



Integrity ★ Service ★ Excellence

Aerospace, Chemical and Material Sciences

05 MAR 2012

Dr. Joan Fuller

AFOSR/RSA

Air Force Research Laboratory

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE 05 MAR 2012		2. REPORT TYPE		3. DATES COVERED 00-00-2012 to 00-00-2012	
4. TITLE AND SUBTITLE Aerospace, Chemical And Material Sciences				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Air Force Research Laboratory, Wright-Patterson AFB, OH, 45433				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES Presented at the Air Force Office of Scientific Research (AFOSR) Spring Review Arlington, VA 5 through 9 March, 2012					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 11	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			



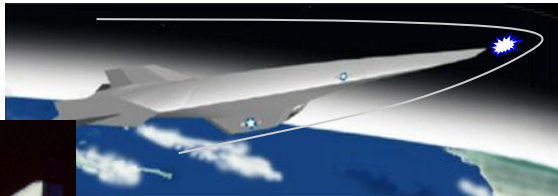
Aerospace, Chemistry and Material Sciences



The Directorate leads discovery and advancement of fundamental and integrated science that enables future air, space and cyberspace power.



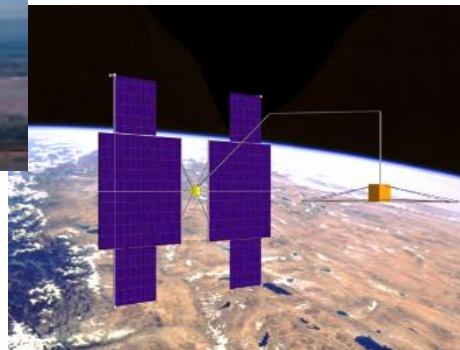
Fluid Mechanics



Solid Mechanics
& Structures



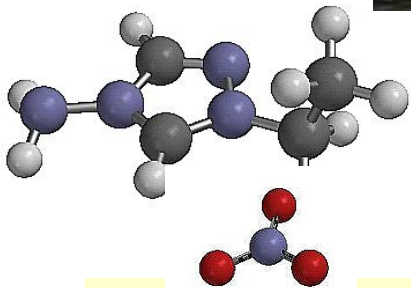
Propulsion



Materials



Chemistry



Transforming the Future of Aerospace Sciences

DISTRIBUTION A: Approved for public release; distribution is unlimited





RSA Investment Portfolio



Aerospace, Chemical & Material Sciences (RSA)

Aero-Structure Interactions and Control

- Flow Interactions and Control
- Aerothermodynamics and Turbulence
- Aerospace Materials for Extreme Environments
- Test and Evaluation

Complex Materials and Structures

- Organic Materials Chemistry
- Low Density Materials
- Mechanics of Multifunctional Materials
- Multi-scale Mechanics and prognosis

Energy, Power, and Propulsion

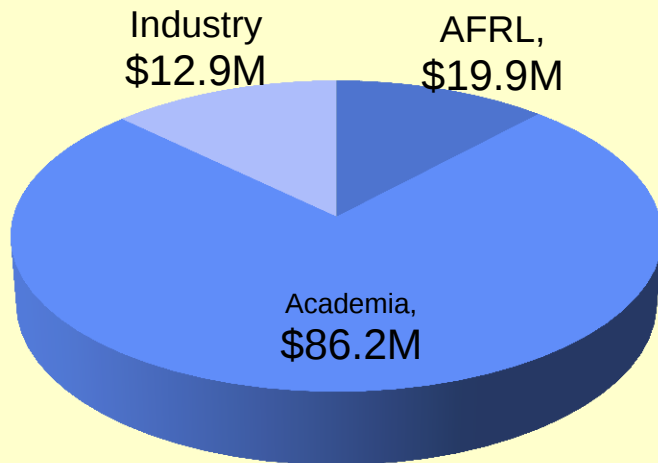
- Molecular Dynamics and Theoretical Chemistry
- Energy Conversion and Combustion Sciences
- Space Propulsion and Power
- Thermal Sciences

Programs: 12 Program Manager's Portfolios
Work Unit: >600 Individual Grants, Contracts





Aerospace, Chemical, and Material Sciences (BPAC 613002) Vision



(Total \$119.1M)

Aero-Structure Interactions and Control:

- Turbulence and laminar-turbulent transition
- Unsteady aerodynamics and flow control
- Aero-elasticity and structural dynamics
- Integrated Modeling

Energy, Power and Propulsion:

- Novel energetic materials
- Combustion and catalysis chemistry
- Thermal science
- Novel means of producing, collecting and storing energy
- System-level analysis and modeling

Complex Materials and Structures:

- Novel lightweight materials
- Materials with tunable properties
- Reconfigurable structures
- Multifunctional materials and structures

DISTRIBUTION A: Approved for public release



Aero Structure Interactions and Control



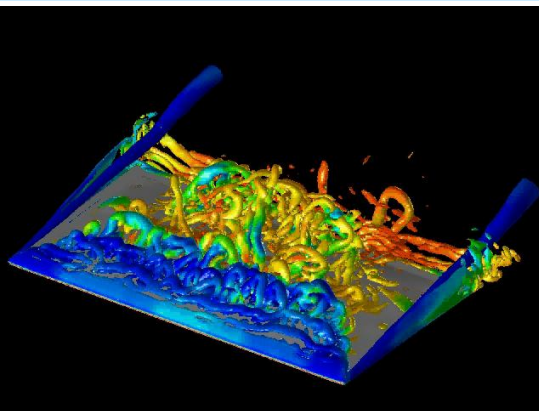
MOTIVATION

- Breakthroughs on the characterization, modeling and exploitation of interactions between the unsteady aerodynamic flow field and the dynamic air vehicle structure to enable enhanced performance in next generation Air Force systems.

STRATEGIC PARTNERSHIPS

- AFOSR, NASA, DOE, National Hypersonics Foundational Research Plan: Three NASA/AFOSR Basic Research Centers (Propulsion, Materials and Structures, Fluid Physics)

R. Gordnier, AFRL/RB High Fidelity Simulation of Highly Flexible Membrane Wings for Micro Air Vehicles



- Membrane Flexibility:
- ✓ Reduces the extent of leading edge separation
 - ✓ Enhances lift at the cost of increased L/D
 - ✓ Reduces nose down pitching moment

Effect of Membrane Flexibility on Leading Edge Separation

PAYOFF

- Increase smooth airflow over the vehicle's upper surface to reduce friction and heat
- Engineered maneuverable micro flight vehicles may incorporate flexible wing membranes as lifting surfaces.
- Advance fluid physics knowledge base and resultant predictive tools



Energy, Power, and Propulsion

MOTIVATION

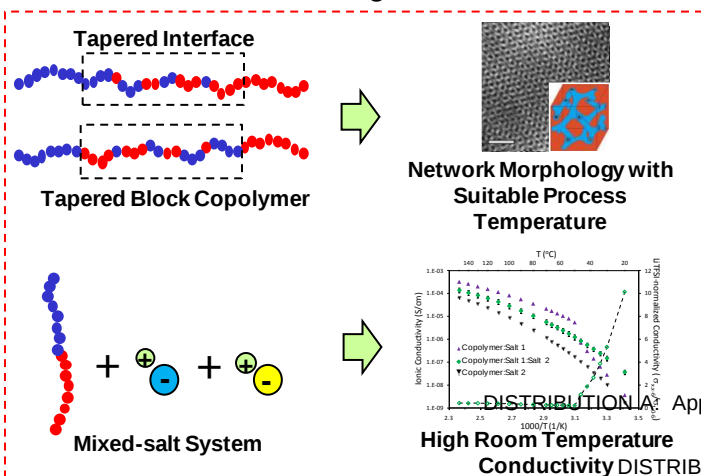
- Novel propulsion methods for aircraft and spacecraft are being explored, as are new ways in which energy can be produced, collected, stored, and utilized. Develop novel energetic materials, as well as understanding and optimizing combustion processes.

STRATEGIC PARTNERSHIPS

Interagency Combustion Working Group (MACCCR), joint coordination of the National Basic Research in Combustion (in particular for Alternate Fuels). Members are AFOSR, ARO, ONR, AFRL, SERDP, DOE, NSF, NIST, NASA, FAA

(PECASE)- Thomas Epps, U of Delaware

Ion-conducting Membranes



Future Lithium Batteries



DISTRIBUTION A: Approved for public release; distribution is unlimited

High Room Temperature Conductivity DISTRIBUTION A: Approved for public release; distribution is unlimited

PAYOFF

- Coated nanoscale aluminum powders could increase the performance by more than 25%
- These energetic ionic liquids have great advantages for use as monopropellants
- New hybrid multi-time scale algorithms to improve accuracy and time





Complex Materials and Structures



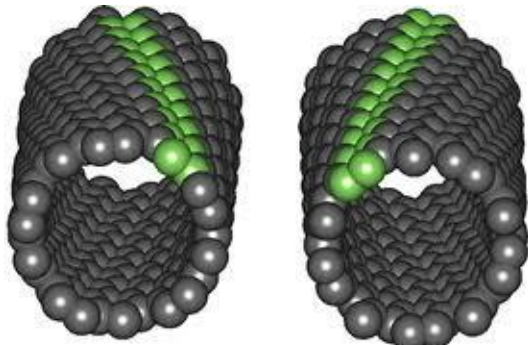
MOTIVATION

- Breakthroughs on future materials and structures that are composed of different classes of materials and may be able to change functionality and/or performance characteristics to enhance the mission versatility of future air and space systems.

STRATEGIC PARTNERSHIPS

NSF Collaborative project on Origami, ASDR&E COI Materials, Joint AFOSR/RX/RH Center of Excellence at Georgia Tech on Bio Materials

B. Maruyama, AFRL/RX & Prof Boris Yakobson, Rice Univ
Nucleation and Growth of Carbon Nanotubes



Rice professor's nanotube theory confirmed: Air Force Research Laboratory experiment shows chirality of tube controls speed of growth

PAYOFF

- Develop structures that are more durable & longer-lasting aircraft structures
- Developed carbon nanotube based muscles, which are 30 times stronger than natural muscles
- Created a new form of metal; absorbs all radiation that shines upon it

Distribution is unlimited





RSA Highlights from 2011



- **Materials and Processes Far from Equilibrium**
 - (\$1M/year new initiative led by Sayir, Birkan, Luginsland)
- **Transformational Computing**
 - (\$1.5M/year new initiative led by Smith, Stargel)
- **Hypersonics (Jason's Study)**
 - (Schmisseur invited expert and our newest AIAA Fellow!!!)
- **AFOSR-NSF collaborative agreement & Origami Initiative**
 - (collaborative initiative led by Harrison and Stargel)
 - (RSA's first Basic Research Initiative awarded! Led by Harrison and Stargel)
- **Energy Horizons & AFRL Energy S&T Plan**
 - Year Long Team RSA effort – Les Lee, Birkan, Schmisseur, Berman, Sayir, Harrison and others
- **Materials Genome Initiative**
 - OSTP Initiative to revitalize Material Science and Engineering – RSA experts
Sayir and Harrison

DISTRIBUTION A: Approved for public release; distribution is unlimited

DISTRIBUTION A: Approved for public release; distribution is unlimited





RSA Changes in 2011



- **Dr. Chiping Li – new PM for Energy Conversion and Combustion Sciences portfolio**
 - 2005-1011-- Aerojet, Chief Engineer Robust Scramjet program and lead for the Hypersonic Analysis Team.
 - 1991-2005 – NRL Scientist
- **Dr. Michael Kendra – new PM for Test and Evaluation portfolio**
 - 2007-2011 – AFRL/RV (Hanscom) Deputy PM Space Object Surveillance Technologies program
 - 1990-2007 – AER/Radex Lead for Infrared and Atmospheric Structure Group
- **Dr. Michael Berman – Sabbatical Leave (Sept-Mar)**
- **Dr. Jeff Owrutsky – PM for Theoretical and Molecular Chemistry**
- **Ms. Laura Cooney – new PM for AFOSR's MURI program**
- **Dr. Kumar Jata – Thermal Sciences PM departed – Leading AFRL/RX Corrosion Study**
- **Lt Kevin Pohl – new masters candidate at AFIT**

DISTRIBUTION A: Approved for public release; distribution is unlimited

DISTRIBUTION A: Approved for public release; distribution is unlimited





RSA -- Transforming the Future of Aerospace Sciences



- **PROACTIVE** in the basic science research community
- **LEADERS** in the DoD scientific community
- **ADVOCATES** for Air Force S&T
- **MENTORS** for future researchers