

# Adaptive Intelligent Materials and Systems (AIMS) Center Newsletter

*“... \$10 Million Grant from NASA for Conducting Air Traffic Safety Research..”*

## HIGHLIGHTED RESEARCH

The AIMS Center is pleased to congratulate these faculty members on their awards for their research projects:

### **Information Fusing for Real-Time National Air Transportation System Prognostics under Certainty**

#### **Sponsor: National Aeronautics and Space Administration**

AIMS faculty member Dr. Yongming Liu was awarded \$10 million grant from NASA to develop next-generation air traffic control. Dr. Liu, the lead project investigator, is directing a diverse, multi-disciplinary team that includes several faculty in ASU's Ira A. Fulton Schools of Engineering (Aditi Chattopadhyay, Nancy Cooke, Pingbo Tang, Lei Ying, Jingrui He and Mary Niemczyk), as well as collaborators from Vanderbilt University, Southwest Research Institute and Optimal Synthesis Inc. The objective is to develop an integrated real-time system-wide information fusion methodology for prognostics and safety assurance of the National Airspace System (NAS).

### **Mechanochemical Sensing and Self Healing Solution Detecting Damage in Composite Structures**

#### **Sponsor: Army Research Office/Army Research Laboratory**

AIMS faculty members, Dr. Aditi Chattopadhyay and Dr. Lenore Dai, in collaboration with Metis Design were awarded a Phase I Small Business Technology Transfer (STTR) program. The primary goal is to develop stress-sensitive mechanophores with improved self-sensing capability and demonstrate their effectiveness to detect early damage in glass fiber reinforced polymer composites.

### **Multimodel Sensing and Information Integration for Multiple Object Tracking**

#### **Sponsor: Air Force Office of Scientific Research**

Dr. Antonia Papandreou-Suppappola, AIMS faculty member, was awarded a research grant in relation to her project to investigate multimodel sensing systems for tracking multiple objects under varying operational and environmental conditions. Machine learning methodologies will be developed under varying context-dependent hypothesis by integrating disparate data sources and multi-strategy reasoning algorithms.

## AIMS CORE PROJECTS

### **Biaxial Testing of Advanced Hybrid Fiber Metal Laminate and Monolithic Materials**

#### **Sponsor: Arconic**

Research is conducted in the areas of static and fatigue testing of biaxial cruciform specimens for fiber metal laminates (GLARE) and metallic materials. The research focuses specifically on comparing the effects that different bonding methods and materials have on specimen failure, fatigue life, and several additional material parameters.

### **Damage Detection in Advanced Foam Core Composites Using NDE and SHM**

#### **Sponsor: Boeing**

The goal is to develop damage detection methodologies, using a combination of non-destructive evaluation (NDE) techniques and structural health monitoring (SHM). An in-service damage detection method in the advance foam core composites is being developed based on SHM techniques such as guided wave-based method and active sensing approach.

### **Damage Detection Methodologies for use in Integrated Circuits using NDE Methods**

#### **Sponsor: Intel**

Damage detection methodologies, for use in integrated circuit (IC) chips, using traditional non-destructive evaluation (NDE) techniques, mainly pulsed thermography (PT) and ultrasonic scanning, is being developed. These methodologies will be used to detect manufacturing induced damages such as delamination in the semiconductor thin film which is bonded to the substrate.

### **Innovation for Prognostics and Health Monitoring Technology**

#### **Sponsor: Raytheon Missile Systems**

Research will be conducted on fracture and fatigue damage prognosis models, simulations for residual useful life estimation (RULE) of materials and devices, and embedded sensors for remote condition sensing. The output of this research will contribute to the development of cutting-edge sensing techniques and will pave the way for exploring self-healing in material systems.

## AIMS CENTER NEW RESOURCES

### X-Ray Microtomography: Most Advanced Nondestructive 3D Microscopy

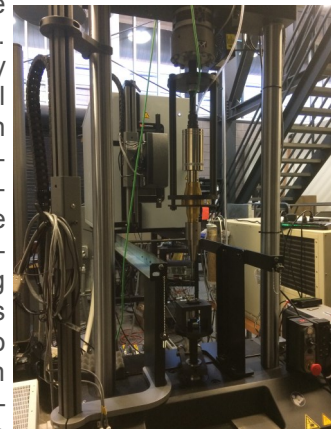


The Micro-CT, an X-Ray 3D imaging machine, was recently added to the AIMS Center Shared Resources. The Micro-CT equipment reconstructs the internal structure and geometry of various material

systems all while keeping the sample perfectly intact. This machine operates on small length scales with improved resolution, and can be used for nondestructive evaluation on materials. The Micro-CT works on a large format 16Mp or 11Mp cooled 14bit X-ray detector in one and is capable of acquiring up to 1456 x 3240 pixels in each projection image. The system is also capable of automatically selecting the best energy/filter combination of each sample. Using the Micro-CT, comprehensive understanding of damage generation mechanisms can be achieved.

### Ultra High Cycle Fatigue Testing Machine Installation

The AIMS Center is pleased to report that the Ultra High Cycle Fatigue Testing Machine has completed its installation. This equipment was originally awarded by the Office of Naval Research (ONR) for the research project, "Fatigue Damage Quantification and Life Prediction in Ultra High Cycle Regime." The system uses a piezo-driven ultrasonic generator to provide testing frequencies up to 20kHz. This allows fatigue life testing up to 109 to 10<sup>12</sup> cycles. The system is also integrated with an Instron-8801 (100kN) load frame which permits a greater variety of loading scenarios such as static and cyclic loading, superimposed tensile and compressive loading, constant and variable amplitude loading, as well as a combination of these options.



## OFFICE OF NAVAL RESEARCH DURIP GRANT

Dr. Green (in collaboration with Prof. Jerry Lin and Prof. César Torres) was awarded a DURIP grant titled "Catalyzing Material Discovery Through Electrochemical and Porosity Analysis." The objective of this new grant will be used to purchase the Micromeritics AutoPore V, a state-of-the-art mercury porosimeter. This instrument would introduce the capability to analyze pore sizes ranging from 3nm-500  $\mu$ m. This instrument will also be able to determine pore volume, pore area, bulk material density, permeability and tortuosity, and particle size. Dr. Green and his associates are very excited for the expansion and new collaborations among the AIMS family that this capability will afford.

### LAWSON AND PAPADOPOULOS SCHOLARS

The AIMS Center is pleased to announce that two of its students—Elizabeth Nofen, a recent PhD graduate under Dr. Lenore Dai, and Christopher Sorini, current PhD student under Dr. Aditi Chattopadhyay, have been named the Lawson and Papadopoulos Scholars by the Phoenix Chapter of the Achievement Rewards for College Scientists (ARCS) Foundation, a national organization dedicated to providing financial scholarships to graduate and undergraduate students conducting research in science, engineering, mathematics, and medicine.



## STUDENT RECOGNITION & AWARDS

Dr. Cheng Zhang and his group (Dr. Pin-Chao Liao & Dr. Yi Ren), under the mentorship of Dr. Pingbo Tang, was awarded the 2nd Place of Best Paper Award in the International Workshop on Computing in Civil Engineering (IWCCE 2017), Seattle, June 25th-27th. Their detailed paper was titled "Imagery-Based Risk Assessment Using Crowdsourcing Technology in Complex Construction Sites." The IWCCE is a prestigious conference which has a long history of success. This past year, they were sponsored by the Computing Division of American Society of Civil Engineers (ASCE). The conference

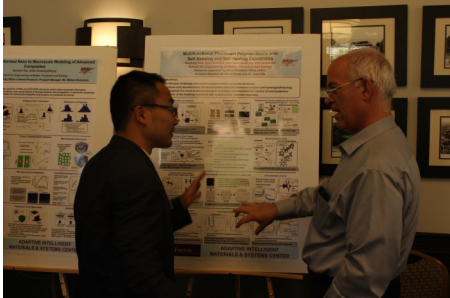
featured the division award, best paper and poster award, extended abstracts and poster demonstration presentation.

Doctoral student, Siddhant Datta, along with Dr. Aditi Chattopadhyay and Dr. Masoud Yekani Fard, recently had their paper, "High-Speed Surfactant-Free Fabrication of Large Carbon Nanotube Membranes for Multifunctional Composites", win the Best Paper Honorable Mention in the 2016 *Journal of Aerospace Engineering*. The paper was on "self-sensing glass fiber composites with embedded carbon nanotube buckypapers." The award will be presented at the 2018 ASCE Earth and Space Conference in Cleveland, Ohio.



## AIMS CENTER 2017 OPEN HOUSE

On May 11th, the AIMS Center held its annual Open House at the ASU Tempe Campus. Local industry members were invited to attend, view, and discuss the collaboration between the AIMS Center. The program consisted of: opening remarks by Dr. Elizabeth Cantwell and Dr. Lenore Dai, an AIMS Center Overview presentation led by Dr. Aditi Chattopadhyay, industry presentations from Dr. Tom Stoumbos (Orbital ATK) and Dr. James Neumann (Honeywell Aerospace), followed by a poster session and Collaboration Discussion facilitated by Dr. Malcolm Green to end the meeting.



## DR. ASHA HALL SEMINAR

The AIMS Center invited Dr. Asha Hall to present her seminar titled, "Embedded Sensing of Composite System" on Wednesday, April 19, 2017.

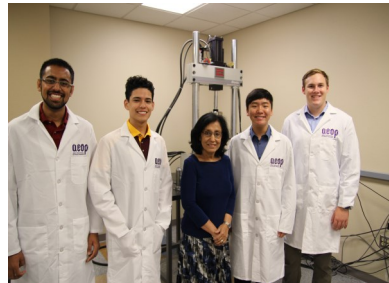
Dr. Asha Hall is a materials science engineer at U.S. Army Research Laboratory under the Vehicle Technology Directorate. She is currently an acting team leader for the Prognostics and Diagnostics Team in the Mechanics Division.

**Abstract:** The integrity of composite structures gradually degrades due to the onset of damage such as matrix cracking, fiber/matrix de-bonding, and delamination. Embedded sensing offers the prospects of proving real-time, in service monitoring of damage where weight savings is a major factor in Aerospace Industry.



## UNDERGRADUATE AND HIGH SCHOOL RESEARCH APPRENTICESHIP PROGRAM (URAP/HSAP)

The Army Educational Outreach Program (AEOP) provides genuine science and engineering experience through research opportunities alongside current PhD researchers, sponsored by the Army Research Office. This year, the AIMS Center receives its URAP/HSAP funding for the third consecutive year. Congratulations to Jack Miller, Bhavik Patel, & Aldo Soberon (URAP) and Chase Lee (HSAP) students. Each student is guided by a graduate mentor as they work on their ARMY related research. The AIMS Center is proud to have them on the team and is looking forward to recognizing their achievements throughout this upcoming semester.



## NEW AIMS CONSORTIUM MEMBER

We are pleased to announce our newest AIMS Consortium Member, Raytheon Missile Systems. We are looking forward to working with this prestigious company and are grateful to the Dean's office for supplementing additional funding for this new membership.

**Raytheon**

<p><b>AIMS Center</b> 501 E. Tyler Mall ERC 429 Tempe, AZ 85287</p> <p><b>AIMS Center Contact</b> April MacCleary Phone: 480-727-9320</p> <p>E-mail: April.MacCleary@asu.edu</p> <p>Website: aims.engineering.asu.edu</p>	<p><b>VISION</b></p> <p>The vision of the Adaptive Intelligent Materials &amp; Systems (AIMS) Center is to become a national Center of Excellence in the area of intelligent materials and adaptive systems. This is being accomplished by integrating a variety of interdisciplinary areas spanning mechanical, material, electrical and computational engineering, and developing a solid foundation in the area of integrated intelligent system design. Research in this area will solve large-scale problems that have direct benefit to the economy and society as well as a significant impact on aerospace and mechanical systems and civil infrastructures. Such problems are of interest to both industry and government.</p>
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<b>Consortium Members</b>
Boeing
Intel
Arconic
Raytheon
<b>AIMS Faculty Members</b>
Aditi Chattopadhyay Director
Lenore Dai Associate Director
Daniel Bliss
Matthew Green
Hamid Marvi
Hanqing Jiang
Yongming Liu
Narayanan Neithalath
Antonia Papandreou-Suppappola
Masoud Yekani Fard
Pingbo Tang
Julianne Holloway
John Rajadas Industry Liaison