A JOURNEY TO THE COOLEST JOB ON THE PLANET!

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Materials Chemistry and Physics Branch
NASA Glenn Research Center
Cleveland, OH

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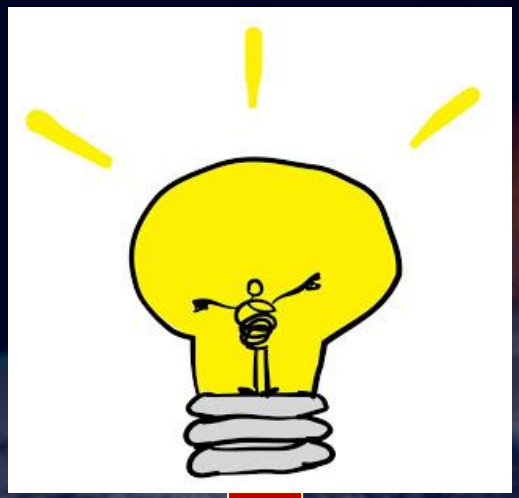
NASA's missions to explore our world, solar system, galaxy and universe presents extraordinary complex challenges. These challenges can only be met with excellence in science, technology, engineering, and math (STEM) education, innovation, and a lot of rigorous team work.

Where does excellence in STEM begin?

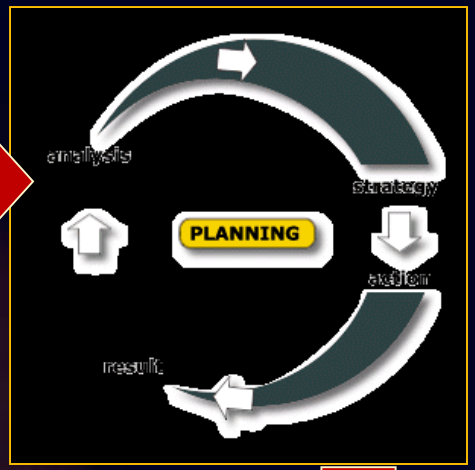
Future Excellence in STEM Begins with YOU!

- Brain Power
- Love of Science & Technology
- Dedication
- Perseverance
- Flexibility
- Integrity
- And a little bit of confidence!

Make a Plan →Achieve Your Goals



Ask yourself…
What do I want?
How can I get it?
Where should I go?
… and When?
Who can help me?



Educational Background

1992 B.S. / M.S. ElectroChemical Engineering
Moscow University of Chemical Technology
Research: Surface catalysis and adsorption of organic molecules on organized metal surfaces

1997 Ph.D. Chemical Engineering / Analytical Chemistry
University of Illinois at Urbana-Champaign
Research: Electrochemical biosensors for monitoring of complex biochemical systems

Career in Industry

LUBRIZOL Corporation *(1998-2004)*

Senior Research Scientist

Developed electrochemical *in-situ* fluid condition monitoring systems and sensors for traditional (ICE) and renewable (wind) energy sources

LUBRIZOL Corporation *(2005-2008)*

Business Development Manager

Managed introduction of a line of diagnostic products and sensors (QDiS™, FluiSens™, FluiSys™) commercialized through Lubrizol partnerships with Continental AG and Delta Electronics.

CRANE Aerospace Corporation *(2011-2012)*

Principle Engineer

Lead development of diagnostic products for aircraft engines

Career in Academia

Case Western Reserve University *(2001-)*

Adjunct Associate Professor of Chemical Engineering

Electrochemical Impedance Spectroscopy – Theory and Applications for studies of electrochemical processes in batteries, fuel cells, corrosion, biomedical devices, clinical applications, materials properties analysis

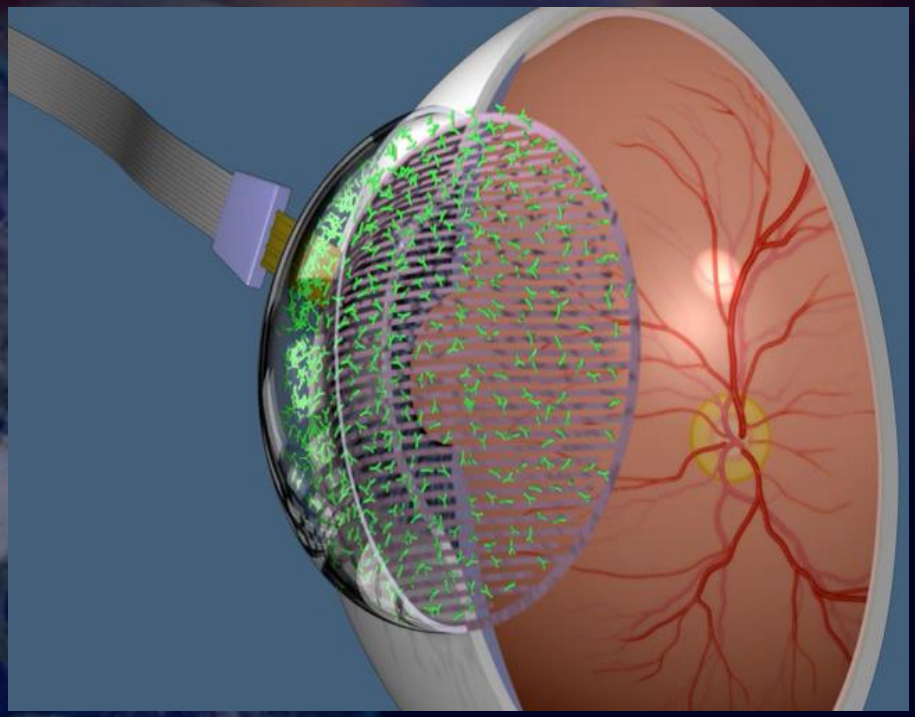
Career at the Cleveland Clinic

Cleveland Clinic

Cleveland Clinic Lerner Research Institute *(2008-2011)*

Senior Staff, Biomedical Engineering

Lead development and commercial introduction of biomedical devices, sensors, wound care and drug delivery systems



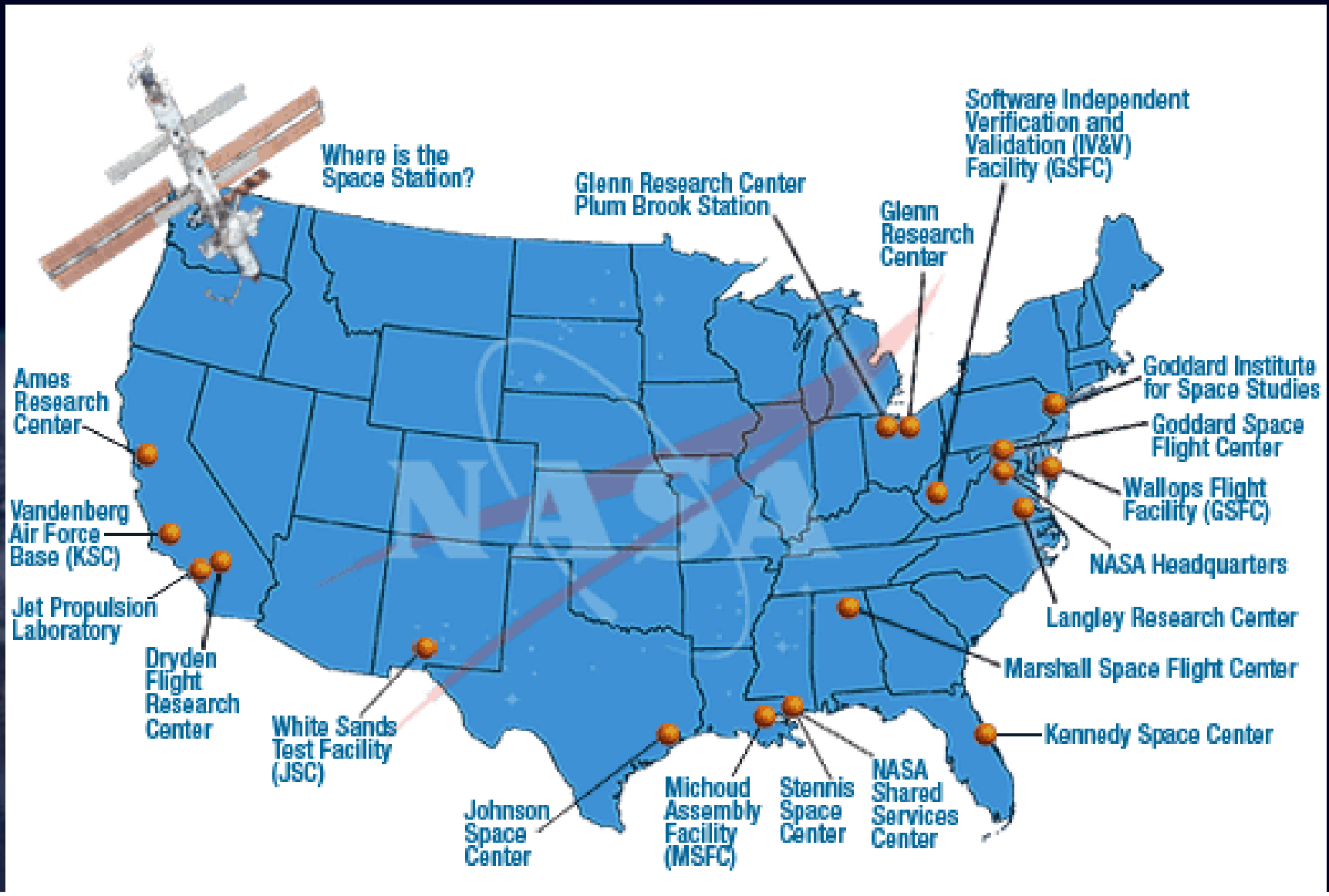
Career at NASA

NASA Glenn Research Center *(2012-)*

Branch Chief, Electrochemical Systems

Branch Chief, Materials Chemistry and Physics

NASA Facilities



Glenn Research Center

Lewis Field

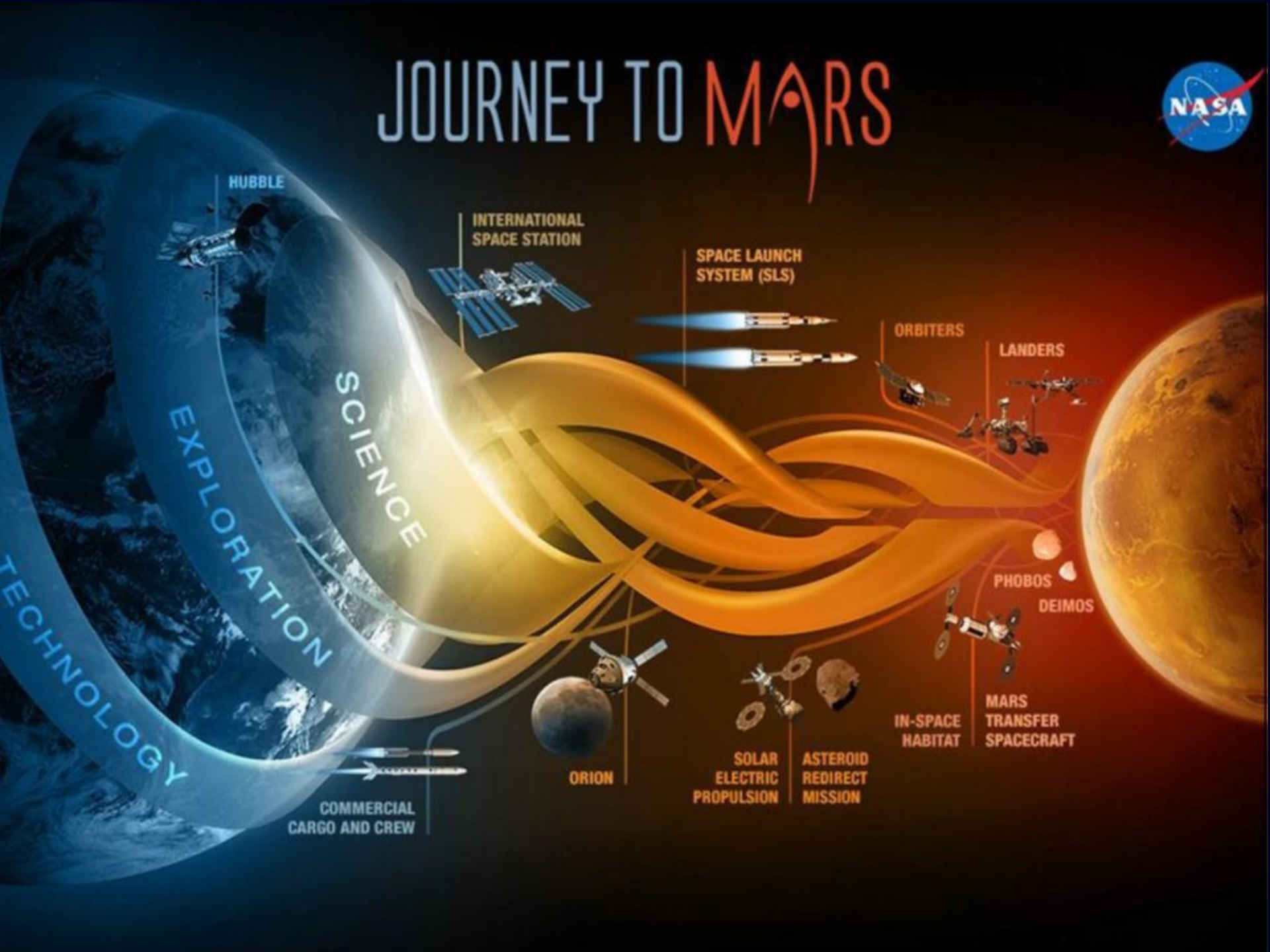
(Cleveland, OH)

- 350 acres
- ~ 1550 civil servants and 1500 contractors

Plum Brook Station Test Site

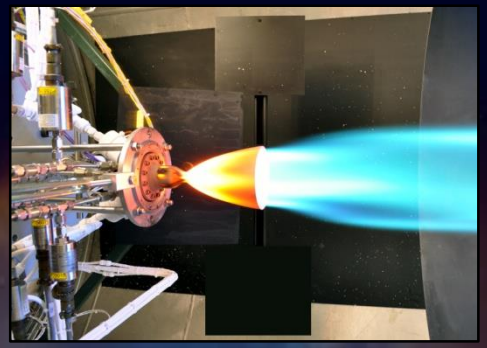
(Sandusky, OH)

- 6500 acres
- ~ 10 civil servants and 100 contractors


JOURNEY TO MARS
NASA
HUBBLE
INTERNATIONAL SPACE STATION
SPACE LAUNCH SYSTEM (SLS)
ORBITERS
LANDERS
SCIENCE
EXPLORATION
TECHNOLOGY
PHOBOS
DEIMOS
IN-SPACE HABITAT
MARS TRANSFER SPACECRAFT
ORION
SOLAR ELECTRIC PROPULSION
ASTEROID REDIRECT MISSION
COMMERCIAL CARGO AND CREW

NASA Glenn Core Competencies

Air-Breathing Propulsion

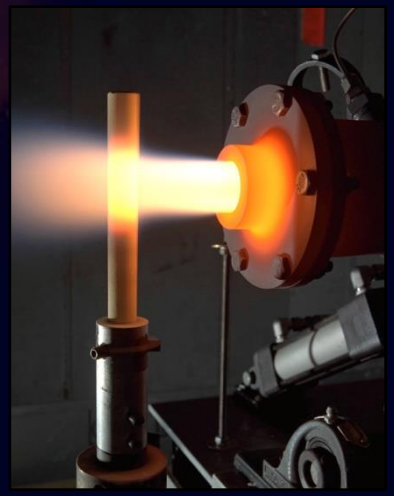


In-Space Propulsion and Cryogenic Fluids Management

Physical Sciences and Biomedical Technologies in Space

Communications Technology and Development

Power, Energy Storage and Conversion

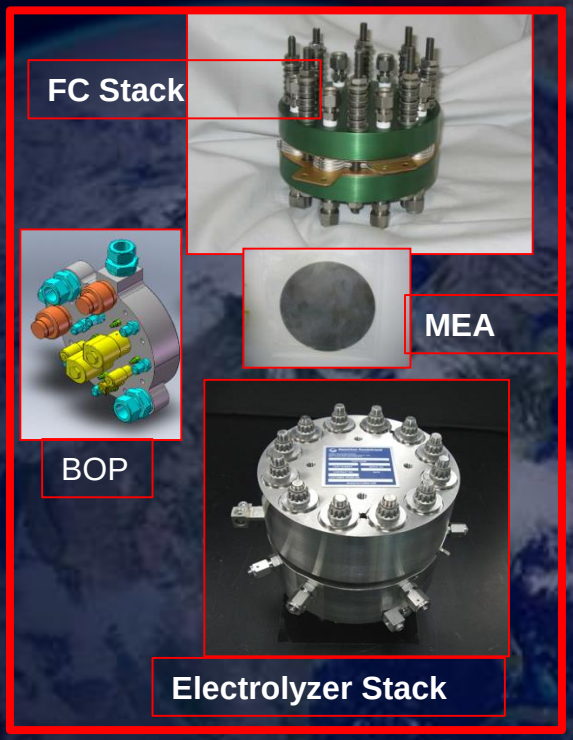


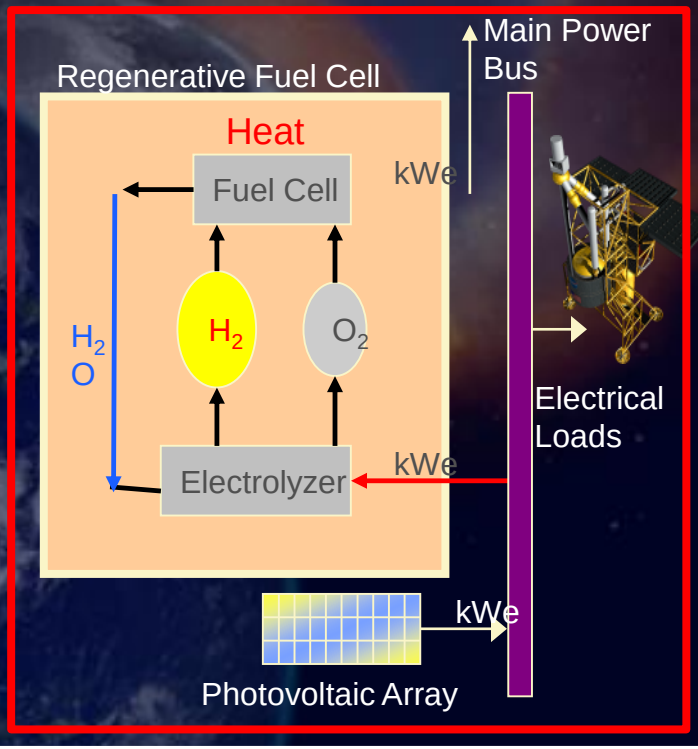
Materials and Structures for Extreme Environments

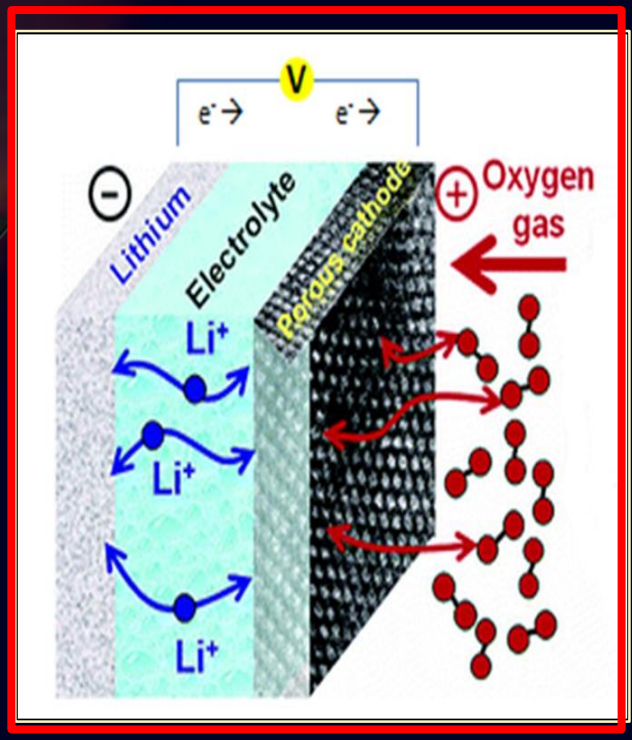
Chief of Electrochemical Systems Branch

- The Branch plans, conducts and directs research and technology maturation efforts in the area of electrochemical systems.
- Power system is 20-30% of spacecraft mass and budget.

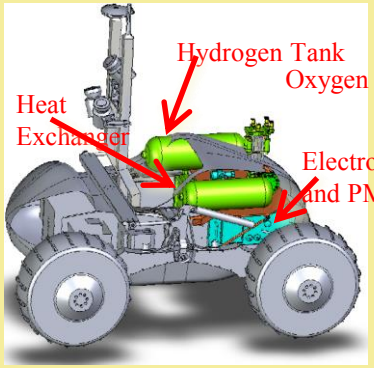
Power Generation	Power Conversion	Energy Storage
Fuel Cells	Electrolyzers	Batteries







NASA Drivers for High Performance Electrochemical Systems



Planetary Rovers and Landers, Space Exploration:

- Fuel Cell provides primary power to drive exploration-class rovers, landers, & Space Launch System Exploration Upper Stage

Electric Aviation

- Green aviation – Less noise, lower emissions, high efficiency
- Hybrid / All-electric aircraft – Limited by mass of energy storage system
- Commercial aviation – Safe, reliable, lightweight on-board electric auxiliary power unit

Extravehicular Activities (Spacesuit power)

- Astronaut life support
- Safety and reliability are critical
- Requires >400 Wh/kg
- 100 cycles

Life support & Mobile Oxygen Concentrator

- Electrolysis system
- Generates high pressure (>2000 psi) oxygen from CO_2 and / or water

Requirements far exceed the capabilities of current chemistries

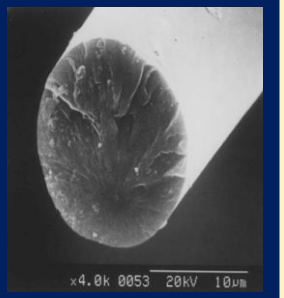
➢ Progress in these areas requires advances in safe, low weight, very high energy batteries and fuel cells

Chief of Materials Chemistry and Physics Branch

High Temperature Materials

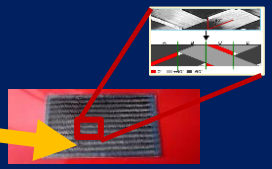
Ceramic fiber materials

SiC fiber with >2700^0 F temperature capability and mechanical stability



High temperature alumosilicate aerogels for seals

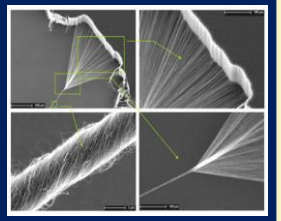
High temperature Polymer composites



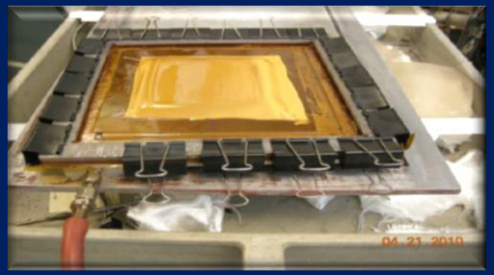
Lightweight and Nanotechnology Materials

Flexible Aerogel

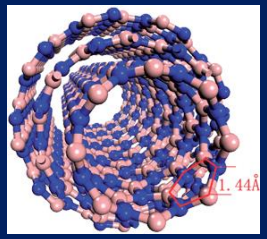
Nanotube Yarn



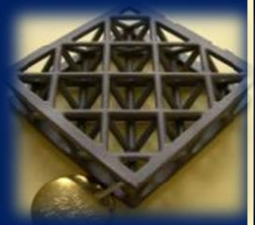
Carbon Fiber-CNT Yarn Hybrid Reinforcement



Boron Nitride nanotechnology



Lattice Block



Power System and Multifunctional Materials

Materials for High Power Density Electric Motors

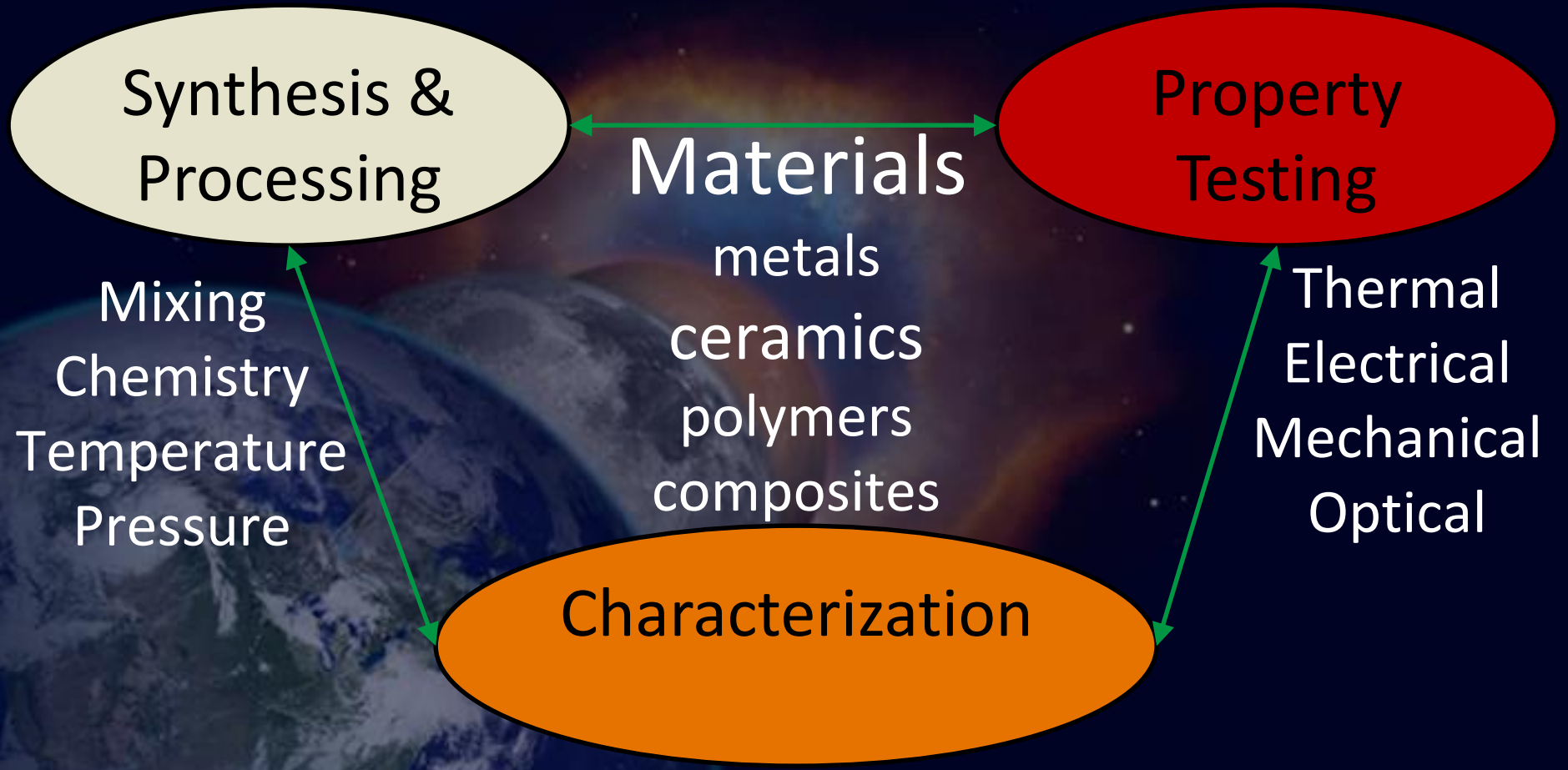
Lightweight Power Transmission Cable

Solid Oxide Fuel Cell Materials

SiC High Voltage parts

Energy Storage Materials

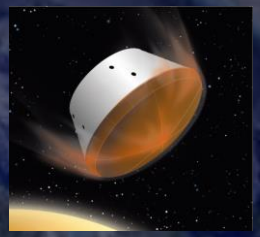
Materials Research



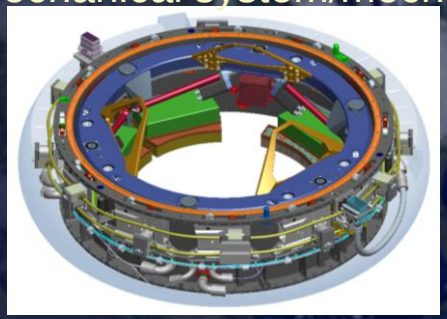
Materials Research Driven by Key Aerospace Challenges

Advanced multifunctional materials for power, propulsion, communication systems

Higher temperature and harsh environment for aerospace propulsion and planetary entry



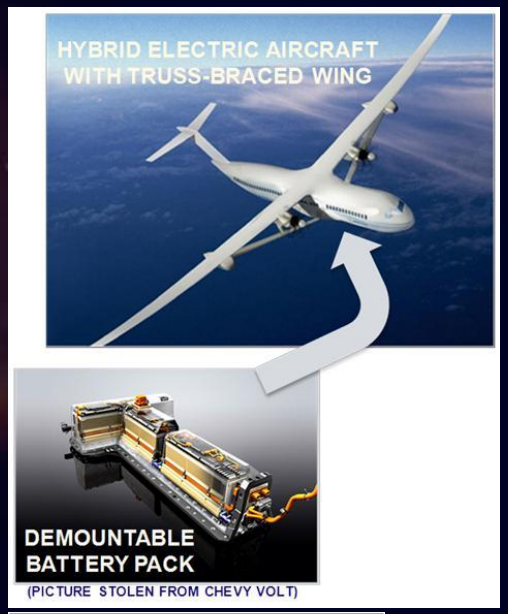
Lightweight and durable mechanical system/mechanisms

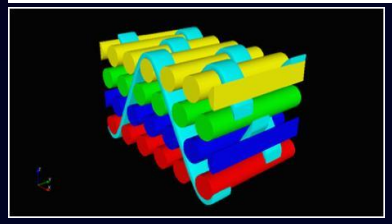


Lightweight requirements for large structures

Long-term durability in harsh environments

Low carbon and low emission aircraft





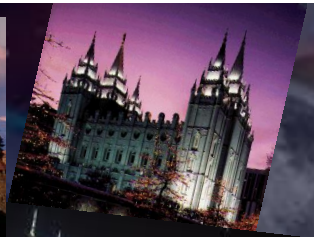
Computational modeling across multiple length scales

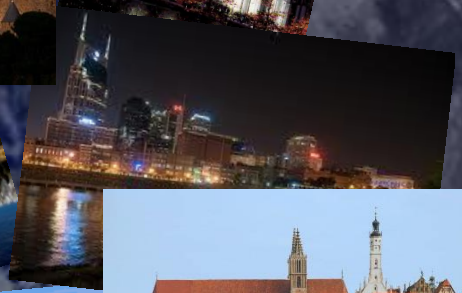
Working Hard Takes You Places!

International Society of Electrochemistry

The Electrochemical Society
Advancing solid state & electrochemical science & technology

- 1 book
- 5 book chapters
- 8 patents,
- >40 peer-reviewed papers
- > 50 conference presentations
- International Society of Electrochemistry
- The Electrochemical Society

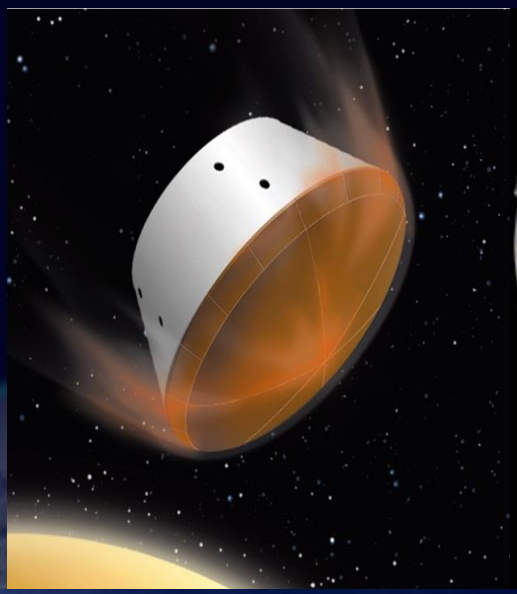



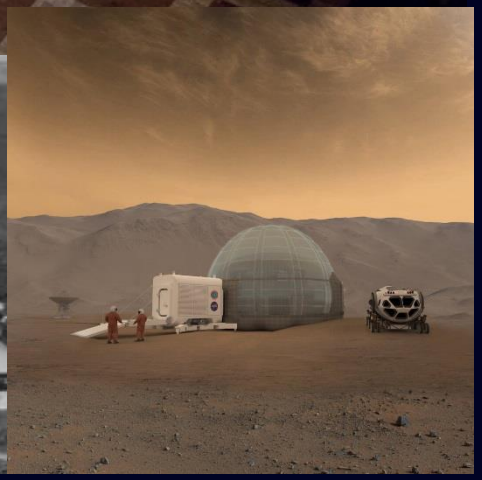







CHOOSE to Pursue A STEM Education

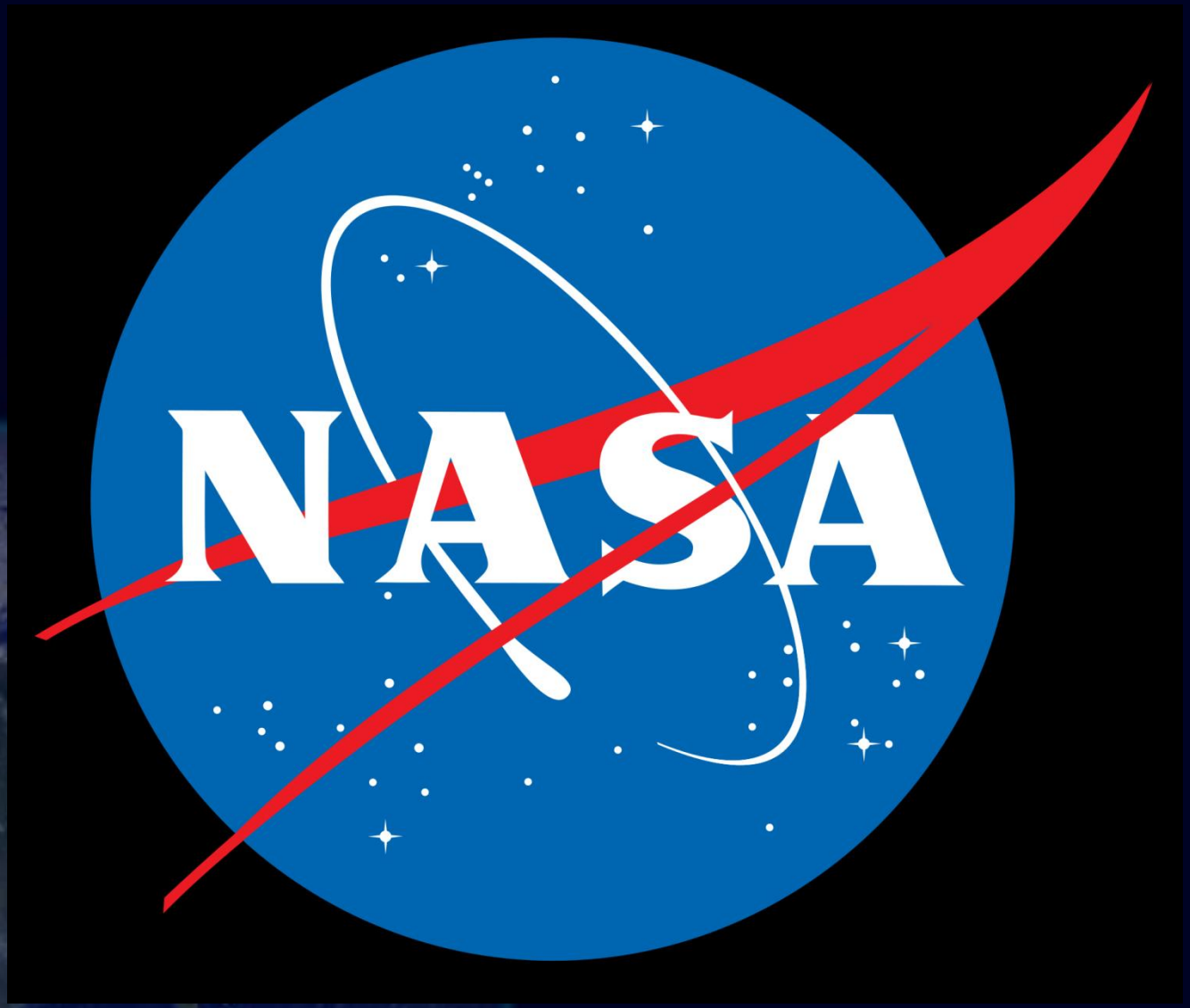




The Rewards Are Out of This World…

NASA Opportunities for Students

- Student Opportunities – high school, undergraduate, graduate, Pathway:
  - Prepares students for careers by providing related work experience
  - Rotates scheduled work sessions with school
  - https://intern.nasa.gov
  - Search Opportunities
  - Example-Search “glenn pathways”


NASA