ASME

Adaptive Structures & Material Systems

AIAA

ASME & AIAA Adaptive Structures & Material Systems Newsletter — Spring 2013

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MESSAGE FROM THE CHAIR

Diann Brei, University of Michigan ■ The Aerospace Division has experienced a rebirth - becoming a healthy, vibrant division with over 5000 members, 2 branches and 9 technical committees. The mission of the division is to support Aerospace Engineering and its supporting fields and technologies by providing effective and highly quality forums for multidisciplinary communication and collaborations, promotion of technical innovation, and professional development of a global membership. The Aerospace division has embarked on several new initiatives for the next year: increase communication and social media, develop young professional/student groups, and endow our key professional awards raising their status within ASME society.

Due to the diversity that comes from the inter-disciplinary nature of Aerospace engineering - the division has organized itself into two branches: 1) Adaptive Structures and Material Systems Branch and 2) Aero Systems Branch. These branches represent a synergistic grouping of technical committees giving a forum for communication across specializations. The Adaptive Structures and Material Systems Branch focuses on advancing the state of the art, science, and technology in the area of adaptive structures and material systems through the application of analytical, experimental and computational techniques. The Aero Systems Branch connects traditional mechanical fields that are fundamental to the success of Aerospace systems. Typically, 60-100 members are active in a branch through participation in 3 to 6 technical committees.

The workhorse of the division is the technical committees which bring together experts, typically 15 to 40 members, from around the world in a given topical area. Technical committees serve the needs of the profession and the membership by promoting the advancement of technical knowledge as it applies to the practice of engineering. Typical technical committee activities include but are not limited to organizing technical conferences, student and community outreach, best papers awards, and short courses. I encourage you to join and actively participate in one of the 9 technical committees described below. If you have an active technical community that supports mechanical engineering in the field of Aerospace Engineering, and it is not represented below - please contact me, Diann Brei Aerospace Division Chair at *dibrei@umich.edu*. We would love our Aerospace Division to be your home.

Adaptive Structures and Materials Systems Branch

Active Material Technology and Integrated Systems TC

The mission of the Active Material Technologies and Integrated Systems Technical Committee is to innovate, nurture, and accelerate the growth of novel active material technologies from the device through the system integration level. Our members seek to educate and recognize the efforts of those who integrate active materials into devices geared to advancing the state of the art. The focus of this committee encompasses the full spectrum of components/devices/systems that incorporate active materials from concept designs to product prototypes. To address challenges associated with maturing an idea into a final product such as reliability of smart structures, classification into appropriate technology readiness levels, qualification testing, etc., the committee aims to help formulate guidelines and examples demonstrating the transitions through the different stages in the product development lifecycle. The committee will also be involved in outreach in the form of promoting education & training opportunities for the next generation of smart materials researchers.

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Message from the Chair

Active and Multifunctional Materials TC

The scope of the Active and Multifunctional (A&M) Materials Technical Committee includes development of new A&M materials, characterization of A&M materials, development of theoretical and computational models, and application of A&M materials. Known A&M materials include ferroelectrics, electrostrictives, ferromagnetics, magnetostrictives, electro-optic materials, electroactive polymers and electrets, liquid crystal polymers, thermomechanical and ferromagnetic shape memory alloys, shape memory polymers, multiferroic composites, nanostructured materials and any other material exhibiting multi-field coupling and/or having relevance for structural applications while simultaneously exhibiting non-structural functionality such as sensing, actuation, memory, self-healing, energy storage or energy conversion. New A&M materials, enhancement of the active and/or multifunctional properties of existing materials and fundamental understanding of the material mechanics are sought via experimental, theoretical and computational means to facilitate technology breakthroughs in application of these materials. Advancements in methods for material synthesis, structural fabrication, material characterization, material modeling and analysis-based design are of great interest.

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Energy Harvesting TC

The Energy Harvesting Technical Committee (EHTC) is concerned with all aspects of energy harvesting from dynamical systems, ranging from electromechanical modeling and simulations to experiments and system-level applications by leveraging smart material-based transduction mechanisms such as piezoelectricity and magnetostriction as well as alternative energy conversion methods such as electromagnetic induction and electrostatic transduction. The examples of energy harvesting technologies and systems in this context span from NEMS/MEMS power generators for low-power sensor systems to meso-scale and large-scale harvesters for recovering wind and wave energy. Therefore, the potential sources of energy in this context include but are not limited to ambient vibrations and other forms of kinetic energy, aquatic, wind, and wave energy, as well as structure-borne and air-borne acoustic energy. The interdisciplinary nature of EHTC includes and welcomes academic, governmental, and industrial professionals from the disciplines of mechanical and aerospace, civil and environmental, electrical and electronics, and materials science engineering, among other disciplines of engineering and applied sciences.

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Bio-Inspired Structures and Systems TC

The Bio-Inspired Systems and Structures Technical Committee fosters the creation of societally significant biologically-inspired research areas by bringing leading researchers from government, academia, and industry together. The committee aims to advance the state of the art of bio-inspired systems and structures by strengthening ties with the engineering and scientific disciplines including mechanical, aerospace and biomedical engineering, evolutionary biology, cell and molecular biology, organic chemistry, and STEM education. The committee fulfills this purpose by (a) encouraging the presentation and publication of substantive papers in the area of bio-inspired research, (b) serving as a focal point for bio-inspired research by interacting with other related groups within and outside the area of bio-inspired research, (c) highlighting and promoting technical innovations in the field of bio-inspired research, and (d) promoting interdisciplinarity and industrial collaborations.

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Adaptive Systems Dynamics and Controls TC

The Modeling, Dynamics, and Control of Adaptive Systems Technical Committee (MDCTC) focuses on the development and implementation of mathematical tools and experimental techniques to model and control the static/dynamic behavior of smart materials and distributed adaptive systems with the goal of advancing the science, and technology in sensing, actuation, and integration of such systems. Specifically, within the context of smart materials and adaptive structures, the committee aims to i) develop analytical, computational, and phenomenological models to formalize and interpret experimental observations, ii) exploit the resulting models to simulate the response behavior of such systems, and iii) implement classical and modern control algorithms (linear, nonlinear, adaptive, stochastic, continuous, and discrete) to improve their response characteristics. To achieve these objectives, the committee emphasizes an environment, which promotes and encourages interdisciplinary and collaborative research efforts while promoting education at the interface between physics, mathematics, and engineering.

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Message from the Chair

Structural Health Monitoring TC

The Structural Health Monitoring Technical Committee focuses on interdisciplinary research on smart and multifunctional materials (including piezoelectric, magnetostrictive, nanotechnology, shape memory alloys, electroactive polymers, etc.) through their applications for Structural Health Monitoring. Research can be theoretical, analytical, and experimental investigations to cover all aspects of structural health monitoring. Research includes novel hardware and software tools, experimental data from small-scale laboratory demonstrators, and measurements made on large-scale structures. The scope includes but is not limited to: damage detection; decision making; self-diagnostics and prognostics; vibration and wave propagation methods; sensor and multifunctional material design; monitoring of composite, metallic, new, and aging structures and infrastructure; bio-nanotechnology applied to structural monitoring; and interdisciplinary approaches and applications for structural health monitoring. Such research is essential for creating optimal life-cycle management of structures from cradle to grave, including minimizing maintenance and operation costs, ensuring user/occupant safety, and maximizing performance / serviceability.

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Aero Systems Branch

Structures and Materials TC

The Structures and Materials Technical Committee has four objectives: (i) to foster the continuing development of aerospace oriented structures and materials sciences and technologies within the Aerospace Division, within ASME and with other professional societies; (ii) to encourage publication of significant research and development results of Aerospace Division members; (iii) to support dissemination of structures and materials information and data via publications, workshops and conferences; and (iv) to promote liaison and interaction with other ASME division committees with similar interests in structures and materials. The Committee sponsors sessions at IMECE and co-sponsors AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference (SDM). The Committee also seeks to recognize excellence through its award activities. In particular, the Committee makes selection of the ASME/Boeing Structures and Materials Award for the best paper presented at the SDM Conference.

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Vice Chair: Wenbin Yu
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Propulsion TC

The Propulsion Technical Committee focuses on research and development of propulsion devices and supporting subsystems for aerospace vehicles. This includes air-breathing engines, liquid, solid and hybrid rockets, as well as advanced spacecraft propulsion including nuclear, solar sail and electric propulsion systems. This development includes the design, analysis and integrated modeling and simulation of systems such as: hybrid and distributed technologies for intelligent control systems; prognostics, diagnostics and conditioned-based maintenance; sensing and measuring technologies for propulsion systems and controls; and advanced seal technologies. The committee supports this effort primarily by organizing technical sessions at the annual Joint Propulsion Conference, including selecting and presenting the annual ASME Best Propulsion Paper award, and has sponsored short courses for education outreach.

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Crew Systems TC

The Crew Systems Technical Committee concerns itself with a wide spectrum of environmental systems technology as applicable to humans living and working in hostile environments. Applications span across terrestrial, aeronautical and space vehicles and habitats including both the internal and external environments. The Crew Systems covers topics including environmental/thermal control and life support systems, personnel protective systems, controlled ecological life support systems, human factors and interfaces, and space extravehicular activity technologies. The full hardware life cycle from design, development, test, and operation of these systems is included in our scope. The Committee has been newly reformed and will be developing its charter and objectives in the upcoming year. New members are encouraged to join the committee and help shape it. The Committee participates in the International Conference on Environmental Systems (ICES).

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Vice Chair: Amy Ross
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For more information visit our Websites:

ASME Aero Divison:
http://divisions.asme.org/Aerospace

ASMS Branch:
http://asms-branch.org

AIAA:
http://info.aiaa.org/tac/adsg/ASTC/default.aspx

World News

Stimulus Methods and Applications of Shape Memory Polymer Composites

Jinsong Leng, Harbin Institute of Technology ■ Smart materials can be defined as the materials that have the capability of sensing and reacting to environmental conditions or stimuli. As a typical smart material, shape memory polymers (SMPs) and their composites (SMPC) have drawn a great deal of attention from researchers in aerospace, due to their shape memory effect. The actuation methods of SMPs and their composites can be generally divided into heat, electricity, light, magnetism, moisture, etc.

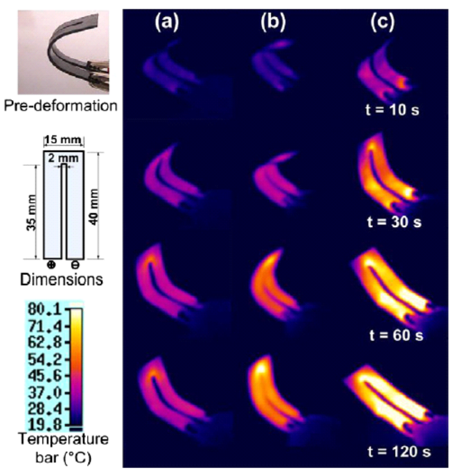

Figure 1. Sequence of shape recovery and temperature distribution. Top-left inset: dimensions of sample; middle-left inset: pre-bent shape; bottom-left inset: temperature bar (oC). Sample (a) 10 vol.% of CB only; Sample (b) 10 vol.% of CB, 0.5 vol.% of random distributed Ni and Sample (c) 10 vol.% of CB, 0.5 vol.% of chained Ni.

Since the discovery of SMPs in the 1980s, they have been rapidly growing during the last decades. This work presents some recent progress of stimulus methods and applications related to SMPs and their composites. Special emphasis is focused upon their applications in space deployable structures and morphing structures.

Space deployable structures

For the traditional aerospace deployable devices, the change of structural configuration in-orbit is accomplished through the use of a mechanical hinge, stored energy devices or motor driven tools. There are some inherent drawbacks for the traditional devices, such as complex assembling process, large volumes and undesired effects during deployment. In view of this, the deployment devices fabricated using SMPs and their composites are proposed to address this problem.

The SMPC hinge consists of two curved circular SMPC shells in the opposite directions. Figure 2 shows the deployment process for the SMPC hinge. A voltage of 20V is applied on the resistor heater embedded in each circular laminate. The temperature of the hinge keeps a constant of 80oC after heating for 30 s. The whole deployment process takes about 100 s. In addition, a deployment of a solar array prototype that is actuated by a SMPC hinge is demonstrated.

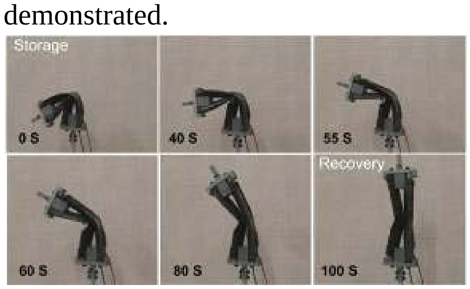

Figure 2. Shape recovery process of SMPC hinge

Morphing Structures

Traditional wings should be designed according to the special mission, flight altitude, Mach number and flight weight of the aircrafts. It is usually optimized in the most concerned flight performance. However, in an integrated flight cycle with continuously varied flight parameters, the geometry of wings is not always optimal. In view of these, morphing aircrafts are designed to solve this problem. Morphing aircrafts can realize the optimal objective through changing its shape according to the outside flight environment.

Based on the SMP materials, a morphing concept of a variable camber wing was developed, as shown in Figure 3. It comprises a flexible SMP skin, a metal sheet and a honeycomb structure. Metal sheet is used to keep the surface smooth during the camber changing. The honeycomb with in-plane high-strain was used to provide support to the flexible skin. The flexible SMP skin is covered to create the smooth aerodynamic surface. The experimental tests demonstrated the feasibility of SMP flexible skin.

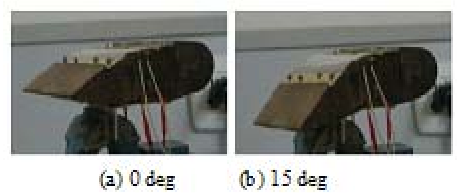

Figure 3. Photograph of the original and morphing configurations of the variable camber wing

In addition, a new kind of variable stiffness skin that composed of SMPC tube and flexible matrix has also been presented. While the variable stiffness skin exhibits high out-of-plane stiffness, it can undergo large strain and has low in-plane stiffness by changing the temperature of the SMPC tube. A corresponding circulating heating system was designed and fabricated to heat the SMPC tube which embedded into the morphing skin. The infrared test showed that the temperature of the morphing skin could reach up to 85°C after

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INVESTIGATIONS INTO TAILORED ELECTRO-MAGNETIC MULTI-FUNCTIONAL MATERIALS FOR SPACE STRUCTURES

Aaron Hock, Derek Doyle, and Brandon Arritt, Air Force Research Laboratory ■ Over the past two decades, researchers have pushed the boundaries in construction of materials with desirable electromagnetic (EM) properties. These new engineered materials are made to perform beyond what is found naturally in traditional materials. The most popular term for these materials has been 'metamaterials'. Many in the academic community have used this term to be synonymous with a homogenous design. While others have applied this to all tailored EM designs, we have adopted the term 'Electromagnetic Tailored Structures (EMTS)' to avoid the argument. Our research into EMTS is meant to explore the utility and limitation of this new class of multi-functional material to handle the structural and electromagnetic requirements of future space systems.

Design for satellite structures is typically stiffness-driven in order to: a) help the satellite survive the dynamic launch environment and b) enable optimal on-orbit mission performance. Other functions frequently asked of the structure include thermal and electrical conductivity and shielding. Structures constitute the majority of a satellite's surface area. Our goal with EMTS is to expand the engineer's material "tool-kit," enabling the utilization of this surface area for advantageous electromagnetic functions; i.e. thermal management, communications, sensors, and protection from the environment. We also believe that the integration of these extra functions into the structure of the satellite can yield significant system-level reductions in size, weight and power without commensurate sacrifices in performance.

While the buzz around these materials is frequently invoked by terms like 'cloaking,' EM tailored materials have more practical potential in miniaturized electronic components, mechanically/electrically tunable filters, tunable/conformal antennas, absorbers, super/planar lenses and wireless sensors. Because many of these applications have a role in Air Force systems, there is significant interest in understanding the limitations in the materials as well as the design process. Of particular importance is the extremely narrow band behavior and suitability in a space vehicle environment.

To date, much of our work at the Air Force Research Laboratory (AFRL), Space Vehicles Directorate has been directed at understanding the linkage between operating environment (mechanical and thermal loading) and EM performance. To develop the appropriate level of understanding, we are employing a 3-part process:

1) Preparing analytical descriptions based on an in-depth under-standing of the underlying physics, enabling designers to more rapidly develop solutions that either mitigate or maximize that response for the given requirements;

2) Multi-physics numerical modeling to verify the analytic descriptions, assess performance in an austere environment, and enable comparisons to results from others in the field; and

3) Multi-physics experimentation (mechanical, thermal, EM) to validate the analytic and numerical models.

An example of our work is shown in Figure 1. It describes the temperature-dependent real part of the permittivity of a metamaterial unit cell (shown in the upper right), over a temperature range of interest for space applications (-150°C to +150°C) [1].

With SensorMetrix, Inc., of San Diego, CA, we have recently developed a

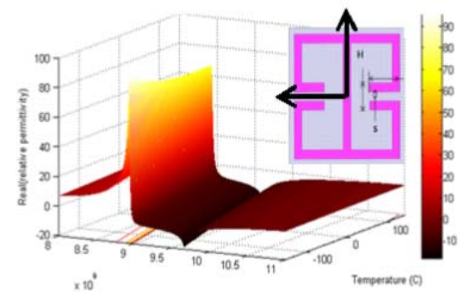

Figure 1. 3D contour plot depicting the temperature-dependent real part of the permittivity for the metamaterial unit cell shown in the upper right.[1]

Fabry-Perot resonator to measure dielectric constant and dielectric losses of EMTS. It is aligned with an MTS load frame, allowing EM characterization during the application of mechanical loads. With Sensor Metrix, we are also

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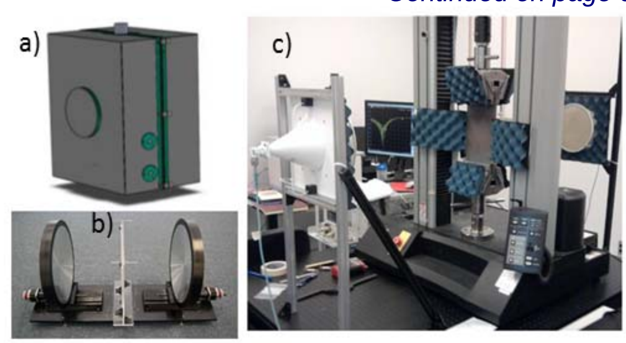

Figure 2. a) Thermal dielectric chamber, b) Fabry Perot Resonator, c) Previous set-up, established at Duke University, where an Instron Load frame was utilized by the team to determine strain-dependent EM behavior.

Energy Harvesting: Aerospace to Medical Applications

D. J. Inman, University of Michigan ■ When you start out in a basic research program you never know what area might end up being a good application of the developed theories. For more than a decade our group has been working on energy harvesting methods using piezoelectric transduction with wireless sensing for the unmanned air vehicles and bridges in mind as the applications. Two of the major roadblocks in developing useful devices to harvest ambient vibration energy were increasing the amount energy harvested and being able to harvest over a large range of frequencies (i.e., increasing the bandwidth). These drawbacks were substantially improved by the introduction of nonlinearities into the device. Another problem, arising for small packaging applications, was that the smaller the device, the higher the first resonant frequency making MEMs scale devices near useless for harvesting significant amounts of vibration energy. This problem was solved by employing a unique geometry in the design of a harvesting device. Much to our surprise, the result of these discoveries resulted in a technology suitable for running pacemakers.

One of the key difficulties with pacemaker technology is battery replacement. Today's pacemakers have batteries that last between 7 and 10 years on average. Pacemakers are installed in patients as young as two years old. Such a person would require as many as 10 battery replacement surgeries throughout their lifetime. Replacement of a pacemaker battery is both expensive and potentially painful, requiring surgery. The battery is not actually replaced but rather the entire pacemaker unit is replaced. In the end it turns out that our developments made to solve harvesting problems for wireless sensor systems for both the Air Force Office of Scientific Research and the National Institutes of Standards and Technologies (NIST) have potentially solved this long standing medical problem. Figure 1 shows a pacemaker next to a harvesting device used in a laboratory proof of concept experiment.

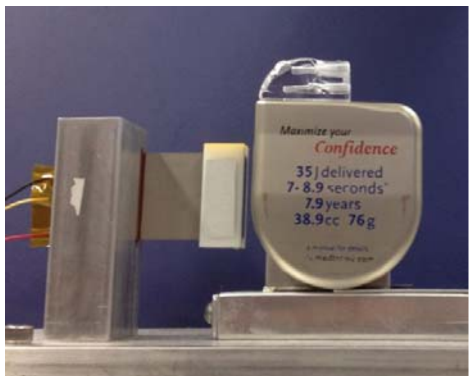

Figure 1. A pacemaker demo used to size the energy-harvesting device.

Early commercial approaches to vibration energy harvesting using piezoelectric transduction use a cantilever beam with a tip mass to tune the resonant frequency of the beam to the dominant ambient frequency. The beam is coated with a piezoceramic material and strain is induced in the ceramic as the beam vibrates. The vibration is converted to an electric field by the piezoelectric effect. The voltage appearing across the piezoelectric material exhibits a resonance behavior. Because of this these devices are not very robust to changes in the frequency of the ambient vibration. The smart structures community started to address this issue in a variety of ways eventually solving it by using nonlinear dynamics.

Students at Virginia Tech (T. Tanner, H.A. Sodano, S. R. Anton, A. Erturk and M. A. Karami) worked extensively on various aspects of energy harvesting as did others in the community. Tanner (2001) used a stack actuator to harvest ship deck vibrations, Sodano (2002) examined off resonance harvesting and Erturk (2008) introduced broadband harvesting through induced nonlinearity. Anton (2008) developed self-charging structures by integrating thin film battery technology into harvesting in the same structure. Karami (2009) examined MEMs scale harvesting solutions.

Based on this previous research and developing a method to shrink harvesting devices to a small size, M.A. Karami in the Aerospace Department at the University of Michigan has developed a novel way to harvest vibrations inside the human chest cavity at a level and frequency range large enough to power a pacemaker. Working in conjunction with a Dr. David Bradley, a cardiac surgeon at the University of Michigan's C.S. Mott's children's hospital, they have made measurements to validate their theoretical predictions. The device is based on a combination of piezoelectric and magnetic materials and fits inside the current pacemaker casing. Measurements have been made in pigs and goats to obtain realistic vibration characteristics. Goats and pigs have hearts similar to humans. This data (see Figure 2) was then used to validate the

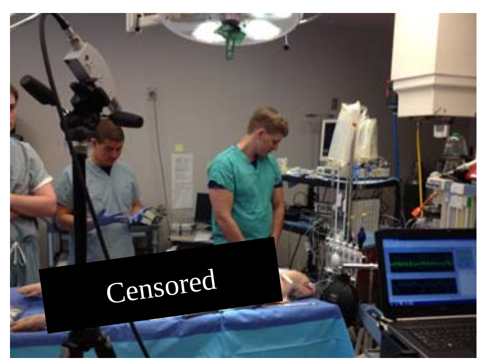

Figure 2. Measuring chest cavity vibrations with a laser vibrometer (upper left hand corner during open heart surgery on a pig.

AIAA/ASME OFFICERS

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Secretary: Laila Asheghian, *lasheghian@nextgenaero.com*

theory (see Figure 3) that predicts that a pacemaker could be run from vibrations internal to the human chest cavity and to do so during a range of human activity and hence a wide range of heart rates.

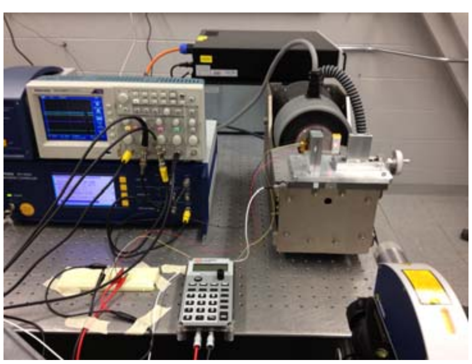

Figure 3. Using data taken from measurements of pig hearts the basic idea is experimentally validated and shows that the levels of energy are high enough to harvest.

Criticism of the proposed method run along the lines of "isn't this perpetual motion". But of course it is not because humans continually take in energy by eating. In addition the function of the pacemaker is not to power the heart but to regulate it's beating. The second question is "isn't putting a piezoceramic material inside the body dangerous?" Note that a pacemaker is hermetically sealed and the majority of it is actually the lithium-iodide battery so this problem is already solved.

Pacemakers require less than microwatt of power, easily exceeded by the proposed harvesting design. The next phase is to perform further experiments on animals, to fine tune the details of the design and to build a case for use in humans. ■

WORLD

World News Article from page 4

applying hot water (90°C) for 210 s, which is higher than the glass transition temperature of SMPC tube (around 62°C).

As a relatively new kind of shape memory materials, the current development and application of SMPs seemingly lag behind other smart materials. In consideration of their advantages, SMPs and their composites are expected to become one of the leading roles in the field of aerospace, automobile, biological medicine, smart textiles and fabrics in the future. ■

2012 GARY ANDERSON EARLY ACHIEVEMENT AWARD

Zoubeida Ounaies, The Pennsylvania State University ■ Dr. William Oates is the 2012 Gary Anderson Early Achievement Award recipient. He is an associate professor of mechanical engineering at Florida A&M / Florida State University. Dr. Oates completed his PhD in mechanical engineering at the Georgia Institute of Technology in 2004. His current research focus is in field-coupled mechanics of active materials and development of multifunctional systems and structures. Re-

cent applications in Oates' group relate to integration of liquid crystal elastomer actuators and active flow control using piezoelectric microjet actuators. Since he joined academia in 2006, Dr. Oates has been recognized with a number of prestigious research and teaching awards, such as the DARPA Young Faculty Award, the FSU Guardian of the Flame Teaching Award, the ASEE Summer Faculty Fellowship Award, and the NSF Career Award.

The Gary Anderson Early Achievement Award is presented by the ASME ASMS Branch for notable contributions to the field of Adaptive Structures and Material Systems. The winner of the award must be within 7 years of terminal degree at the time of nomination. Nominations for the 2013 award may be received at large from any source and should be sent to Zoubeida Ounaies *zxo100@psu.edu* or Mohammad Elahinia *mohammad.elahinia@utoledo.edu* by December 2013. ■

2012 ASME ADAPTIVE STRUCTURES AND MATERIALS SYSTEMS PRIZE

Zoubeida Ounaies, The Pennsylvania State University ■ Prof. Norman M. Wereley, Minta Martin Professor and Chair in the Dept. of Aerospace Engineering at the University of Maryland, was honored with the American Society of Mechanical Engineers (ASME) Adaptive Structures and Material Systems Prize. Dr. Wereley was recognized primarily for his contributions to the theory and application of semi-active magnetorheological (MR) dampers, and their application to occupant protection, vibration isolation, and stability augmentation systems using advanced optimal and feedback control strategies. He has also made significant contributions to electrohydraulic actuators, elastomeric damping, composites, pneumatic artificial muscles and their applications to robotics and aerospace actuation systems. Dr. Wereley has coauthored over 150 journal articles, 11 book chapters, and over 240 conference articles. He is also co-inventor on over a dozen patents and over a dozen patents pending, many of which are currently being commercialized in projects related to systems that protect vehicle occupants from vibration, shock, crash, and mine blast loads. Dr. Wereley's scholarship has been recognized by numerous awards; recent ones include the 2012 American Helicopter Society (AHS) Best Paper Award in Crash Safety, the 2012 ASME Adaptive Structures and Material Systems Best Paper Award in Structural Dynamics and Control, the 2011 AHS Harry T. Jensen Award as part of the Boeing Active Crash Protection Team, and the 2011 AIAA Sustained Service Award. Dr. Wereley is a fellow of AIAA (2012), ASME (2008) and IOP (2001). He has a B.Eng. from McGill University (1982) and M.S. (1987) and Ph.D. (1990) from the Massachusetts Institute of Technology.

Dr. Wereley received the Adaptive Structures and Materials Systems Prize, and delivered the Adaptive Structures Prize Lecture, at the 20th AIAA/ASME/AHS Adaptive Structures Conference, which was held in conjunction with the 53rd AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference from 23-26 April 2012 in Waikiki, HI.

The ASME Aerospace Division and the ASME ASMS Branch present the Adaptive Structures and Materials Systems Prize to an individual who has "made significant lifetime contributions to the sciences and technologies associated with adaptive structures and/or materials systems." Nominations for the 2014 award, consisting of a one page biosketch, may be received at large from any source and should be sent to Zoubeida Ounaies *zxo100@psu.edu* or Mohammad Elahinia *mohammad.elahinia@utoledo.edu* by June 2013. The 2014 Adaptive Structures and Materials Systems Prize will be presented at the 22nd AIAA/ASME/AHS Adaptive Structures Conference to be held concurrently with AIAA SCITECH in January 2014. ■

Honors and Awards

ASMS Best Paper Awards

Zoubeida Ounaies, The Pennsylvania State University ■ The best paper in Materials and Material Systems was awarded to F. Gao and L.M. Weiland for their paper entitled "Streaming Potential Hypothesis for Ionic Polymer Transducers in Sensing: Roles of Ionomer State and Morphology", published in JIMSS, 22 [14], pp. 1623-1630, 2011.

The best paper in Structures and Structural Dynamics was awarded to B. Woods, C. Kothera, and N.M. Wereley for their paper entitled "Wind Tunnel Testing of a Helicopter Rotor Trailing Edge Flap Actuated via Pneumatic Artificial Muscles", published in JIMSS, 22 [13], pp. 1513-1528, 2011.

The ASME ASMS Branch awards the two best papers, in Materials and Material Systems and in Structures and Structural Dynamics, to outstanding papers published in journal publications relevant to smart materials and structures and conference proceedings sponsored by the ASMS Branch. Selection of nominations can occur one of three ways: 1) Selected papers published in ASME transactions and/or journals related to smart materials and structures during a given calendar year; 2) SPIE Smart Structures and Materials (SSM), ASME Smart Materials, Adaptive Structures and Intelligent Systems (SMASIS), AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, and the International Conference on Adaptive Structures & Technology (ICAST); and 3) Nominations from ASMS Branch members.

Nominations for the 2013 Best Paper Awards (appearing during calendar year 2012) should be sent to: Zoubeida Ounaies *zxo100@psu.edu* or Mohammad Elahinia *melahin@utnet.utoledo.edu* by December 2013. ■

Government

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developing a dielectric thermal chamber that can be coupled to the same load frame. The dielectric case allows EM measurements while imposing a wide range of thermal (-100°C to +100°C) and mechanical loads. The three components can be seen in Figure 2.

EM tailored structures are a new tool for engineers to design to a desired EM function. While they have vast applications, further studies are required to understand and optimize performance for the extreme environments in which defense systems operate. AFRL Space Vehicles Directorate is developing analytic and numerical models and unique test facilities to understand the multi-physics linkage between structural and thermal loading and EM properties.

References: [1] Arritt, B., D. Smith, T. Khraishi, "Analytically Describing the Temperature-Dependent Constitutive Parameters of an Electromagnetic Metamaterial," J. Int. Mat. Sys. Struct., 23, 4, 463-471 (2012). ■

Historical Note - The Early Meetings

James E. Hubbard, Jr., University of Maryland ■ On March 23, 1983 then President Ronald Reagan announced his intentions to develop a new system to reduce the threat of nuclear attack and end the strategy of mutual deterrence in an address to the nation entitled, Address to the Nation on Defense and National Security. The system he proposed became known as "Star Wars," after the popular movie. His speech mobilized the entire nation and focused us on a research and development path toward this end.

During this period Dr. Tony Amos, then a manager with the Air Force Office of Scientific Research (AFOSR) began holding a series of invitation only workshops to discuss these systems, associated problems and potential solutions. The list of invitee's included members of government, academia and the private sector who were all active in this area of research. Senior, mid-career and junior researchers from diverse fields that encompassed structural vibrations, active control, fluid dynamics, applied mathematics and more were in attendance. The group included a number of well-known, distinguished scholars such as Professor Leonard Meirovitch in the field of vibrations, Professor Holt Ashley the field of aeroelastic structures and unsteady aerodynamics, and Professor Michael Athans in the field of control theory. This was during a period in which multidisciplinary collaborations were rare and it quickly became apparent to the group that we lacked a common nomenclature for discussions. A simple example involved terminology to describe structural damping. Some of spoke of loss factor, some of damping ratio and others of "Q" factor. This of course led to numerous philosophical debates and vociferous discussions on the fundamentals required for characterization and performance assessment for LSS.

This group met regularly for several years and culminated with the formation of an annual meeting at Virginia Polytechnic and State University hosted by Professor Meirovitch entitled VPI&SU/AIAA Symposium on Dynamics and Control of Large Structures in Blacksburgh, Virginia. This would be the first of many gatherings leading to the formation of the field Smart Structures. ■

Education Corner

New TANMS NSF Center at UCLA Focuses on Nanoscale Multiferroic Materials

Chris Lynch and M. Chin, UCLA

■ Fundamental research developed in the smart materials and structures community over the past several decades is moving toward the nanoscale in a big way. Professor Greg Carman has brought together a multidisciplinary research team from UCLA, UC Berkeley, Cornell, CSU Northridge, and ETH-Zurich to develop some of the world's tiniest electromagnetic devices - thanks to a Engineering Research Center grant from the National Science Foundation. Center details and contact information can be found at www.tanms.ucla.edu.

The grant of up to $35 million over 10 years, has funded the NSF TANMS NERC (Translational Applications of Nanoscale Multiferroic Systems - Nanosystems Engineering Research Center). The new center, headquartered at UCLA's Henry Samueli School of Engineering and Applied Science, will focus on research aimed at developing highly efficient and powerful electromagnetic systems roughly the size of a red blood cell - systems that can power a range of devices, from miniaturized antennas and memory for consumer electronics to technologies important for national security. Researchers are working to replace traditional electric current driven magnetic field changes with direct ferroelectric to ferromagnetic (i.e. smart or active materials) switching by employing a fundamentally new approach to electromagnetic power at the nanoscale.

"We believe this is an opportunity for a truly revolutionary change in miniaturized electromagnetic devices," said Greg Carman, director of the new center and a UCLA professor of mechanical and aerospace engineering. "If you combine all three of our application areas - memory, antennas, and motors - it really opens the possibilities of what new platforms may become possible. Present electromagnetic devices are based on concepts discovered nearly 200 years ago by Oersted and, while working well in large systems, they suffer from severe limitations in the small scale." He added, "TANMS overcomes this problem by developing a new, game-changing approach to produce electromagnetic fields using nanoscale multiferroic materials with lengths as small as a few hundred atoms."

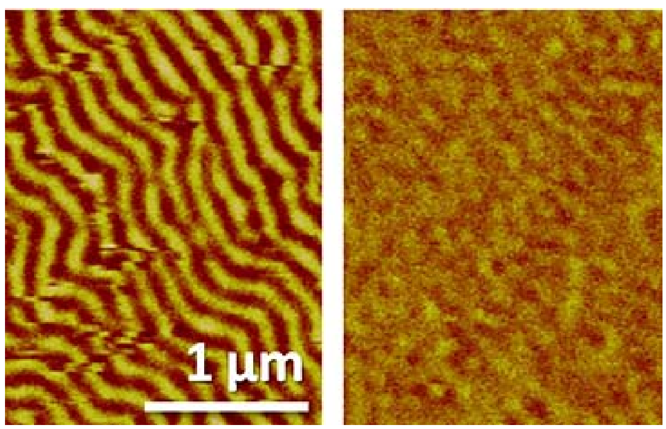

Figure 1. TANMS researchers have used an electric field to turn a magnetic field on (l) and off (r).

Electromagnetic devices ubiquitous in today's world operate by passing an electric current through a wire, a concept first demonstrated in 1820 by Oersted.. And while this technology works extremely well in the large scale, it fails in the small scale and has been a roadblock to advancements in miniaturization. As a wire's diameter decreases, so does the amount of current flowing through it, limiting the ability of this approach to create and control electromagnetic energy at the nanoscale. The new approach being developed by TANMS researchers seeks to solve this problem by taking advantage of multiferroic materials, which use electric fields to intrinsically switch the magnetic state of a material. Over the past decade, TANMS researchers have led fundamental and explorative efforts demonstrating the unique properties present in multiferroics at the nanoscale.

"With platform technologies such as the ones we are developing (memory, antennas, motors), new active devices that are more efficient, substantially smaller, and more powerful will be available to engineers working on a wide class of problems" said Prof. Carman. "Of course, each individual focus application represents a significant advancement. For example, the ability to decrease the antenna size in a cell phone by an order of magnitude is an important step not only for consumers but also the military. I feel very fortunate to lead the world's best academic researchers in nanoscale multiferroics."

While the new center's major focus is on research, it also aims to develop a unique ecosystem around the five-university alliance that is focused on both education and commercialization. TANMS faculty are already working closely with UCLA's Institute for Technology Advancement to help define and transition to market the intellectual property that will be developed under the new program. Currently 21 companies, ranging from small businesses to large corporations, have sent letters of interest to help translate and commercialize TANMS and seven companies

Continued on page 13

SMASIS Conference Synopsis

Adaptive Structures and Materials Systems by definition are intelligent, flexible systems that have sentience and responsiveness to ever changing environments. The field has rapidly matured due to synergistic interdisciplinary efforts across sectors of universities, government and industry. To continue the high impact growth of this field and lead it into the future, the purpose of this conference is to assemble world experts across engineering and scientific disciplines (mechanical, aerospace, electrical, materials, and civil engineering, biology, physics chemistry, etc) to actively discuss the latest breakthroughs in smart materials, the cutting edge in adaptive structure applications and the recent advances in both new device technologies and basic engineering research exploration. The conference is divided into symposia broadly ranging from basic research to applied technological design and development to industrial and governmental integrated system and application demonstrations.

Schedule

March 22, 2013:	400 word abstract due
April 23, 2013:	Authors informed of abstract acceptance
May 20, 2013:	Final full-length paper due
June 3, 2013:	Copyright form due

Full paper will appear in an archival ASME Conference Proceedings. Selected papers will be published in archival Journals.

Participation

Authors should submit a 400 word abstract to the conference web site **www.asmeconferences.org/SMASIS2013.** Questions can be directed to:

Nancy Johnson, General Chair
nancy.l.johnson@gm.com

Andrei Zagrai, Technical Chair
azagrai@nmt.edu

Ralph Smith, Technical Co-Chair
rsmith@eos.ncsu.edu

Executive Committee

Diann Brei, Greg Carman, Inderjit Chopra, Kon-Well Wang, Alison Flatau, Ephrahim Garcia, Dan Inman, Nancy Johnson, Jay Kudva, Dimitris Lagoudas, Chris Lynch, Anna McGowan, Roger Ohayon, Greg Reich, Janet Sater, Sergio dos Santos e Lucato, Stefan Seelecke

Images courtesy of Scott Catron and Skyguy414

Call for Papers

ASME Conference on

SMART MATERIALS, ADAPTIVE STRUCTURES AND INTELLIGENT SYSTEMS

September 16 - 18, 2013
Snowbird (Salt Lake City), UT, USA

Sponsored by the Adaptive Structures & Materials Systems Branch, Aerospace Division
Participating society: AIAA Technical Committee on Adaptive Structures

The conference is divided into symposia broadly ranging from basic research to applied technological design and development to industrial and governmental integrated system and application demonstrations. The symposia specifically are:

Development and Characterization of Multifunctional Materials

Chair: Hani E. Naguib, *Univ. of Toronto*
Co-Chairs: Billy Oates, *Florida State*
Henry Sodano, *Univ. of Florida*

Topical areas: Material formulations, evaluation, synthesis, and processing; multifunctional composites and hybrid materials; bio-inspired and nano-composites; self-healing materials; novel triggering approaches, including optical, chemical, electrical, and mechanical; material property enhancement; interface and interaction science.

Mechanics & Behavior of Active Materials

Chair: Travis Turner, *Langley Research Center*
Co-Chairs: Iain Anderson, *Univ. of Auckland*
Nazanin Bassiri-Gharb, *Georgia Tech*

Topical areas: Advanced constitutive measurements, micro- and nano-mechanics of actuator & sensor materials, phase field modeling, multi-scale and multi-physics material models, finite element implementations, reliability issues: aging, fatigue, and fracture, materials for energy storage.

Modeling, Simulation and Control of Adaptive Systems

Chair: Eugenio Dragoni, *Univ. of Modena*
Co-Chairs: Bjoern Kiefer, *TU Dortmund*
Jeong-Hoi Koo, *Miami Univ., Ohio*

Topical areas: Micro and macro level modeling, vibration and acoustic control, passive/semi-active/active damping and stiffness variation, actuation and motion control, intelligent and adaptive control, nonlinear control, hysteresis control, modeling simulation and control of micro/nano systems, nonlinear dynamics, and nonlinear vibration.

Integrated System Design and Implementation

Chair: Eric Ruggiero, *GE*
Co-Chair: Onur Bilgen, *Old Dominion Univ.*
Rich Beblo, *Dayton Research Inst.*

Topical areas: Sensors and actuators, power and control electronics, smart devices and technologies, compliant mechanism design, adaptive / intelligent / integrated systems design, smart structures design processes and tools, Industrial and Government smart products and system applications, smart electronics and devices, MEMS.

Structural Health Monitoring

Chair: Oliver Myers, *Mississippi State*
Co-Chairs: Kenneth Loh, *UC Davis*
Andrew Swartz, *Michigan Tech*

Topical areas: Damage identification & mitigation, sensor networks, data fusion, data mining and management, damage diagnostic and prognostic modeling software, system integration, and applications.

Bioinspired Smart Materials and Systems

Chair: Vishnu Baba Sundaresan, *VCU*
Co-Chairs: Andy Sarles, *Univ. of Tennessee*
Richard Trask, *Univ. of Bristol*

Topical areas: Modeling of biological systems, understanding physical phenomena in biological systems, biomimetic and bio-inspired devices, machines and robotics, utilizing biological systems, smart prosthetic systems and intelligent implant materials and structures.

Energy Harvesting

Chair: Mohammed Daqaq, *Clemson Univ.*
Co-Chairs: Adam Wickenheiser, *George Washingon Univ.* ***Kazuhiko Adachi,*** *Kove Univ.*

Topical areas: Modeling and experiments of energy harvesting using piezoelectric and magnetostrictive materials; dielectric, ferroelectric, and ionic electroactive polymers; inductive and capacitive devices; deterministic and stochastic excitations; broadband and nonlinear systems; aeroelastic, hydroelastic, and acoustic energy harvesting; MEMS and NEMS configurations; novel circuits and storage devices.

ASME
SETTING THE STANDARD

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EDUCATION CORNER

Darren Hartl, Texas A&M ■ Research at Texas A&M University in the area of active materials and aircraft structural morphing recently intersected with the study of advanced architectural design and fabrication methods, resulting in a new kinetic art installation in the H.R. "Bum" Bright (HRBB) Building, home of the Dept. of Aerospace Engineering at Texas A&M University. The morphing wall is a new adornment to the building's south entrance.

The concept was originally envisaged by Darren Hartl, a Texas Engineering Experiment Station (TEES) Research Assistant Professor in the Texas A&M Department of Aerospace Engineering, and Gabriel Esquivel, Assistant Professor in the Dept. of Architecture. Hartl is the Director of Operations of the Texas Institute for Intelligent Materials (TiiMS) and Structures focusing on Shape Memory Alloy (SMA) technologies. Esquivel is an active instructor and mentor in the Mitchel Lab, which specializes in advancing the methods of advanced digital design of architectural forms. The morphing wall incorporates elements of both research efforts, and required the entirety of the fall semester to design and fabricate.

"The piece wasn't a preconceived idea at all," said Esquivel. "The design emerged from our research discoveries." Hartl was enthusiastic about the collaboration. "In teaming with the design students, we were provided with a design challenge in which aesthetic goals can, at times, supersede quantified and purely functional objectives," said Hartl, "This is also an opportunity to carry our technological solutions to a new and broader audience." Esquivel's students began collaborating with their counterparts in aerospace engineering during the spring 2012 semester, when they worked with Hartl to evaluate the structural integrity of composite materials they used to create unconventional and multifunctional home exteriors.

The kinetic art concept was further encouraged by the department heads of Aerospace Engineering (Rodney Bowersox) and Computer Science and Engineering (Hank Walker), the two departments housed in HRRB.The configuration and aesthetic of the morphing wall were completely designed by architecture students under the guidance of Esquivel. These students, who also collectively self-funded the majority of the project, made extensive use of the College of Architecture's Digital Fabrication Facility at Texas A&M's Riverside Campus to create the piece. The various offset surfaces that comprise the overall wall are constructed of layers of resin and a C-glass fiber weave. The colorful pattern is printed onto large sheets of paper that are layered in under the final layer of C-glass.

Nearly 30 individual morphing shape memory alloy components are installed throughout the wall, including star-like "flowers" and various morphing flaps. SMA material was donated by Dynalloy and SAES-Getters. Daniel Whitten, a TiiMS Undergraduate Research Assistant and student in the Department of Mechanical Engineering, designed and custom-built a 16-channel Arduino-based controller. Arduino is an open-source electronics prototyping platform. Aerospace master's student Stephen Cornell assisted in fabrication of several of the SMA components.

Timed actuation of the morphing components creates a subtle aesthetic of motion from left to right. Named for the inspiration of Pop-up books and the pop art and "Op-Art" movements, the creation known as "Pop/Op" creates "motion through overlapping layers, graphics and the moving elements," said Esquivel. The wall is intended to be powered and active during normal university business hours, and the new installation is considered to be a permanent feature of the Bright building.

"Pop/Op" is a tribute to engineer/artist Frank Malina '34, who earned a Master's in Aeronautical and

Education Corner

Mechanical Engineering at Texas A&M. Malina was the co-founder of the Jet Propulsion Laboratory and directed it in the 1940's. As an engineer, Malina conceived and directed the design, construction and testing of the United States' first successful high-altitude research rocket in 1945. He was also a kinetic artist who became internationally recognized as a pioneer of light and motion in art. He founded Leonardo, a research journal focusing on the interactions between contemporary arts, science and technology. His kinetic art is housed in collections at the Smithsonian Institution and art museums in Paris and San Francisco. Two pieces remain in the permanent collection of Texas A&M University and are exhibited on the lower level of the MSC.

Hartl and Esquivel won a grant from the Texas A&M Academy for the Visual and Performing Arts to construct a second such piece in the spring semester. Their team will focus on a free-standing "sculpture" configuration and plan to push the bounds of morphing and control even further, integrating such features as the ability of a passing viewer to use a smart-phone based interface to directly control the wall in real time. The participation of faculty and students from other departments such as Computer Science and Engineering is being discussed. "These collaborations are an indication of where architecture can go in combination with other disciplines," said Esquivel. "This is taking architecture into a new territory that includes animation and robotics."

It is the hope of the faculty and students involved in the creation of "Pop/Op" that those passing through HRRB enjoy this new fusion of engineering and art. A video of the installation can be found here: *http://vimeo.com/55485528* ■

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are in the process of formalizing an agreement with the new TANMS center.

On the educational front, TANMS has a unique "cradle-to-career" program that will introduce undergraduate and high school students to the center's facilities, as well as provide them with unique opportunities throughout their college careers. TANMS's educational philosophy focuses on teaching students about the important interactions between the engineering and business sectors that are necessary to advance new technologies that benefit society.

"The United States has always led in technology development during the last century, and to continue this, our country needs to expand the pipeline of future engineers and scientists with more students from diverse backgrounds," Carman said. "At TANMS, we envision high school students, undergraduates and graduate students taking part in research and translational efforts associated with the research. We are trying to help our best and brightest students find their path toward being the next Henry Ford, Steve Jobs or Henry Samueli. I firmly believe that teaching our students that engineering is as much about business as it is about science will lead to a new wave of students interested in entering engineering, and I expect our new paradigm to become a model program for other universities across the country."

The TANMS NFS NERC closely integrates fundamental research with testbeds and industrial systems level applications. This approach brings together researchers that focus on fundamental barriers to technology development with industrial partners that drive the technology needs and will transition the technology to near term applications.

The National Science Foundation's Engineering Research Center (ERC) program, established in 1985, fosters extensive collaborations to create technological breakthroughs for new products and services and to prepare U.S. engineering graduates for successful participation in the global economy. The nanosystems ERCs - or NERCs - are expected to create transformational science and engineering platforms for the respective fields of nanoscale research, education and innovation. As appropriate to its particular areas of research, each NERC will highlight the societal and environmental implications of its nano-enabled scientific and technological breakthroughs. For more on the National Science Foundation, visit www.nsf.gov. ■

Thank You!

To all those that contributed and helped in the preparation of this newsletter!

Brandon Arritt	*AFRL*
Diann Brei	*University of Michigan*
M. Chin	*UCLA*
Derek Doyle	*AFRL*
Daren Hartl	*Texas A&M*
Aron Hock	*AFRL*
James Hubbard	*Univ. of Maryland*
Dan Inman	*University of Michigan*
Jinsong Leng	*Harbin Institute of Technology*
Sergio L. dos Santos e Lucato	*Teledyne Scientific*
Chris Lynch	*UCLA*
Zoubeida Ounaies	*Penn State*
Janet Sater	*IDA*

Calendar of Events

SPIE Smart Structures & Materials Symposium
San Diego, CA
Dates: March 10-14, 2013
http://spie.org/smart-structures-nde.xml

IWPMA 2013
Hannover, Germany
Dates: July 14-18, 2013
http://www.iwpma2013.uni-hannover.de

AIAA/ASME/AHS Adaptive Structures Conference
Location: Boston, MA
Dates: April 8-11, 2013
http://www.aiaa.org/SDM2013

2013 International Workshop on Acoustics Transduction Materials and Devices
Location: State College, PA
Dates: May 7-9, 2013
http://www.mri.psu.edu/conferences/usnavy

ASME Conference on Smart Materials, Adaptive Structures and Intelligent Systems
Location: Snowbird, UT
Dates: September 16-18, 2013
Abstracts Due: March 22, 2013
http://www.asmeconferences.org/SMASIS2013

International Conference on Adaptive Structures and Technologies
Location: Aruba
Dates: October 7-9, 2013
Abstracts Due: May 1, 2013
http://icast2013.engin.umich.edu

AIAA/ASME/AHS Adaptive Structures Conference
Location: National Harbor, Maryland
Dates: January 13-17, 2014
Abstract Due: June 5, 2013
http://www.aiaa.org/scitech2014

Education Corner

Student Spotlight

Noel D'Souza is a Ph.D. student in Mechanical Engineering at the Virginia Commonwealth University in Jayasimha Atulasimha's group. He performed an excellent job in the research projects assigned to him. Furthermore, he has shown tremendous personal initiative in furthering the research collaborations with NIST, Gaithersburg.

Noel has published 3 theoretical papers in two well-reputed journals within 2 years of working with me, on 4-state multiferroic nanomagnetic logic that is funded by the NSF and Semiconductor Research Corporation's: Nanoelectronics Beyond 2020 project.

He is a keen experimentalist and has successfully fabricated ~100 nm lateral dimension elliptical nanomagnets on a piezoelectric substrate with which he plans to show that nanomagnetic logic gate can be clocked with strain! In doing so, he has optimized the e-beam lithography at VCU as well as been instrumental in carrying forward a collaboration with researchers at NIST for visualizing the magnetization in such nanostructures. In summary, he had played a key role in applying smart materials research to an entirely new and emerging field of performing super energy efficient computing using nanomagnets clocked with strain.

Noel excels in presenting his work on computing with nanomagnets to different audiences such as to a primarily Physics audience at the American Physical Society meeting (March 2012) and a with primarily Engineering audience at the ASME Smart Structures conference (August 2011, where he won the ASME Multifunctional Materials Symposium Best Student Paper Award). He has also recently been awarded a GMAG Student Travel Award for the upcoming American Physical Society March Meeting 2013 and is one of only four student recipients of this annual GMAG-sponsored travel award. ■

Masood Taheri Andani is currently perusing his Master's degree in Mechanical Engineering at the University of Toledo in Toledo, Ohio. Masood joined the Dynamic and Smart Systems Laboratory in Mechanical, Industrial, and Manufacturing Engineering Department in September 2011 after completing his bachelor's degree at Isfahan University of Technology in Isfahan, Iran.

Masood's research focuses on constitutive modeling, finite element analysis and material characterization of Shape Memory Alloys, especially Nitinol. His research is also aimed at utilizing the unique properties of this type of smart material in negotiating the functionality barriers of conventional materials. As part of this research, devices such as ankle foot orthosis, SMA antagonistic heart pacing actuator and retrograde bone blade have been modeled and validated with experiments.

Masood developed some analytical platforms for the quick and inexpensive analysis of the thermo-mechanical response of shape memory alloys under complex multi-axial loading conditions. These tools are currently being applied in the design and optimization procedure of SMA based devices developed in Dynamic and Smart Systems Laboratory.

In addition to his own research, Masood has been also involved in several team projects. In a recent one, Masood collaborated with his fellow lab mates to design and fabricate a novel superelastic ankle foot orthosis which was successfully tested and patented.

With one published journal paper, one journal paper in press, four conference publications, and two journal papers under preparation, Masood has an excellent publication record. He is also serving as a reviewer for the Journal of Intelligent Material Systems and Structures and journal of Shock and Vibration. Masood will defend his thesis this summer graduating with a 4.0 GPA and will be seeking a PhD post graduate research position for fall 2013. ■