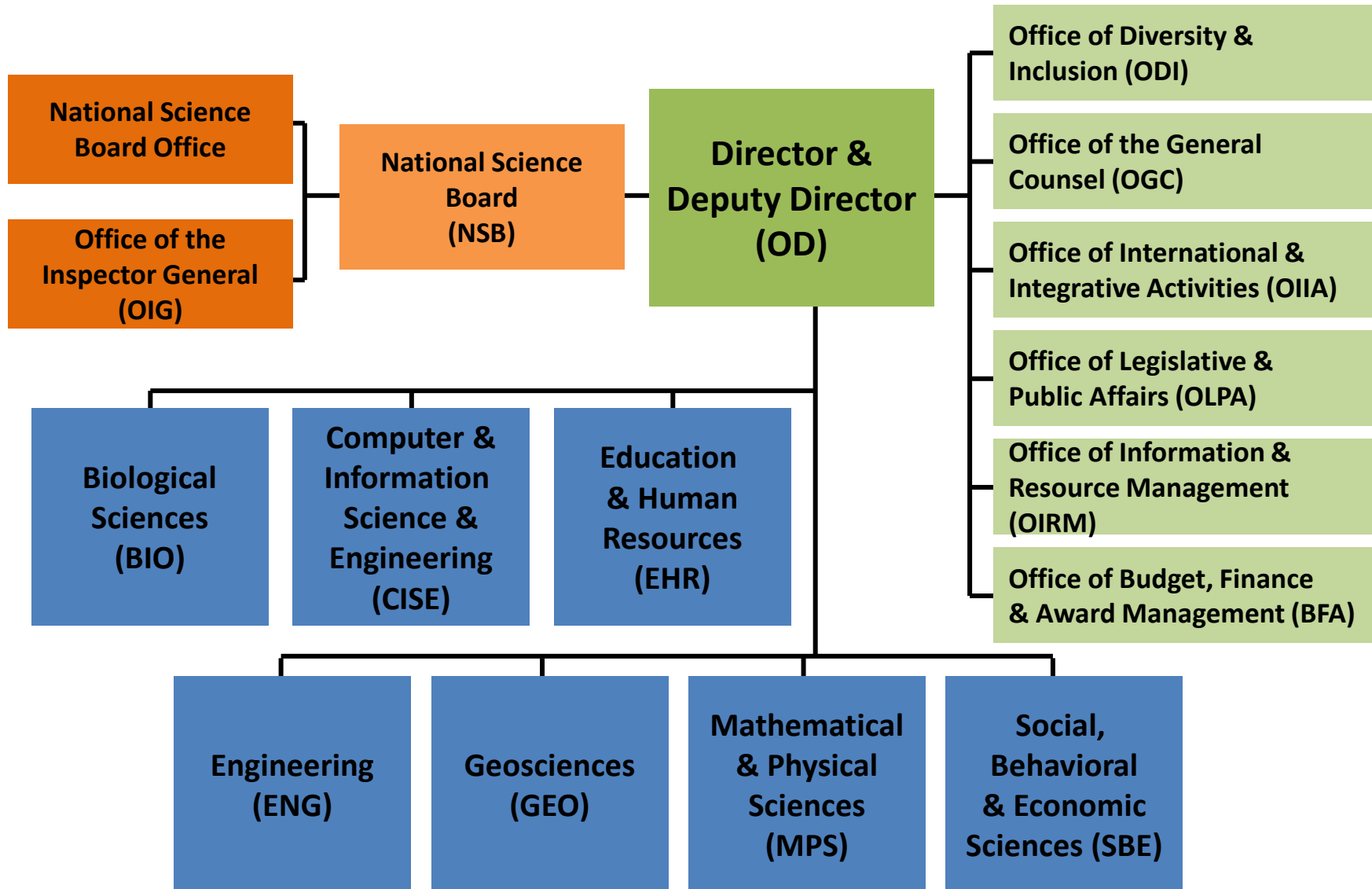


Emerging Frontiers in Research and Innovation (EFRI)

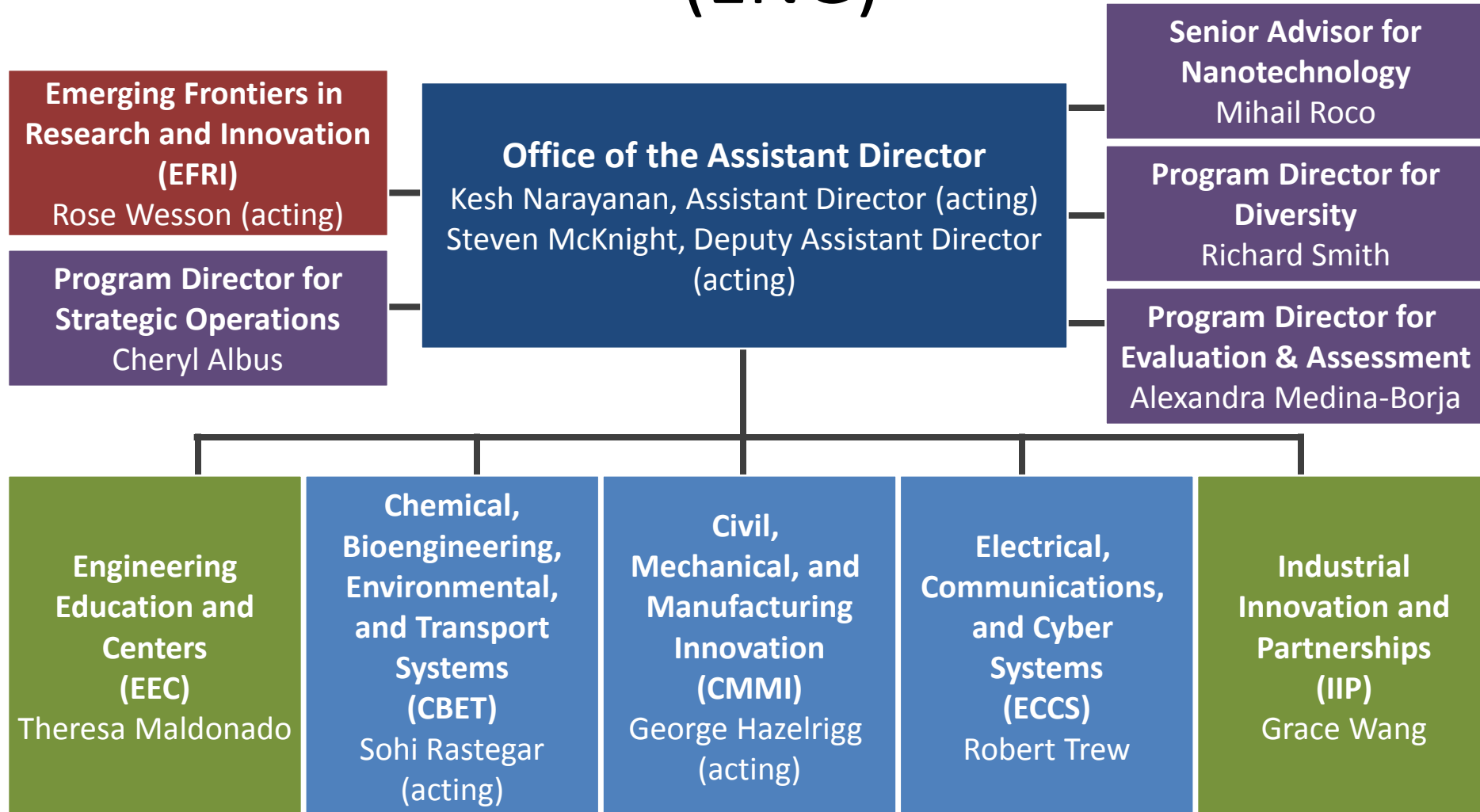
Rosemarie D. Wesson

Acting Director

NSF Organizational Structure



NSF Directorate for Engineering (ENG)



MANDATE AND VISION OF EFRI

MANDATE - EFRI will serve a critical role in helping the Directorate for Engineering (ENG) focus on important emerging areas in a timely manner. EFRI will annually recommend, prioritize, fund, and monitor initiatives at the emerging frontier areas of engineering research and education.

VISION – All NSF ENG Programs support research at the frontiers of research and innovation.

EFRI Office provides opportunities in interdisciplinary areas at the *emerging* frontiers of research and innovation that (a) are transformative, (b) address national needs/grand challenges, and (c) will make ENG unrivaled in its global leadership.

EFRI- In One Slide

- **MANDATE** - Serve a critical role in helping the Directorate for Engineering focus on important emerging areas in a timely manner.
 - **COMMUNITY DRIVEN** - Engages the research community (through DCL) and ENG/NSF PDs to identify and fund a portfolio of projects in strategic emerging interdisciplinary areas that may not be supported with current NSF programs and in which ENG researchers play the leading role.
 - **PTR AND IDR** - Uses PTR (Potentially Transformative / High risk, High reward) and IDR (interdisciplinary) as criteria for project selection
 - **MIDSCALE BUDGET** - It is the main Midscale funding mechanism in ENG (\$2M / 4-year projects)
- **EFRI TOPICS:**

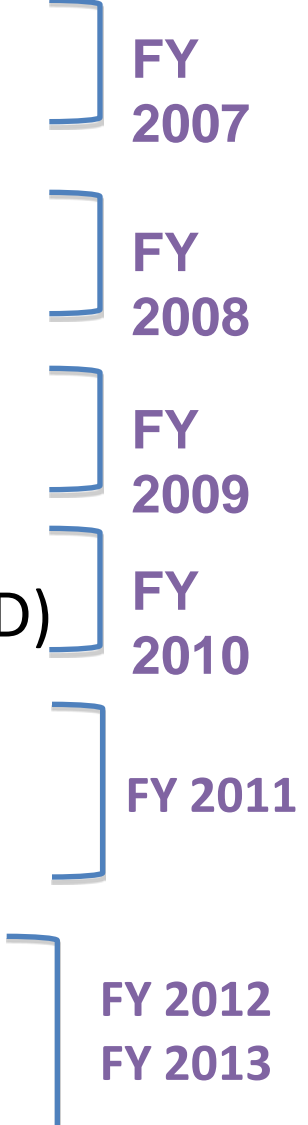
FY 2007	Auto-Reconfigurable Engineered Systems (ARES) Cellular and Biomolecular Engineering (CBE)
FY 2008	Cognitive Optimization (COPN) Resilient and Sustainable Infrastructures (RESIN)
FY 2009	Biosensing and Bioactuation (BSBA) Hydrocarbon from Biomass (HyBi)
FY 2010	Science in Energy and Environmental Design (SEED) Renewable Energy Storage (RESTOR)
FY 2011	Engineering Multicellular and Interkingdom Signaling (MIKS); Mind, Machines, and Motor Control (M3C)
FY '12,'13	Flexible Bioelectronics Systems (BioFlex), Origami Design for the Integration Of Self-assembling Systems For Engineering Innovation (ODISSEI); Photosynthetic Biorefineries (PSBR)
- **TOPIC LEADERS** - Program Directors from ENG Divisions in collaboration with PDs from other NSF Directorates and other Federal agencies when appropriate
http://nsf.gov/staff/staff_list.jsp?org=EFRI&from_org=EFRI
- **CONTACT** - Rosemarie D. Wesson, rwesson@nsf.gov, (703) 292-7070.
<http://nsf.gov/eng/efri> and <http://efri.org>

\$32M
FY 13 Request

EFRI Criteria

- **TRANSFORMATIVE:** Does the proposed topic represent an opportunity for a significant leap or paradigm shift in a research area, or have the potential to create a new research area? [What are the underpinning breakthroughs?]
- **NATIONAL NEED/GRAND CHALLENGE:** Is there potential for making significant progress on a current national need or grand challenge?
- **INTERDISCIPLINARY:** Does the topic require inter/multi-disciplinary expertise?

EFRI Topics

- Auto-Reconfigurable Engineered Systems (ARES)
 - Cellular and Biomolecular Engineering (CBE)
 - Cognitive Optimization (COPN)
 - Resilient and Sustainable Infrastructures (RESIN)
 - Biosensing and Bioactuation (BSBA)
 - Hydrocarbons from Biomass (HyBi)
 - Renewable Energy Storage (RESTOR)
 - Science in Energy and Environmental Design (SEED)
 - Engineering New Technologies Based on Multicellular and Inter-kingdom Signaling (MIKS)
 - Mind, Machines, and Motor Control (M3C)
 - Flexible Bioelectronics Systems (BioFlex)
 - Origami Design (ODISSEI)
 - Photosynthetic Biorefineries (PSBR)
- 
- | Fiscal Year | Topics |
|--------------|---|
| FY 2007 | Auto-Reconfigurable Engineered Systems (ARES), Cellular and Biomolecular Engineering (CBE) |
| FY 2008 | Cognitive Optimization (COPN), Resilient and Sustainable Infrastructures (RESIN) |
| FY 2009 | Biosensing and Bioactuation (BSBA), Hydrocarbons from Biomass (HyBi), Renewable Energy Storage (RESTOR) |
| FY 2010 | Science in Energy and Environmental Design (SEED) |
| FY 2011 | Engineering New Technologies Based on Multicellular and Inter-kingdom Signaling (MIKS), Mind, Machines, and Motor Control (M3C) |
| FY 2012-2013 | Flexible Bioelectronics Systems (BioFlex), Origami Design (ODISSEI), Photosynthetic Biorefineries (PSBR) |

Sustaining EFRI Topics Post-EFRI

- General Ideas For Post-EFRI support:
 - CENTERS (ERCs, STCs, other)
 - NEW PROGRAMS within or across Divisions
 - RESTRUCTURED PROGRAMS at NSF
 - IDR opportunity in ENG (group interdisciplinary awards of up to \$1M; though funds are very limited)
 - OTHER AGENCIES
 - NEW EFRI TOPICS THAT MAY BE AN EVOLUTION OF AN EARLIER TOPIC
 - INTERAGENCY INITIATIVES
 - INTERNATIONAL INITIATIVES
 - Some Topics will not be appropriate for further support.

Sustaining EFRI Topics

Status Check

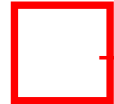
- **CBE (7 projects, FY 2007)**



- **STC AWARD TO ONE EFRI GROUP (MIT, Kamm)**

- Another is competing for STC
- Others will try for ERC or other Center programs
- NIH
- One awarded MIKS (Pruitt); Two MIKS grantees were trained by CBE PIs

- **ARES (5 projects, FY 2007)**



- **MIT-Singapore: Future of Urban Mobility**

- One in STC competition
- Cyber-Physical Systems (CPS)
- ECCS and CMMI support the technical area

- **COPN (4 projects, FY 2008)**



- **ERC AWARD TO ONE (U. Washington, Matsuoko)**

- ECCS and CBET support the technical areas but group awards?
- Some may pursue Centers program

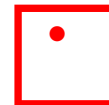
- **RESIN (8 projects, FY 2008)**



- **A RESEARCH CLUSTER IN CMMI**

- TOPIC or a variation may repeat in 2014
- An academic program at UIUC

- **BSBA (12 projects, FY 2009)**

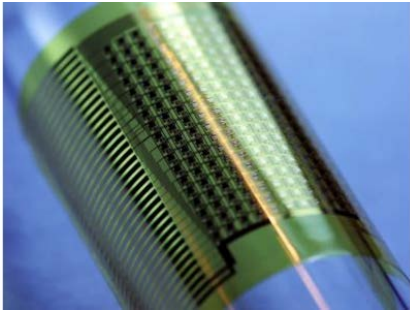


- **NEW PROGRAM IN CBET: Biosensing (Alex Simonian)**

- One PI plans to apply for Center programs

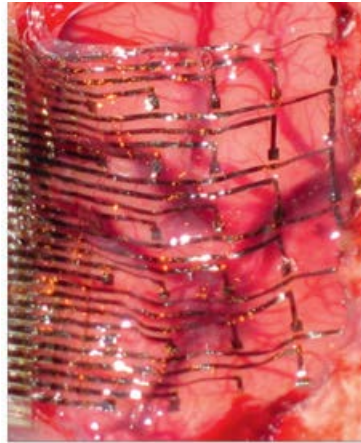
Topic 1: BioFLEX – Flexible Electronics For Biomedical Applications

Flexible electronics

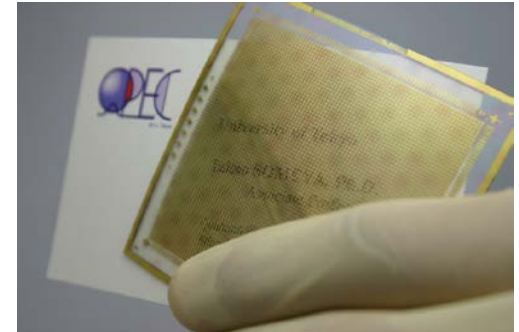


Wrap around cylindrical surface

Stretchable electronics



Flexible Scanner



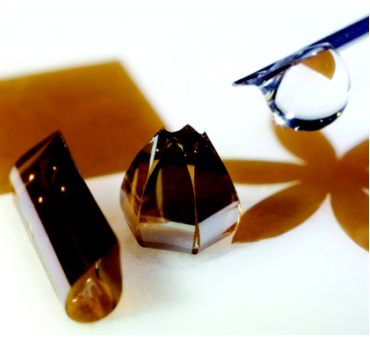
Rogers et al., “Materials and Mechanics for Stretchable Electronics”, Science 327, 1603 (2010)

Expected Transformative Impact:

Advances in basic science and engineering, including materials, devices, circuit design, novel sensors, biomedical applications

Develop/focus enabling technologies that allow enhancing quality of life and patient care while lowering total healthcare costs

New collaborations between different communities (materials, electrical, biomedical, chemical, manufacturing etc.)



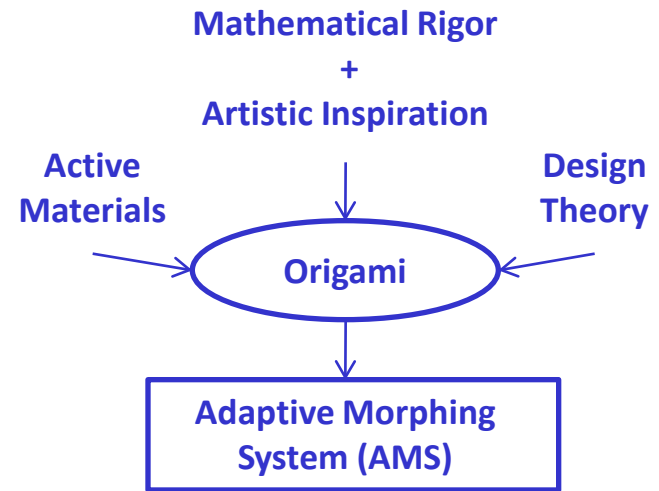
TOPIC 2:

FOLD: Origami Design for Integration of Adaptive Morphing Systems

Objective: Use origami to enable self-assembling, multifunctional, compliant structures (Adaptive Morphing Systems) through the integration of active materials, design theory and compliant mechanisms, mathematics, and artistic inspiration.

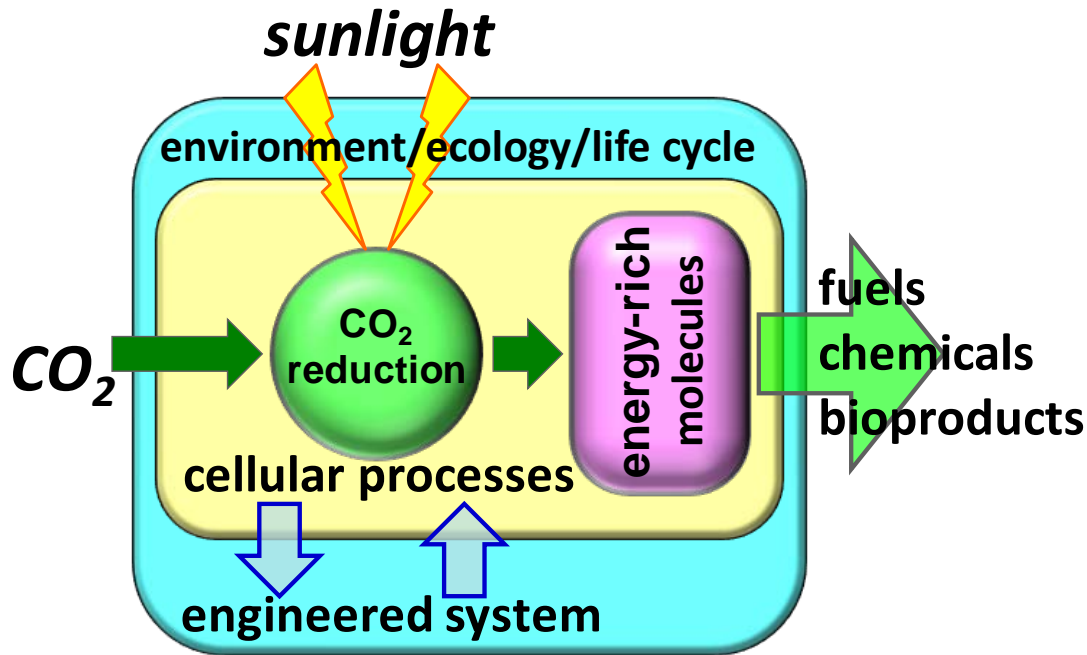
Expected Transformative Impact:

- Foster advances in fundamental understanding of folding and unfolding mechanisms in active materials, design theory, and mathematics
- Underpin design of foldable products at all scales and across scales
- Promote new collaborations between different communities
- Enable novel engineered adaptive morphing systems for breadth of national priorities, including energy, complex design, and manufacturing



Topic 3:

Upscaling Photobiological Processes - The Sustainable Photosynthetic Biorefinery



Objective: Establish the fundamental principles which efficiently deliver light and CO₂ to photosynthetic micro-organisms in scalable platforms for the sustainable & flexible production of fuels, chemicals, and bio-products

Expected Transformative Impact

- New paradigms for the rational/sustainable design and upscaling of photosynthesis-based, bio-manufacturing platforms that use sunlight and atmospheric CO₂ as inputs
- Advances in the basic science of flexibly transforming atmospheric CO₂ to complex and/or energy-rich molecules through metabolic processes
- Novel engineered systems for the emerging bio-economy