



**The 36th Annual Technical Conference of
American Society for Composites**

**Tri-Agency Symposium on
“Multifunctionality, System Endurance &
Intelligent Structures”**

Incorporating:

**The 2021 Annual Grantees’/Contractors’ Meeting for
AFOSR Program on “Mechanics of Multifunctional
Materials & Microsystems”**

**The 2021 Annual Review for
ARO Program on “Mechanical Behavior of Materials”**

**The 2021 Annual Review for
ONR Program on “Structural Composites &
Non-Destructive Evaluation”**

19-23 September 2021

Texas A&M University (Virtual), College Station, TX 77843

SPONSORED BY:



Symposium Co-Chairs:

Daniel Cole (Army Research Office)
B.-L. ("Les") Lee (Air Force Office of Scientific Research)
Ignacio Perez de Leon (Office of Naval Research)

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Jeffery Baur (Air Force Research Lab)
Ben Dickinson (Air Force Research Lab)
Michael Durstock (Air Force Research Lab)
James Joo (Air Force Research Lab)
Gregory Reich (Air Force Research Lab)
Ajit Roy (Air Force Research Lab)
Richard Vaia (Air Force Research Lab)
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Geoffrey Cranch (Naval Research Lab)
Peter Finkel (Naval Research Lab)
Keith Perkins (Naval Research Lab)
James Thomas (Naval Research Lab)

Session Chairs/Moderators:

Jeffery Baur (Air Force Research Lab)
Geoffrey Cranch (Naval Research Lab)
Ben Dickinson (Air Force Research Lab)
Michael Durstock (Air Force Research Lab)
Peter Finkel (Naval Research Lab)
Ming Han (Michigan State Univ.)
Robert Haynes (Army Aviation and Missile Center)
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James Joo (Air Force Research Lab)
Sridhar Krishnaswamy (Northwestern Univ.)
Jay Kudva (NextGen Aeronautics, Inc.)
Daniel Magagnosc (Army Research Lab)
John Michopoulos (Naval Research Lab)
Daniel O'Brien (Army Research Lab)
Anisur Rahman (Office of Naval Research)
Gregory Reich (Air Force Research Lab)
Ajit Roy (Air Force Research Lab)
Derek Schesser (Army Research Lab)
Nancy Sottos (Univ. of Illinois)
James Thomas (Naval Research Lab)
Richard Vaia (Air Force Research Lab)
Stanley Williams (Texas A&M Univ.)

Keynote Speaker:

Siddiq Qidwai (National Science Foundation)

Speakers, PI's & Co-PI's (Non-Government):

Douglas Altshuler (Univ. of British Columbia)
Andres Arrieta Diaz (Purdue Univ.)
Leif Asp (Chalmers Univ. of Technology)
Francois Barthelat (Univ. of Colorado)
Ray Baughman (Univ. of Texas at Dallas)
Will Boley (Boston Univ.)
Richard Bomphrey (Royal Veterinary College)
Fu-Kuo Chang (Stanford Univ.)
Ioannis Chasiotis (Univ. of Illinois)
Yong Chen (Univ. of California, Los Angeles)
Nikolaus Correll (Univ. of Colorado, Boulder)
Andrew Croll (N. Dakota State Univ.)
Mark Cutkosky (Stanford Univ.)
Yiming Deng (Michigan State Univ.)
Martin Dunn (Univ. of Colorado, Denver)
Aaron Esser-Kahn (Univ. of Chicago)
Philippe Geubelle (Univ. of Illinois)
Somnath Ghosh (Johns Hopkins Univ.)
Victor Giurgiutiu (Univ. of South Carolina)
Cody Gray (Acellent Technologies)
Emile Greenhalgh (Imperial College London)
Ming Han (Michigan State Univ.)
Darren Hartl (Texas A&M Univ.)
Lei He (Univ. of California, Los Angeles)
Ximin He (Univ. of California, Los Angeles)
Noel Holbrook (Harvard Univ.)
Jonathan Hopkins (Univ. of California, Los Angeles)
Yuhang Hu (Georgia Inst. of Technology)
Guoliang Huang (Univ. of Missouri)
Haiying Huang (Univ. of Texas at Arlington)
Doug Hunsaker (Utah State Univ.)
Daniel Inman (Univ. of Michigan)
Sung Kang (Johns Hopkins Univ.)
Alamgir Karim (Univ. of Houston)
David Kisailus (Univ. of California, Irvine)
Lou Kondic (New Jersey Inst. of Technology)
Roy Kornbluh (SRI International)
Nicholas Kotov (Univ. of Michigan)
Rebecca Kramer-Bottiglio (Yale Univ.)
Sridhar Krishnaswamy (Northwestern Univ.)
Jay Kudva (NextGen Aeronautics, Inc.)
Amrita Kumar (Acellent Technologies)
Walter Lacarbonara (Univ. of Rome)
Giulia Lanzara (Univ. of Rome)
David Lentink (Stanford Univ. / Univ. of Groningen)
Valery Levitas (Iowa State Univ.)
Carmel Majidi (Carnegie Mellon Univ.)
Hayk Martirosyan (Skydio, Inc.)
Kurt Maute (Univ. of Colorado, Boulder)
Majid Minary-Jolandan (Univ. of Texas at Dallas)
Jeffrey Moore (Univ. of Illinois)
Boris Murmann (Stanford Univ.)
Dave Myszka (Univ. of Dayton)
Gift Nyikayaramba (Stanford Univ.)
William Oates (Florida A&M / Florida State Univ.)
Ozden Ochoa (Texas A&M Univ.), **ASC Conference Organizer**
Xiaoqing Pan (Univ. of California, Irvine)
Jason Patrick (North Carolina State Univ.)
Harry Perkinson (TRI Austin, Inc.)
Kara Peters (North Carolina State Univ.)
Shelly Peyton (Univ. of Massachusetts, Amherst)
Gary Pickrell (Virginia Polytechnic Inst.)

Shashank Priya (Pennsylvania State Univ.)
Jerry Qi (Georgia Inst. of Technology)
Jordan Raney (Univ. of Pennsylvania)
Elisa Riedo (New York Univ.)
S. Andrew Sarles (Univ. of Tennessee, Knoxville)
Robert Shepherd (Cornell Univ.)
Henry Sodano (Univ. of Michigan)
Nancy Sottos (Univ. of Illinois)
Geoffrey Spedding (Univ. of Southern California)
David Srolovitz (Univ. of Pennsylvania)
Abraham Stroock (Cornell Univ.)
C. T. Sun (Purdue Univ.)
Sameh Tawfik (Univ. of Illinois)
Logan Theis (Virginia Polytechnic Inst.)
Salvatore Torquato (Princeton Univ.)
Garritt Tucker (Colorado Sch. of Mines)
Chris Weinberger (Colorado State Univ.)
Stanley Williams (Texas A&M Univ.)
Yan Xia (Stanford Univ.)
Jianhua (Joshua) Yang (Univ. of Southern California)
Kai Yu (Univ. of Colorado, Denver)
Pablo Zavattieri (Purdue Univ.)
Dan Zenkert (KTH Royal Inst. of Technology)
Jun Zhang (Univ. of Michigan)

Speakers, PI's & Co-PI's (Government):

Andrew Abbott (Air Force Research Lab - AFRL/RXCCM)
Jeffery Baur (Air Force Research Lab - AFRL/RXCCM)
Philip Beran (Air Force Research Lab - AFRL/RQVC)
Philip Buskohl (Air Force Research Lab - AFRL/RXAS)
Daniel Cole (Army Research Office), ***Symposium Co-Chair***
Geoffrey Cranch (Naval Research Lab)
Larry Drummy (Air Force Research Lab - AFRL/RXAS)
Michael Durstock (Air Force Research Lab - AFRL/RXA)
John Ferguson (Air Force Research Lab - AFRL/RXAN)
James Joo (Air Force Research Lab - AFRL/RQVS)
Abby Juhl (Air Force Research Lab - AFRL/RXAS)
B.-L. ("Les") Lee (Air Force Office of Scientific Research), ***Symposium Co-Chair***
John Michopoulos (Naval Research Lab)
Alex Pankonien (Air Force Research Lab - AFRL/RQVC)
Ignacio Perez de Leon (Office of Naval Research), ***Symposium Co-Chair***
Siddiq Qidwai (National Science Foundation), ***Keynote Speaker***
Gregory Reich (Air Force Research Lab - AFRL/RQVC)
Ajit Roy (Air Force Research Lab - AFRL/RXAN)
Christopher Tabor (Air Force Research Lab - AFRL/RXAS)
Gyaneshwar Tandon (Air Force Research Lab - AFRL/RXCCP)
James Thomas (Naval Research Lab)
Carl Thrasher (Air Force Research Lab - AFRL/RXAS)
Richard Vaia (Air Force Research Lab - AFRL/RX)

AGENDA

All listed times are CDT in Chicago

(11:00 West Coast = 12:00 Denver = 13:00 Chicago = 14:00 East Coast = 20:00 Rome)

Sunday, September 19		
Time	Speaker	Title of Presentation
13:00		Registration
Session Chair: Michael Durstock (Air Force Research Lab)		
13:15	Ozden Ochoa Texas A&M U	Welcome Remarks
13:25	Les Lee AFOSR Ignacio Perez ONR Dan Cole ARO	Opening Remarks & Program Overview
13:55	Salvatore Torquato Princeton U	Extraordinary Multifunctional Disordered Composites
14:20	Rich Vaia Larry Drummy AFRL/RX	Extreme Mechanical Energy Absorption: Plasticity of Polymer-Nanoparticle Solids
14:45	Yan Xia Stanford U	Development of Polymers with Dramatic and Multifaceted Response to Mechanical Force
15:10	Coffee	Break
Session Chair: Daniel Magagnosc (Army Research Lab)		
15:25	Nicholas Kotov U Michigan	Graph Theory of Nanoscale Framework Materials
15:50	Ioannis Chasiotis U Illinois	Local Multiphysics Studies in Nanostructured Materials
16:15	Garritt Tucker Colorado School of Mines	Mechanistic-Design of Multilayered Nanocomposites: Hierarchical Metal-MAX Materials for Tunable Strength and Toughness
16:40	Elisa Riedo New York U	Pressure-induced Phase Transitions in 2D Materials
17:05	Valery Levitas Iowa State U	Plasticity and Plastic Strain-induced Phase Transformations in Traditional and Rotational Diamond Anvils: Experiment, Four-scale Theory, and Phenomena
17:30	Adjournment	Adjournment

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Monday, September 20		
Time	Speaker	Title of Presentation
09:30		Housekeeping
Session Chair: Derek Schesser (Army Research Lab)		
09:35	Chris Weinberger Colorado State U	Tailored Temperature Dependent Deformation in Ultrahigh Temperature Ceramic Composites

10:00	Francois Barthelat U Colorado	Engineered Granular Crystals as Platform for New Materials, New Mechanics and New Functionalities
10:25	Lou Kondic New Jersey Inst. of Technology	Material Response of Granular Systems: From Understanding to Predicting
10:50	Coffee	Break
Session Chair: Todd Henry (Army Research Lab)		
11:05	Jordan Raney U Pennsylvania	Bifurcation Based Actuation for Autonomous Smart Structures
11:30	Shelly Peyton U Mass Amherst	Force-Activated, Mechanically Adaptive Soft Materials: Harnessing Cryptic Bonds in Synthetic Systems
11:55	Carmel Majidi Carnegie Mellon U	Soft Intelligent Materials with Liquid Metal and Liquid Crystal Elastomer
12:20	Lunch	Break

Luncheon Talk - Moderator: Anisur Rahman (Office of Naval Research)		
12:30	Leif Asp Chalmers Univ. of Technology Dan Zenkert KTH Royal Institute of Technology Emile Greenhalgh Imperial College London	Invited Lecture: (i) Damage Tolerance and Durability of Structural Power Composites; (ii) Mechanical and Impact Properties of Structural Power Devices
13:20	Coffee	Break
Session Chair: Rich Vaia (Air Force Research Lab)		
13:30	Mike Durstock Phil Buskohl Abby Juhl AFRL/RX	Architecting the Future of Energy Storage – From 2D to 3D
13:55	Ray Baughman U Texas Dallas	Knowledge-Driven Design and Optimization of New Types of Yarn and Fiber Artificial Muscles
14:20	Somnath Ghosh Johns Hopkins U	Integrated Multi-Physics, Multi-scale Computational Modeling Framework for Multifunctional Applications
14:45	William Oates Florida A&M / Florida State U	Quantifying Complexity to Advance the Discovery and Design of Next Generation Smart Materials
15:10	Coffee	Break
Session Chair: Robert Haynes (Army Aviation and Missile Center)		
15:25	Andrew Croll N. Dakota State. U	Using Adhesion to Control Dissipation in Crumpled Matter
15:50	Henry Sodano U Michigan	Aramid Nanofibers for High Durability Polymers, Interfaces and Composites
16:15	Xiaoqing Pan UC Irvine David Srolovitz U Pennsylvania	Quantitative Prediction and Observation of Grain Boundary Dynamics

16:40	Ajit Roy John Ferguson AFRL/RX	High Temperature Electronics Module Failure Physics and Design
17:05	Somnath Ghosh Johns Hopkins U Jim Thomas NRL	Validation of Multiscale Modeling and Design Platform for Protective Hybrid Composite Systems for Aerospace Structures
17:30	Adjournment	Adjournment

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Tuesday, September 21		
Time	Speaker	Title of Presentation
09:30		Housekeeping
Session Chair: Ben Dickinson (Air Force Research Lab)		
09:35	Abraham Stroock Cornell U Noel Holbrook Harvard U	Plant-Mimetic Functional Materials for Thermal Management and Suppression of Freezing
10:00	Alamgir Karim U Houston	Multilayered Protective Biomimetic Coatings from Sustainable Chitin and Chitosan
10:25	David Kisailus UC Irvine Pablo Zavattieri Purdue U	Investigation of Force Transduction and Actuation in Integrated Multifunctional Biological Structures
10:50	Coffee	Break
Session Chair: Ajit Roy (Air Force Research Lab)		
11:05	Majid Minary-Jolandan U Texas Dallas	Self-Sensing and Self-Healing Metal Matrix Composites
11:30	Chris Tabor Carl Thrasher AFRL/RX	Responsive Electronics Using Liquid Metal Colloids
11:55	Aaron Esser-Kahn U Chicago	(PECASE) Sensing and Modulating Materials Properties Using Piezoelectric Response Elements
12:20	Lunch	Break

Luncheon Talk - Moderator: Jim Thomas (Naval Research Lab)		
12:30	Siddiq Qidwai National Science Foundation	Keynote Invited Lecture: Multifunctionality, System Endurance, and Intelligent Structures: An Engineering Perspective from the National Science Foundation
13:20	Coffee	Break
Session Chair: Nancy Sottos (Univ. of Illinois)		
13:30	Nancy Sottos Ioannis Chasiotis	CoE'20 in "Self-Healing, Regeneration & Structural Remodeling" – (i) Overview

	Jeffrey Moore Philippe Geubelle U Illinois Aaron Esser-Kahn U Chicago	(ii) Rapid Manufacturing of Multifunctional Composites (iii) Durability and Damage Resistance of pDCPD Composites in Space Environment (iv) Modeling of Frontal Polymerization and Instabilities (v) Frontal Polymerization and Phase Change Materials for Patterning (vi) Toward Morphogenic Manufacturing
15:10	Coffee	Break
Session Chair: Jeff Baur (Air Force Research Lab)		
15:25	Jason Patrick North Carolina State U	(YIP) Integrated Self-healing and Self-sensing using Optical Waveguides in Microvascular Fiber-Composites
15:50	Ximin He UCLA	(YIP) Bio-inspired Artificial Homeostatic Multifunctional Material Microsystems (AHM3)
16:15	Yuhang Hu GA Tech	(YIP) Tough Gel: A Perfect Platform for Designing Chemo-Mechano-Chemically Responsive Multi-Functional Materials
16:40	Sung Kang Johns Hopkins U	(YIP) Bioinspired Synthesis of Multifunctional Materials with Self-Adaptable Mechanical Properties and Self-Regeneration
17:05	Sameh Tawfick U Illinois	(YIP) Polymorphic Hair Material Systems for Multifunctional Reconfiguration and Damage Restoration
17:30	Adjournment	Adjournment

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Wednesday, September 22		
Time	Speaker	Title of Presentation
09:30		<i>Housekeeping</i>
Session Chair: Sridhar Krishnaswamy (Northwestern Univ.)		
09:35	Walter Lacarbonara U Rome Sapienza Giulia Lanzara U Rome Tre	A High Damping Cellular Material with Integrated Arrays of Nanocomposite Web-like Vibration Absorbers
10:00	Guoliang Huang U Missouri C. T. Sun Purdue U	Programmable Elastic Metamaterials for Unprecedented Wave and Dynamic Control
10:25	Guoliang Huang U Missouri	Polar Metamaterials for Perfect Cloaking in Elastic Media
10:50	Coffee	Break
Session Chair: John Michopoulos (Naval Research Lab)		
11:05	John Michopoulos NRL	On the Development of Heterogeneous Micro-Robotic Teams for Distributed Damage Detection and Repair (HeRo-D3R) of Naval Platforms
11:30	Shashank Priya Penn State U	Exploiting Anisotropy, Defect Engineering and Elastic Non-linearity for Designing Ultra-high Performance Piezoelectric Materials
11:55	Victor Giurgiutiu U South Carolina	Extracting Crack-Length Information from Acoustic Emission Signal Spectrogram
12:20	Lunch	Break

Luncheon Talk - Moderator: Stanley Williams (Texas A&M Univ.)		
12:30	Yong Chen UCLA	Briefing on AFOSR MURI '19: "Brain-Inspired Networks for Multifunctional Intelligent Systems in Aerial Vehicles" (2 nd Annual Review at UCLA on July 14-15, 2021; UCLA / U Tenn / U SoCalif / Stanford U / U Michigan / Texas A&M) (PI: Yong Chen ; Co-PIs: Andy Sarles, Joshua Yang, Lei He, Fu-Kuo Chang, Daniel Inman, Stanley Williams, Jun Zhang) (PM: Les Lee ; Co-PM's: Kenneth Goretta, Patrick Bradshaw, Fariba Fahroo, Hal Greenwald)
13:20	Coffee	Break
Session Chair: Ming Han (Michigan State Univ.)		
13:30	Phil Buskohl AFRL/RX	Interplay of Nonlinearity and Topological Diversity in Opto-Mechanical Reservoir Computing
13:55	Sridhar Krishnaswamy Northwestern U	3D Printing of Microscale Photonic Devices
14:20	Geoffrey Cranch NRL	Distributed Fiber Optic Sensor Technology for Structural Monitoring on Navy Platforms
14:45	Ming Han Michigan State U	Fiber-Optic Sensors for Acoustic Emission Detection
15:10	Coffee	Break
Session Chair: Geoffrey Cranch (Naval Research Lab)		
15:25	Yiming Deng Michigan State U	Deep Learning Based Damage Monitoring and Characterization through Acoustic Emission Modeling and Signal Processing
15:50	Kara Peters North Carolina State U	Coupling of Lamb Waves to Optical Fibers for Imaging of Composites
16:15	Haiying Huang U Texas Arlington	Understanding the Resonant Characteristics of Stub Resonators
16:40	Logan Theis Gary Pickrell VA Polytechnic Inst	Acousto-Optic Coupling for Enhanced Sensor Response
17:05	Amrita Kumar Cody Gray Acellent Technologies Gift Nyikayaramba Boris Murmann Fu-Kuo Chang Stanford U	(STTR Phase II) Flexible Sensor Network and Its Embedded Integrated Circuits for Structural Health Monitoring
17:30	Adjournment	Adjournment

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Thursday, September 23		
Time	Speaker	Title of Presentation
Session Chair: Greg Reich (Air Force Research Lab)		
09:10	Will Boley Boston U	(YIP) 4D Printing Materials with Programmed Responsiveness and Stiffness for Multifunctional Adaptive Architectures
09:35	Giulia Lanzara U Rome Tre	Multi-constrain Effect of Magnetic Field-Particles Interaction Towards Advanced Morphing

	Walter Lacarbonara U Rome Sapienza	
10:00	Rebecca Kramer-Bottiglio Yale U	(YIP) Robotic Fabrics: Multifunctional Fabrics for Reconfigurable and Wearable Soft Systems
10:25	Rob Shepherd Cornell U Nikolaus Correll U Colorado	Localized and Rapid Variable Compliance Via Phase Changing Matter and Distributed Computation
10:50	Coffee	Break
Session Chair: Peter Finkel (Naval Research Lab)		
11:05	James Joo AFRL/RQ Doug Hunsaker Utah State U Dave Myszka U Dayton	Bio-inspired Flight Using a Rotating Empennage
11:30	Jonathan Hopkins UCLA	Mechanical Neural-network Architecture Materials that Learn
11:55	Greg Reich Philip Beran Alex Pankonien AFRL/RQ	Bio-inspired Reconfigurable System Design via Topology Optimization
12:20	Lunch	Break

Luncheon Talk - Moderator: Jay Kudva (NextGen Aeronautics)		
12:30	Dan Inman U Michigan David Lentink Stanford U / U Groningen	Briefing on AFOSR Basic Research Initiative '16: "Muscular-Skeletal System Inspired Morphing Air Vehicles Using Active Materials" (<i>U Michigan / Stanford U / UCLA / Texas A&M / U British Columbia / Royal Veterinary College / U Rome</i>) (PI: Daniel Inman ; Co-PIs: Henry Sodano, David Lentink, Fu-Kuo Chang, Yong Chen, Darren Hartl, Douglas Altshuler, Richard Bomphrey, Giulia Lanzara) (PM: Les Lee ; Co-PM's: Gregg Abate, Patrick Bradshaw, David Garner, Douglas Smith)
13:20	Coffee	Break
Session Chair: James Joo (Air Force Research Lab)		
13:30	David Lentink Mark Cutkosky Stanford U Hayk Martirosyan Skydio Inc.	Briefing on Defense Enterprise Science Initiative (DESI) '19: "Highly Maneuverable Autonomous UAV" (<i>Stanford U / Skydio, Inc.</i>) (PI: David Lentink ; Co-PIs: Mark Cutkosky, Hayk Martirosyan) (PM: Les Lee ; Co-PM's: Jean-Luc Cambier, Frederick Leve)
14:07	Jay Kudva Concepts to Systems Geoffrey Spedding U Southern Calif Roy Kornbluh SRI International	(STTR Phase II) Biomimetic Design of Morphing Micro Air Vehicles
14:45	Andres Arrieta Diaz Purdue U	Span-wise Morphing with Multistable Honeycomb Metastructures
15:10	Coffee	Break

Session Chair: Daniel O'Brien (Army Research Lab)		
15:25	Jerry Qi GA Tech Martin Dunn Kurt Maute U Colorado	Hybrid 3D Printing: Pick-and-Place Robotics for Additive Fabrication of 4D Composites;
15:50	Jerry Qi GA Tech Martin Dunn Kai Yu U Colorado	Integrated Multiscale Design and Additive Manufacture of Multifunctional Composites
16:15	Jeffery Baur Andrew Abbott G. P. Tandon AFRL/RX	Additive Printing of Continuous Fiber Thermosetting Composites
16:40	Les Lee AFOSR Ignacio Perez ONR Dan Cole ARO	Concluding Remarks
16:55	Adjournment	Adjournment

MAIN WEBSITE

<https://na.eventscloud.com/website/17366/>

**The 36th Annual Technical Conference of American Society for Composites (ASC)
Tri-Agency Symposium on "Multifunctionality, System Endurance & Intelligent Structures"**

Virtual

1. ASC Tri-Agency Symposium follows the meeting schedules of (a) **1:00 PM through 5:30 PM Central Time** on **19 September 2021 (Sunday)**, (b) **9:30 AM through 5:30 PM Central Time** on **20-22 September 2021 (Monday-Wednesday)** and (c) **9:10 AM through 4:55 PM Central Time** on **23 September 2021 (Thursday)**.
2. Except up to four luncheon briefings dealing with the collaboration among multiple research institutions, each of all Symposium talks will last 20 min with additional 5 min for Q&A.
3. Registration will start on 15 April 2021 (target date).
4. After creating an individual account with his/her name, ID email, phone number, etc., the Registration Portal will require each participant to select the registration category. As Tri-Agency Symposium participants, proceed to Standard \$100 category and select the option "Tri-Agency Symposium invitees-presenters."

Standard \$100 (covering annual membership, e-book proceedings and attendance in all technical sessions)

☐ Non-presenter
☒ Tri-Agency Symposium invitee-presenter *Submit Abstract to <oochoa@tamu.edu>*
☐ Special Panel-Minisymposia invitee-presenter