 – Introduction to Computational Tools: Course was comprised of computer aided design and solid modeling concepts including 3D model definition though geometry sketching, constraining, and dimensioning; 3D solid modeling techniques; engineering drawings; assembly creation; assembly animations; and rendering.

- Developed and taught sophomore undergraduate CAD course for two separate course sections.
- Prepared and delivered weekly lectures.
- Course utilized Solid Edge CAD software.
- Course included semester-long 3D modeling projects.

Course: MAE490&MAE491 – Senior Design I&II: Application of basic design principles including: design methodology, decision making, creativity, product liability, human factors, patents, ethics, and technical writing. Students are assigned to multi-disciplinary teams to develop project requirements and initial concepts.

- Developed new senior design course based on the design of an electric race car for the FSAE electric vehicle (EV) competition

- Created and delivered weekly lectures.

Summer 2020 **University of Alabama in Huntsville**

Course: MAE378 – Materials and Manufacturing Process: The objectives of this course are to understand the principles of material properties, how material structure influences material properties, considerations for material selection during design, and the fundamentals of manufacturing processes such as casting, forming, machining, and how these processes effect material properties.

- Prepared and delivered weekly lectures.
- Developed course assignments and tests.

01/07/2019 – 05/04/2019 **Georgia Institute of Technology**

Course: ME6124 – Finite Element Method: Theory and Practice

- Instructor of record for graduate level course
- Provided an in-depth understanding of the theory and formulation behind various finite elements with exposure to applications in mechanical engineering
- In addition to lectures based on finite element theory, provided hands-on experience with practical aspects of finite-element modeling using ANSYS software.

09/01/2014 – 04/01/2015 **Lecturer, University of Michigan-Flint**

Course: EGR165 –Computer Aided Design

- Developed and taught undergraduate CAD/FEA course.
- Prepared and delivered weekly lectures and lab sessions on 3D modeling techniques, engineering drawings, and engineering design principles.
- Created and graded homework assignments, tests, and projects.
- Course software included CREO/Pro-E.

08/01/2007 – 05/01/2013 **Graduate Teaching Assistant, Georgia Institute of Technology**

Course: ME4041 – Computer Graphics and Computer Aided Design

- Developed and taught senior level undergraduate CAD/FEA lab course.
- Prepared and delivered weekly tutorials and lab session lectures.
- Created and graded homework assignments and tests.
- Course software included I-DEAS and UGS-NX.

04/01/2009 – 06/01/2010 **Nanotechnology Research Center (NRC) Equipment Trainer (Staff), Georgia Institute of Technology**

- Responsible for weekly training sessions of clean room users on the operation of Tencor and Dektak contact profilometers and Wyko optical non-contact profilometer.
- Developed training literature for Dektak contact profilometer and Wyko optical non-contact profilometer.

INDUSTRY EXPERIENCE

Summer 2006 **Graduate Intern - Intel Corporation (ATD Q&R), Chandler, AZ**

- Developed experiments to understand the solder joint reliability of lead-free microelectronic packages.
  - Examined effect of variation of loading frequencies in a cyclic four-point bend test.
  - Correlated solder joint crack size with in-situ data acquisition during four-point bend testing.
- Created the *Solder Joint Reliability Data Summary Document* for engineers and technicians to easily organize, archive, and compare existing and new reliability data.
- Required to demonstrate an in depth understanding of microelectronic packaging, solder joint reliability, and failure analysis at completion of internship.

Summer 2004 **Undergraduate Intern - YORK International HVAC Engineering Sales Group, Edison, NJ**

- Created bid submissions to large construction firms for industrial size HVAC equipment.
- Tracked monthly/yearly quota pace of regional engineering sales group.

Summer 2003 **Undergraduate Intern – Public Service Electric and Gas (PSE&G) Apprentice Engineering Technician, Secaucus, NJ**

- Corrected and updated circuit CAD diagrams and conducted electrical equipment field-checks.
- Gained technical understanding of the electric utility system.

GRANTS

- Funding Agency: Semicondoctor Research Corporation (SRC)
  - Project: “Magnetic Actuation Metrology for Interfacial Adhesion Measurement for Electronic Packages”, Start Date: 1/1/2020
  - Amount: $225K over 3 years

JOURNAL PUBLICATIONS

- Y. N. Chen, N. J. Ginga, W. S. LePage, E. Kazyak, A. J. Gayle, J. Wang, M. D. Thouless, N. P. Dasgupta; “Enhanced Interfacial Toughness of Thermoplastic–Epoxy Interfaces Using ALD Surface Treatments,” *ACS Appl. Mater. Interfaces,* vol. 11, no. 46, pp. 43573–43580, Nov. 2019.
- G. A. Kim, N. J. Ginga, S. Takayama; “Integration of Sensors in Gastrointestinal Organoid Culture for Biological Analysis,” *Cellular and Molecular Gastroenterology and Hepatology (Cmgh),* vol. 6, no. 1, pp. 123-131.e1, 2018.
- N. J. Ginga, W. Chen, and S. K. Sitaraman, "Waviness reduces effective modulus of carbon nanotube forests by several orders of magnitude," *Carbon*, vol. 66, pp. 57-66, 2014.

- N. J. Ginga and S. K. Sitaraman, "The experimental measurement of effective compressive modulus of carbon nanotube forests and the nature of deformation," *Carbon,* vol. 53, pp. 237-244, 2013.
- N. J. Ginga and S. K. Sitaraman, "New Method to Measure Tensile Strength of Low Modulus Thin Films," *International Journal of Fracture,* vol. 170, pp. 199-206, 2011.
- M. B. Modi, N. J. Ginga, and S. K. Sitaraman, "Microcontact spring reliability: Design against interfacial fracture," *IEEE Transactions on Components and Packaging Technologies,* vol. 32, pp. 197-206, 2009.
- J. Zheng, M. B. Modi, N. J. Ginga, and S. K. Sitaraman, "Silicon and nanoscale metal interface characterization using stress-engineered superlayer test methods," *IEEE Transactions on Components and Packaging Technologies,* vol. 32, pp. 333-338, 2009.

CONFERENCE PUBLICATIONS

- R. Chen, N. J. Ginga, S. K. Sitaraman, "Magnetic Actuation Test Methods Development for Interfacial Reliability Assessment," in *2021 IEEE 71th Electronic Components and Technology Conference (ECTC),* 2021, Accepted.
- B. G. Stewart, N. J. Ginga, S. K. Sitaraman, "Electromechanical Characterization of Ecoflex and Carbon Nanotube Composites Using Biaxial Inflation," in *2020 IEEE 70th Electronic Components and Technology Conference (ECTC)*, Lake Buena Vista, FL, 2020.
- Y. N. Chen, N. J. Ginga, W.S. LePage, E. Kazyak, A. J. Gayle, J. Wang, M. D. Thouless, N. P. Dasgupta, "Enhanced interfacial fracture toughness of polymer-epoxy interfaces using ALD surface treatments," in 19th *International Conference on Atomic Layer Deposition*, Bellevue, Washington, July 2019.
- J. Zheng, M. B. Modi, N. J. Ginga, and S. K. Sitaraman, "Silicon, low-K dielectric, and nano-scale metal interface characterization using stress-engineered superlayer test methods," in *Electronic Components and Technology Conference (ECTC)*, Sparks, NV, United States, 2007, pp. 1384-1389.

CONFERENCE PRESENTATIONS

- B. G. Stewart, N. J. Ginga, S. K. Sitaraman, "Electromechanical Characterization of Ecoflex and Carbon Nanotube Composites Using Biaxial Inflation," in *Electronic Components and Technology Conference (ECTC),* Lake Buena Vista, FL, 2020.
- Y. N. Chen, N. J. Ginga, W.S. LePage, E. Kazyak, A. J. Gayle, J. Wang, M. D. Thouless, N. P. Dasgupta, "Enhanced interfacial fracture toughness of polymer-epoxy interfaces using ALD surface treatments," in 19th *International Conference on Atomic Layer Deposition*, Bellevue, Washington, July 2019.
- N. J. Ginga, S. K. Sitaraman, "Mechanical Performance Study of CNT Bundles as Off-Chip Interconnects," at *ASME International Mechanical Engineering Congress & Exposition (IMECE),* San Diego, CA, 2014.

- J. Zheng, M. D Modi, N. J Ginga, and S. Sitaraman, "Silicon, low-K dielectric, and nano-scale metal interface characterization using stress-engineered superlayer test methods," in *Electronic Components and Technology Conference (ECTC)*, Sparks, NV, United States, 2007. (presented by S. Sitaraman)

POSTERS

- N. J. Ginga, G. T. Ostrowicki, S. Raghava , S. K. Sitaraman, "Innovative Mechanical Characterization Techniques and Computer-Simulation Tools for Next-Generation, Cu-Low-K Microelectronic Devices," IEEE Global Interposer Technology Workshop, Atlanta, GA, Nov. 14-16, 2012.
- N. J. Ginga, S. K. Sitaraman, "Development of Fixtureless Cohesive Fracture Toughness Measurement Technique for Low-k thin Films," Georgia Tech Interconnects and Packaging Center (IPC) System Integration Workshop 2011, Atlanta, GA, June 13, 2011.
- N. J. Ginga, J. Zheng, S. K. Sitaraman, "Interfacial Fracture Toughness Measurement of Thin Film Interfaces for Ti/Si, Ta/low-k, and Eutectic SnPb solder/CNTs," 13th Annual Surface Mount Technology (SMTA) Expo, Duluth, GA, April 16, 2009.
- N. J. Ginga, J. Zheng, S. K. Sitaraman, "Interfacial Fracture Toughness Measurement of Thin Film Interfaces for Ti/Si and Ta/low-k" Georgia Tech Packaging Research Center (PRC) Industrial Forum Day (IFD) 2007, Atlanta, GA, Mar. 14, 2007.

AWARDS/HONORS

- Atlanta Surface Mount Technology Association (SMTA) Scholarship, 2009.
- The College of New Jersey Mechanical Engineering Leadership Award, 2005.
- The College of New Jersey Armstrong Mechanical Engineering Award, 2002-2005.
- New Jersey Scholar's Award, 2001-2003.
- College of New Jersey Scholar Athlete, 2002 and 2003.
- New Jersey Bloustein Scholar, 2001.
- Golden Key Honor Society.

SERVICE / ACTIVITIES

- Georgia Tech Surface Mount Technology Association (SMTA) Student Chapter President, 2009-2011.
- Georgia Tech Mechanical Engineering Graduate Association Vice President, 2006-2008.
- ASME president of student section at The College of New Jersey, 2004-2005.
- ASME secretary of student section at The College of New Jersey, 2003-2004.

- The College of New Jersey Solar/Electrical Boat Team, 2002-2005.
- 5th place overall at ASME Solar Splash Solar/Electrical Boat Competition, 2005.
- College of New Jersey winter and spring varsity track team, 2001-2003.

PROFESSIONAL ORGANIZATION MEMBERSHIP

- American Society of Mechanical Engineers (ASME).
- Surface Mount Technology Association (SMTA).
- International Microelectronics Assembly and Packaging Society (IMAPS).
- Institute of Electrical and Electronic Engineers (IEEE).