National Aeronautics and
Space Administration

Ceramic Integration Technologies for Dissimilar Materials

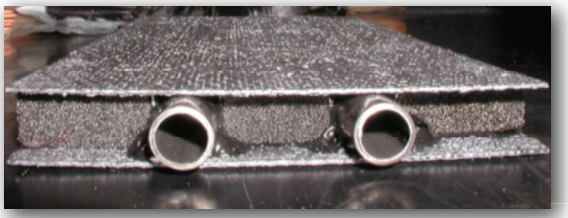
For integration and low-cost manufacturing of energy-efficient components and systems

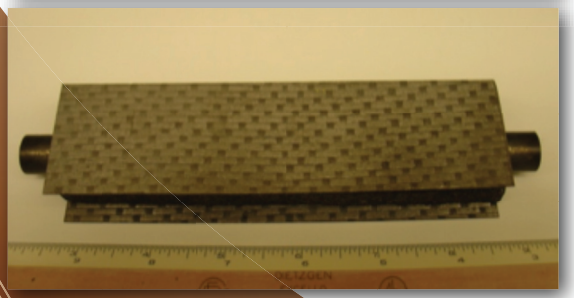
TECHNOLOGY OPPORTUNITY

Scientists at NASA's Glenn Research Center and the Ohio Aerospace Institute have developed innovative approaches to integrate ceramics to metals. This novel process allows for greater utilization of advanced ceramics and composite components in high-performance energy and environmental systems. Through ceramic integration technologies, dissimilar materials can be bonded together to create components that are more durable, lightweight, energy efficient, and wear resistant than ever before. These methods offer significant benefits for the automotive industry, including lighter weight components, longer component life, and lower costs for parts, operation, and maintenance. NASA's novel process enables robust manufacturing of components used in automotive support systems, including thermal management, energy production, energy storage and distribution, and energy conservation and efficiency.

BENEFITS

- **Enables greater use of ceramics and ceramic matrix composites (CMCs):** Dissimilar materials can be bonded together to create more durable, lightweight, and wear-resistant components
- **Advantages over metals:** Components are lighter weight, and insulative, with higher temperature capability and greater resistance to corrosion and wear
- **Improves vehicle performance:** Vehicles will be more durable, fuel efficient, and safe; reduces costs, heat losses, and weight
- **Low-cost manufacturing:** Integrates easily into various manufacturing processes; joint properties can be tailored
- **Enables complex shapes:** Allows for large three-dimensional shapes to be fabricated, including curved surfaces and internal cavities
- **Robust:** Maintains good joint strength and integrity in various operating conditions

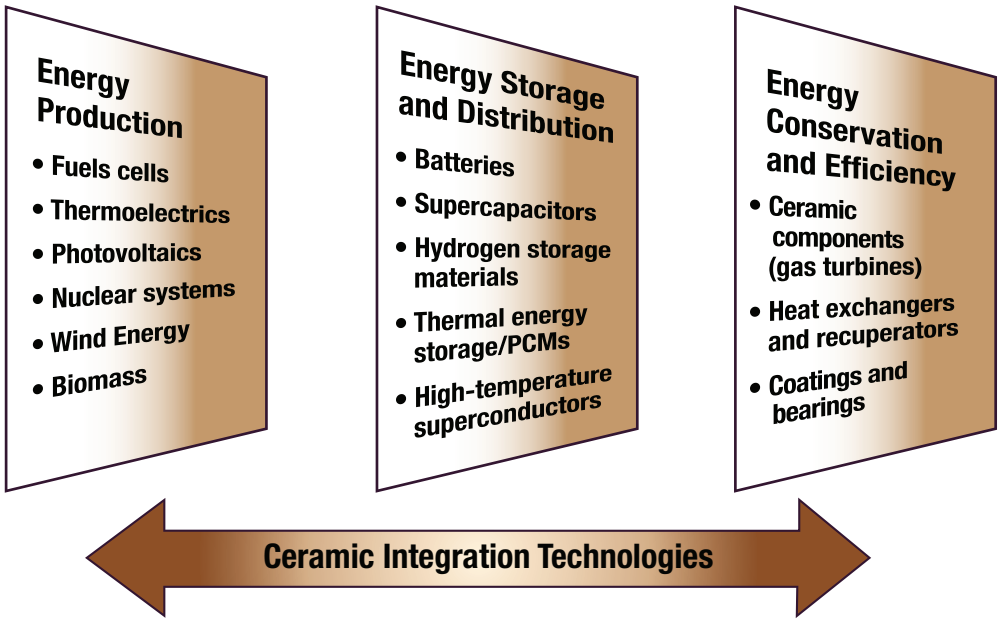




Heat exchanger components.

APPLICATIONS

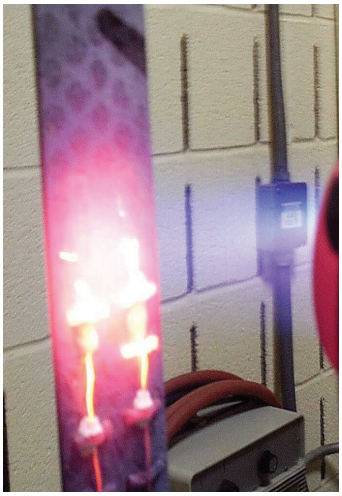
- Systems for piston heads and rings; turbo-charger rotors
- Packaging of sensors and actuators
- Energy production systems
  - Fuel cells, thermoelectrics, photovoltaics, nuclear systems, and wind energy
- Energy storage and distribution systems
  - Batteries, supercapacitors, thermal energy storage/phase change materials (PCMs), and high-temperature superconductors
- Energy conservation and efficiency systems
  - Ceramic components (gas turbines), heat exchangers and recuperators, coatings, and bearings



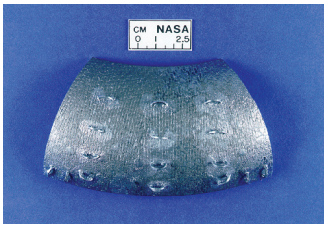
Integration technologies are critical for various energy systems.

HOW IT WORKS

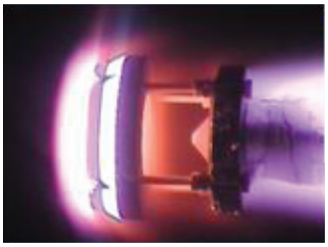
Ceramic-metal integration technologies allow robust bonding and assembly of a wide variety of components, allowing for longer component lives and wider utilization of ceramics and CMCs. In this process, ceramic or CMC materials are bonded/brazed to metals using metallic interlayers (active braze alloys or solders). A number of ceramic-metal systems (including oxides, such as alumina and yttria-stabilized zirconia (YSZ), and nonoxides, such as silicon carbide and silicon nitride) have been bonded to different metals for use in automotive energy, environmental, and thermal management systems. This process enables the integration of ceramic components into various automotive support systems, such as cooling (e.g., metallic manifolds), fuel (e.g., metallic fuel tubes), and monitoring and performance-based maintenance (e.g., sensor and actuators).



Attachment for sensors.



Attachment for integration of sensors.



Testing.

WHY IT IS BETTER

Ceramic components offer several benefits, including lighter weight, higher temperature capability, improved electrical insulation, and better thermal insulation for lower heat losses. They also enhance durability through improved heat capacity and greater resistance to corrosion and wear. Such benefits translate to lower costs for component parts, operation, and maintenance. These technologies are critical for the manufacturing of next-generation energy-efficient systems with reduced cost and improved efficiency.

LICENSING AND PARTNERING OPPORTUNITIES

Glenn's Office of Technology Partnerships and Planning seeks to transfer technology to and from NASA to benefit the space program and U.S. industry. NASA invites companies to consider licensing the Ceramic Integration Technologies.

FOR MORE INFORMATION

For more information about this and other technology licensing opportunities, please contact

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