



Integrity ★ Service ★ Excellence

Complex Materials and Devices

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Scientific Opportunities: Both bottom up & top down approaches



Focus on 10-20-year time horizon

Technology Horizons 2010-2030

- ASD(R&E) “Six Disruptive Basic Research Areas”

- Metamaterials and Plasmonics
- Quantum Information Science
- Cognitive Neuroscience
- Nanoscience and Nanoengineering
- Synthestic Biology
- Computational Models of Human Behavior

- Tech Horizons Grand Challenges:
 - Inherently Intrusion-Resistant Cyber Networks
 - Trusted Highly-Autonomous Decision-Making Systems
 - Fractionated, Composable, Survivable Remote-Piloted Systems
 - Hyper-Precision Air Delivery in Difficult Environments



RTD Current Scientific Goals



Complex Materials and Structures

- Focused on future materials and structures
- Change functionality or performance characteristics
- Exploit the interaction between the environment and the material interface
- New materials of complex design and function

Complex Electronics and Fundamental Quantum Processes

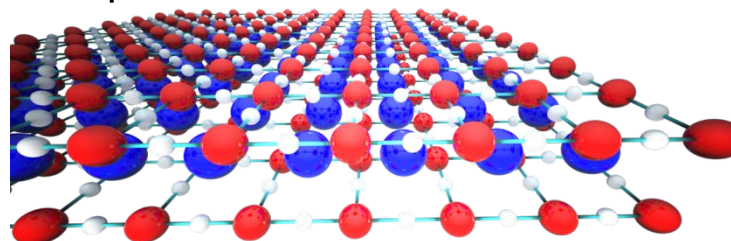
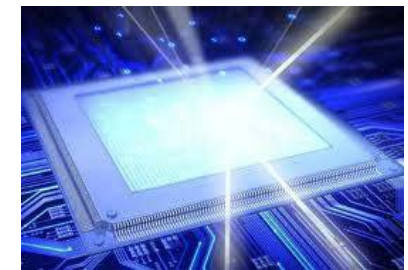
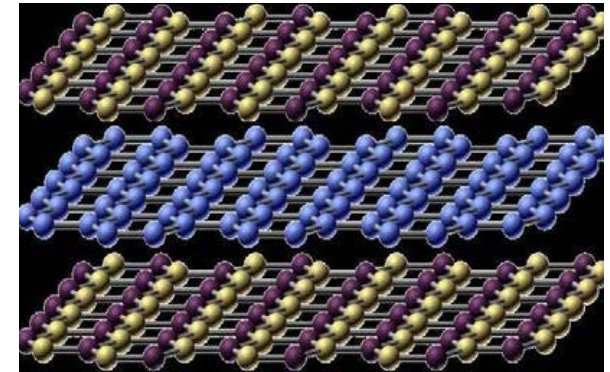
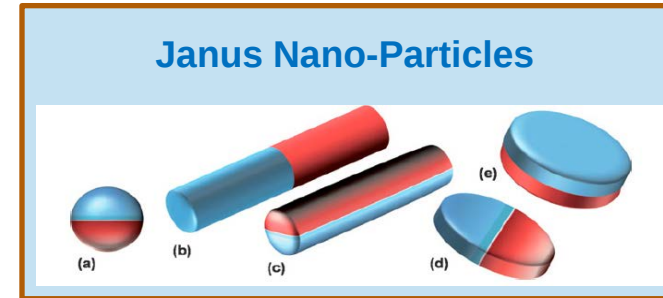
- Complex engineered materials and devices
- Devices based on quantum phenomena
- Integration into new classes of devices

Optics, Electromagnetics, Communication, and Signal Processing

- Adaptive optics and optical imaging
- Lasers and nonlinear optics
- Distributed multilayered sensing

Natural Materials and Systems

- Using, mimicking, or altering ways that natural systems build materials and sensors and perform under extreme conditions.



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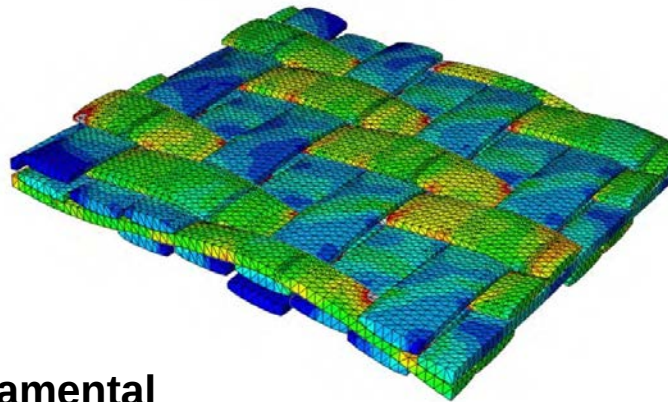
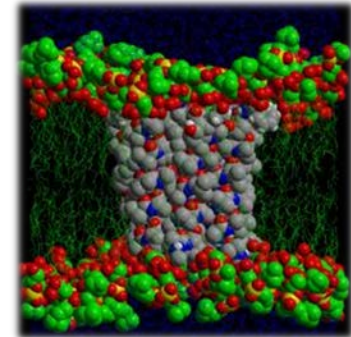
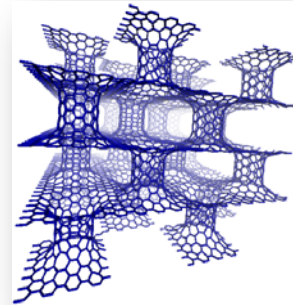


RTD Technical Programs



Complex Materials and Structures

Organic Materials Chemistry (Lee, C)
Low Density Materials (Harrison)
Mechanics of Multifunctional Materials and
Microsystems (Lee, B)
Aerospace Materials for Extreme
Environments (Sayir)



Complex electronics and fundamental quantum processes

Quantum Electronic Solids (Weinstock)
Photonics and Optoelectronics (Pomrenke)
GHz-THz Electronics (Hwang)

Natural Materials and Systems

Natural Materials and Systems (DeLong)





RTD Future Strategic Direction

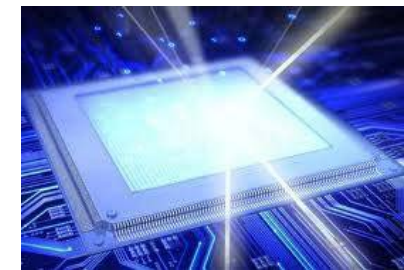
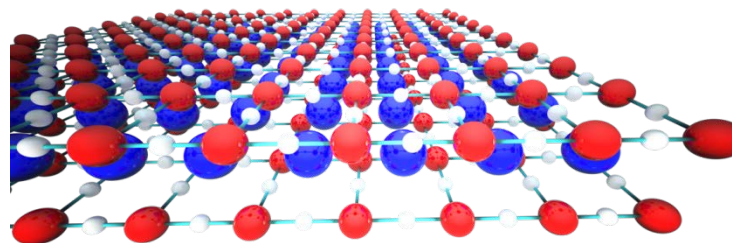
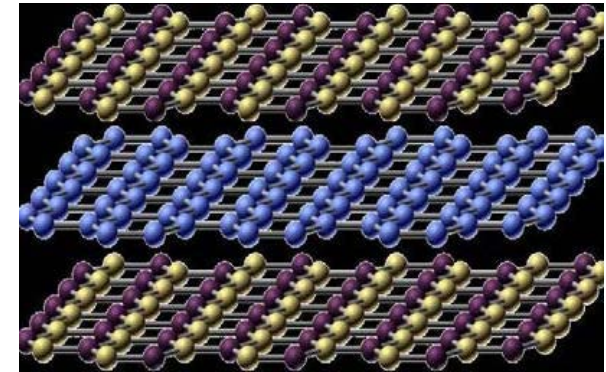
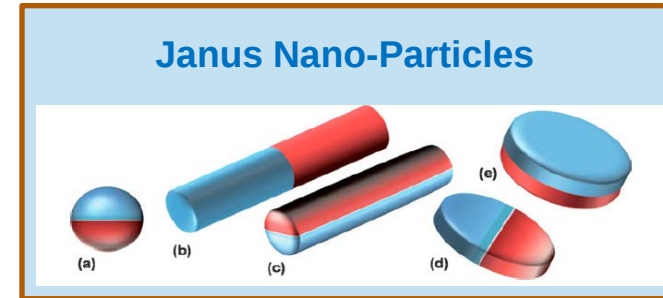


Structural and Functional Materials

- Focus on complex materials, microsystems and structures
- Hierarchical design of mechanical and functional properties
- Dynamic functionality and/or performance
- Studying, using, altering or mimicking of biomaterials
- Understanding the natural of the biotic/abiotic interface

Devices and Systems

- Integration into new classes of devices
- Fundamental understanding of materials that are not amenable to conventional computational means.
- Exploration and understanding of a wide range of complex engineered systems and devices
- Mimicking of existing natural sensory systems



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New Directions

(Cross-Directorate /Cross-DoD/Cross-Agencies/International Collaborations)



BRI Topics (FYs 12, 13 & 14)

Active, Functional Nanoscale Oxides (Weinstock)

Bionanocombinatorics (DeLong, Hearn)

Origami Design for the Integration of Self-Assembling Systems (Harrison, Stargel, Smith, Fahroo)

Autonomic Material Systems Utilizing Biomolecular Transduction (Lee B, DeLong)

Layered Structured 2D-Materials (Sayir)

Pulse Laser Processing of Materials (Parra, Harrison)

Sustainable Alloy Design - Rare Earth Metals (Sayir, Fuller)

Bio-Sensing of Magnetic Fields (Larkin, Bradshaw, Curcic, DeLong)

2D Materials & Devices Beyond Graphene (Hwang, Pomrenke, Harrison, Mah)

Nanoscale Building Blocks for Novel Materials (Berman, DeLong)

Theory-based engineering of biomolecular circuits (Fahroo, DeLong)

Metal Dielectric Interface (Sayir, Luginsland)

QUESTIONS?