

International Forum on “Autonomic Multifunctional Structures”

Incorporating:

**The 2023 Annual Grantees’/Contractors’ Meeting for
AFOSR Program on “Mechanics of Multifunctional
Materials & Microsystems (M⁴)”**

**The 4th Annual Review for DoD MURI Program on
“Brain-Inspired Networks for Multifunctional Intelligent
Systems in Aerial Vehicles”**

**Kick-off Meeting for Basic Research Initiative on
“Hybrid Biomolecular Synapses for Multifunctional Sensing
and Neuromorphic Computing”**

**Kick-off Meeting for DoD Mission Partnership Program on
“Bio-inspired Power Sources from Soft Materials”**

23-26 October 2023

**Location: Univ. of California, Los Angeles
Cohen Multipurpose Room (ENG VI, Room 134)**

SPONSORED BY:



Forum Co-Chairs:

Yong Chen (Univ. of California, Los Angeles)
B.-L. ("Les") Lee (Air Force Office of Scientific Research)

Opening Session Speakers:

Col Brian Vesey (Chief of Science & Engineering Division, Air Force Office of Scientific Research)
Robert Candler (Associate Dean, Samueli School of Engineering, Univ. of California, Los Angeles)

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

Leif Asp (Chalmers Univ. of Technology, *Sweden*)
Amir Barati Farimani (Carnegie-Mellon Univ.)
Ray Baughman (Univ. of Texas at Dallas)
Jeffery Baur (Univ. of Illinois, Urbana-Champaign)
Will Boley (Boston Univ.)
Fu-Kuo Chang (Stanford Univ.)
M. C. Frank Chang (Univ. of California, Los Angeles)
Ioannis Chasiotis (Univ. of Illinois, Urbana-Champaign)
Yong Chen (Univ. of California, Los Angeles)
Martin Dunn (Univ. of Colorado, Denver)
Aaron Esser-Kahn (Univ. of Chicago)
Philippe Geubelle (Univ. of Illinois, Urbana-Champaign)
Somnath Ghosh (Johns Hopkins Univ.)
Emile Greenhalgh (Imperial College London, *United Kingdom*)
Kevin Haughn (Univ. of Michigan)
Noel Holbrook (Harvard Univ.)
Jonathan Hopkins (Univ. of California, Los Angeles)
Guoliang Huang (Univ. of Missouri)
Doug Hunsaker (Utah State Univ.)
Daniel Inman (Univ. of Michigan)
Neha Kamat (Northwestern Univ.)
Sung Kang (Johns Hopkins Univ.)
Alamgir Karim (Univ. of Houston)
David Kisailus (Univ. of California, Irvine)
Nicholas Kotov (Univ. of Michigan)
Walter Lacarbonara (Univ. of Rome, *Italy*)
Giulia Lanzara (Univ. of Rome, *Italy*)
David Lentink (Univ. of Groningen, *The Netherlands*)
Kurt Maute (Univ. of Colorado, Boulder)
Michael Mayer (Univ. of Fribourg, *Switzerland*)
Majid Minary-Jolandan (Univ. of Texas at Dallas)
Marc Miskin (Univ. of Pennsylvania)
Jeffrey Moore (Univ. of Illinois, Urbana-Champaign)
Dave Myszka (Univ. of Dayton)
Joseph Najem (Pennsylvania State Univ.)
Sang Nguyen (Imperial College London, *United Kingdom*)
William Oates (Florida A&M / Florida State Univ.)
Jason Patrick (North Carolina State Univ.)
James Pikul (Univ. of Pennsylvania)
Jerry Qi (Georgia Inst. of Technology)
Jordan Raney (Univ. of Pennsylvania)
Jonathan Rivnay (Northwestern Univ.)
Fulton Rockwell (Harvard Univ.)
S. Andrew Sarles (Univ. of Tennessee, Knoxville)
Robert Shepherd (Cornell Univ.)
Nancy Sottos (Univ. of Illinois, Urbana-Champaign)
Abraham Stroock (Cornell Univ.)
Ryan Truby (Northwestern Univ.)
Christoph Weder (Univ. of Fribourg, *Switzerland*)
Stanley Williams (Texas A&M Univ.)
Jianhua (Joshua) Yang (Univ. of Southern California)

Suin Yi (Texas A&M Univ.)
Kai Yu (Univ. of Colorado, Denver)
Pablo Zavattieri (Purdue Univ.)
Dan Zenkert (KTH Royal Inst. of Technology, *Sweden*)

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

Hans Cho (Naval Research Lab)
Benjamin Dickinson (Air Force Research Lab - RW)
Larry Drummy (Air Force Research Lab - RX)
Sabyasachi Ganguli (Air Force Research Lab - RX)
Andrew Gillman (Air Force Research Lab - RX)
James Joo (Air Force Research Lab - RQ)
Sina Najmaei (Army Research Lab)
Joe Van Nostrand (Air Force Research Lab - RI)
Qing Wu (Air Force Research Lab - RI)

Session Chairs:

Ray Baughman (Univ. of Texas at Dallas)
Jeffery Baur (Univ. of Illinois, Urbana-Champaign)
Fu-Kuo Chang (Stanford Univ.)
Martin Dunn (Univ. of Colorado, Denver)
Somnath Ghosh (Johns Hopkins Univ.)
Daniel Inman (Univ. of Michigan)
Jay Kudva (NextGen Aeronautics)
David Lentink (Univ. of Groningen, *The Netherlands*)
Nancy Sottos (Univ. of Illinois, Urbana-Champaign)
Jianhua (Joshua) Yang (Univ. of Southern California)

Philip Buskohl (Air Force Research Lab - RX)
James Joo (Air Force Research Lab - RQ)
Ajit Roy (Air Force Research Lab - RX)
LtCol David Swanson (Air Force Office of Scientific Research - IO)
Qing Wu (Air Force Research Lab - RI)

Invitees:

Chagaan Baatar (Office of Naval Research)
Daniel Cole (Army Research Office)
Andrey Kanaev (National Science Foundation)
Ming-Jen Pan (Office of Naval Research)
Ignacio Perez de Leon (Office of Naval Research)
Siddiq Qidwai (National Science Foundation)
James Thomas (Naval Research Lab)

Luke Baldwin (Air Force Research Lab - RX)
Richard Beblo (Air Force Research Lab - RQ)
Philip Beran (Air Force Research Lab - RQ)
Michael Durstock (Air Force Research Lab - RX)
Abby Juhl (Air Force Research Lab - RX)
Alex Pankonien (Air Force Research Lab - RQ)
Gregory Reich (Air Force Research Lab - RQ)
Richard Vaia (Air Force Research Lab - RX)

Javier del Valle (Univ. of Geneva, *Switzerland*)
Stefano Gariglio (Univ. of Geneva, *Switzerland*)

Friedrich Barth (Universität Wien, *Austria*)
Chiara Daraio (California Inst. of Technology)
Paolo Ermanni (Eidgenössische Technische Hochschule Zürich, *Switzerland*)
Peter Fratzl (Max Planck Inst. of Colloids and Interfaces, *Germany*)
Donald Leo (Univ. of Georgia)
Salvatore Torquato (Princeton Univ.)

H. Thomas Hahn (Univ. of California, Los Angeles)
Ozden Ochoa (Texas A&M Univ.)
Mark Spearing (Univ. of Southampton, *United Kingdom*)
Woo Il Lee (Seoul National Univ., *South Korea*)

Review Panel (Government):

Hans Cho (Naval Research Lab)
Daniel Cole (Army Research Office)
Sina Najmaei (Army Research Lab)
Ming-Jen Pan (Office of Naval Research)
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Qing Wu (Air Force Research Lab - RI)

Gregg Abate (Air Force Office of Scientific Research)
Patrick Bradshaw (Air Force Office of Scientific Research)
Kenneth Caster (Air Force Office of Scientific Research)
Fariba Fahroo (Air Force Office of Scientific Research)
Kenneth Goretta (Air Force Office of Scientific Research)
Hal Greenwald (Air Force Office of Scientific Research)
Frederick Leve (Air Force Office of Scientific Research)
Brett Pokines (Air Force Office of Scientific Research)
LtCol David Swanson (Air Force Office of Scientific Research - IO)

AGENDA

Monday, October 23

Time	Speaker	Title of Presentation
07:30		<i>Registration</i>
Session Chair: Daniel Inman (Univ. of Michigan)		
08:00	Yong Chen UCLA Les Lee AFOSR	<i>Opening Remarks</i>
08:10	Col Brian Vesey Chief of Science & Engineering Division, AFOSR	<i>Welcome Remarks</i>
08:25	Robert Candler Associate Dean, Samueli School of Engineering, UCLA	<i>Welcome Remarks</i>
08:40	Somnath Ghosh Johns Hopkins U	Integrated Multi-Physics, Multi-scale Computational Modeling Framework for Multifunctional Applications
09:05	William Oates Florida A&M / Florida State U	Quantifying Complexity to Advance the Discovery and Design of Next Generation Smart Materials
09:30	Nicholas Kotov U Michigan	Graph Theory of Nanoscale Framework Materials
09:55	Coffee	Break
Session Chair: Somnath Ghosh (Johns Hopkins Univ.)		
10:10	Larry Drummy Andrew Gillman AFRL/RX	Elastic Wave Propagation and Plastic Energy Dissipation in Polymer Grafted Nanoparticle Assemblies through Structure Control and Hyperuniformity
10:35	Ioannis Chasiotis U Illinois	Ballistic Studies of Hybrid Material Systems for Space Structures
11:00	James Pikul U Penn	Room Temperature Morphogenesis of Metals
11:25	Majid Minary-Jolandan Univ. of Texas Dallas	Self-Sensing and Self-Healing Metal Matrix Composites
11:50	Lunch	Break

Session Chair: Jeffery Baur (Univ. of Illinois)		
13:20	David Kisailus UC Irvine Pablo Zavattieri Purdue U	Investigation of Force Transduction and Actuation in Integrated Multifunctional Biological Structures
13:45	Alamgir Karim U Houston	Multilayered Protective Biomimetic Coatings from Sustainable Chitin and Chitosan
14:10	Coffee	Break

UIUC CoE'20 in
“Phase II: Self-healing to Morphogenic Manufacturing”
The 3rd Annual Review

Session Chair: Nancy Sottos (Univ. of Illinois)

14:25	Nancy Sottos U Illinois	Overview , Center Motivation, CoE Accomplishments
14:45	Ioannis Chasiotis U Illinois	Resistance of Tough Thermosets to Orbital Debris Impact Damage
15:10	Nancy Sottos U Illinois	Self-Passivating Thermosets for the Extreme Environment of Low Earth Orbit
15:35	Jeffrey Moore U Illinois	Polymerization Chemistry for Multifunctional Materials
16:00	Philippe Geubelle U Illinois	Modeling of Frontal Polymerization Driven Convection, Instabilities, and Patterning
16:25	Jeffery Baur U Illinois	Morphogenesis of Composite Structures / Future Directions
16:55		Wrap-up
17:00	Adjournment	Adjournment

Tuesday, October 24

Time	Speaker	Title of Presentation
08:00		Registration / Housekeeping
Session Chair: Ajit Roy (Air Force Research Lab - RX)		
08:15	Jason Patrick N. Carolina State U	Harnessing Photonic Pathways for Integrated Damage Sensing and Autonomous Self-healing in Composites
08:40	Sung Kang Johns Hopkins U	Bone-Inspired Lightweight Self-Adapting and Damage-Mitigating Materials
09:05	Abraham Stroock Cornell U Noel Holbrook Fulton Rockwell Harvard U	Plant-Inspired Thermal Metamaterials with Tunable Properties
09:30	Jeffery Baur U Illinois	High Temperature Vascular Systems for Multifunctional Space Structures
09:55	Coffee	Break
Session Chair: Ray Baughman (Univ. of Texas at Dallas)		
10:10	Jerry Qi GA Tech Martin Dunn U Colorado Denver	Hybrid 3D Printing: Pick-and-Place Robotics for Additive Fabrication of 4D Composites
10:40	Will Boley Boston U	(YIP) 4D Printing Materials with Programmed Responsiveness and Stiffness for Multifunctional Adaptive Architectures
.11:10	Jerry Qi GA Tech	Integrated Multiscale Design and Additive Manufacture of Multifunctional Composites

	Martin Dunn Kai Yu U Colorado Denver Kurt Maute U Colorado Boulder	
11:50	Lunch	Break

Session Chair: LtCol David Swanson (Air Force Office of Scientific Research - IO)		
13:20	Aaron Esser-Kahn U Chicago	<i>(PECASE)</i> Sensing and Modulating Materials Properties Using Piezoelectric Response Elements
13:45	Guoliang Huang U Missouri	Control-based Non-Hermitian Active Metamaterials for Odd Elastodynamics
14:10	Walter Lacarbonara U Rome Sapienza Giulia Lanzara U Rome Tre	A High Damping Cellular Material with Integrated Arrays of Nanocomposite Web-like Vibration Absorbers
14:35	Giulia Lanzara U Rome Tre Walter Lacarbonara U Rome Sapienza	Moving Towards Highly Tunable Morphing Membranes and Fiber Reinforced Composites by Designing Novel Magnetic Patterns
15:00	Coffee	Break
Session Chair: Fu-Kuo Chang (Stanford Univ.)		
15:15	Marc Miskin U Penn	<i>(YIP)</i> Microrobots for Multifunctional Materials
15:40	Ryan Truby Northwestern U	<i>(YIP)</i> Robotic Architected Materials with Distributed Sensorimotor Capabilities via Free-form Electrochemical Composites
16:05	Rob Shepherd Cornell U	Chemical Wiring in Composites for Multifunctional Energy Storage, Data Transmission, and Distributed Computation
16:30	Fu-Kuo Chang Stanford U	Real-Time Battery Health Monitoring with Built-in Ultrasonic Techniques for Electric Aerial Vehicles
16:55		Wrap-up
17:00	Adjournment	Adjournment

Wednesday, October 25		
Time	Speaker	Title of Presentation
08:00		Registration / Housekeeping

**FY19 DoD MURI Topic #23:
“Brain-Inspired Networks for Multifunctional Intelligent Systems”**

The 4th Annual Review

UCLA / U Tenn / U So Calif / Texas A&M / Stanford U / U Michigan

(PI: Yong Chen, UCLA; PM’s: B.-L. (“Les”) Lee / Patrick Bradshaw / Kenneth Goretta / Hal Greenwald / Fariba Fahroo, AFOSR)

Session Chair: Joshua Yang (Univ. of Southern California)

08:15	Yong Chen UCLA	Overview: Brain-Inspired Networks for Multifunctional Intelligent Systems:
08:45	Andy Sarles U Tenn Knoxville	Biomolecular Synapses that Mimic the Composition, Structure, and Transport Properties of Biological Synapses
09:20	Yong Chen UCLA	Synaptic Resistors (Synstors), Self-Learning Neuromorphic Integrated Circuits (SNIC), and Synstor-based Multifunctional Intelligent Systems (SMIS)
09:55	Coffee	Break

Session Chair: Qing Wu (Air Force Research Lab)

10:10	Joshua Yang U So Calif	Engineering Memristive Dynamics for Synstor and Neurons
10:45	Stanley Williams Suin Yi Texas A&M U	Device Simulations of Synstors and Biological Algorithms of Crossbars for SNIC and Cognitive Learning
11:20	M. C. Frank Chang UCLA	SWaP-Efficient Flight-Controller-on-Chip for Pilotless UAV
11:50	Lunch	Break

Session Chair: Martin Dunn (Univ. of Colorado, Denver)

13:20	Fu-Kuo Chang Stanford U	Flight State Estimation of a Full-size UAS via Multimodal Distributed Sensing and SNIC Neuromorphic Control
13:55	Yong Chen UCLA	SNIC-based Multifunctional Intelligent Systems (SMIS) for Airplane and Spaceship
14:30	Dan Inman Kevin Haughn U Michigan	Sensor Interpretation using Long Short-Term Memory
15:00	Coffee	Break

New Activities on Brain-Inspired Networks:

Session Chairs: Philip Buskohl (Air Force Research Lab)

15:15	Qing Wu AFRL/RI	Briefing: AFOSR/RI/RX CoE'23 in “Extreme Neuromorphic Materials and Computing”
15:40	Hans Cho NRL Joe Van Nostrand AFRL/RI Sina Najmaei ARL	Briefing: DoD ARAP on “Neuromorphic Hardware Development (NeuroPipe)”

	Sabyasachi Ganguli AFRL/RX	
16:05	Jonathan Hopkins UCLA	Metamaterials that Learn to Design Other Metamaterials
16:30	Jordan Raney U Penn	Bifurcation Based Actuation for Autonomous Smart Structures
16:55		<i>Wrap-up</i>
17:00	Adjournment	Adjournment

Thursday, October 26		
Time	Speaker	Title of Presentation
08:00		<i>Registration / Housekeeping</i>
Kick-off Meeting for <i>Basic Research Initiative</i> on “Hybrid Biomolecular Synapses for Multifunctional Sensing and Neuromorphic Computing at the Edge of Biology”		
Session Chair: David Lentink (Univ. of Groningen)		
08:15	Andy Sarles U Tenn Knoxville	Biomimetic Membranes on Conductive Polymers for Selective Hybrid Synaptic Interfaces
08:40	Jonathan Rivnay Northwestern U	Polymer Mixed Conductors for Sensing and Mimicking Biology
09:05	Neha Kamat Northwestern U	Cell-free Expression of Transmembrane Proteins for Sensing at Electronic Interfaces
09:30	Yong Chen UCLA	Biomolecular Synstor Circuits for Sensing and Neuromorphic Computing
09:55	Coffee	Break
Kick-off Meeting for <i>DoD Mission Partnership Program</i> on “Bio-inspired Power Sources for Small Satellites from Soft Materials”		
Session Chair: James Joo (Air Force Research Lab - RQ)		
10:10	Michael Mayer U Fribourg, Switzerland	Power Sources Inspired by Electric Fish
10:35	Joseph Najem Pennsylvania State U	Multi-Material Fabrication Methods of Electric-Fish-Inspired Power Sources
11:00	Amir Barati Farimani Carnegie-Mellon U	Artificial Intelligence Enabled Design and Optimization of Soft Materials for Power Sources
11:25	Christoph Weder U Fribourg, Switzerland	Bio-Inspired Membranes
11:50	Lunch	Break

Session Chair: LtCol David Swanson (Air Force Office of Scientific Research - IO)		
13:20	Ray Baughman U Texas Dallas	Knowledge-Driven Design and Optimization of New Types of Yarn and Fiber Artificial Muscles
13:50	Leif Asp Chalmers Univ. of Technology, Sweden Dan Zenkert KTH Royal Inst. of Technology, Sweden Emile Greenhalgh Sang Nguyen Imperial College London, United Kingdom	Realising Structural Batteries
14:30	Ben Dickinson AFRL/RW	<i>Briefing:</i> AFOSR/RW/RQ/RX CoE'23 in "Intelligent Structures for Morphing High Speed Vehicles"
15:00	Coffee	Break
Session Chair: Jay Kudva (NextGen Aeronautics)		
15:15	David Lentink U Groningen, Netherlands	Autonomous Morphing of Flexible Wing and Rudderless Air Vehicles with Reflexive and Adaptive Control Capabilities
15:40	Dan Inman U Michigan	Towards Neural Control for Fly-by-Feel Morphing
16:05	James Joo AFRL/RQ Doug Hunsaker Utah State U Dave Myszka U Dayton	Bio-inspired Flight Using a Rotating Empennage
16:30		<i>Announcement</i>
16:45	Les Lee AFOSR Yong Chen UCLA	<i>Closing Remarks</i>
17:00	Adjournment	Adjournment

REGISTRATION WEBSITE

<https://community.apan.org/wg/afosr/w/researchareas/38547/2023-annual-grantees-contractors-meeting-for-afosr-mechanics-of-multifunctional-materials-and-microsystems-m-4-program>

Including the information on the meeting registration, agenda, hotels and parking
PoC: RAGSDALE, KATHY M CIV USAF AFMC AFOSR/ITA <kathy.ragsdale.1@us.af.mil>

MEETING SITE

Campus of the University of California, Los Angeles
Cohen Conference Room (ENG VI, Room 134)
PoC: Prof. Yong Chen <yongchen@seas.ucla.edu>