

Multiscale Integration Challenges in Alternative and Renewable Energy Systems

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It is estimated that globally 10 terawatts of power will be needed (equivalent to an additional 150 million barrels of oil) per day by 2050. Future energy production and distribution must be sustainable, environmentally conscious, and less reliant on conventional fossil fuels that are associated with a massive carbon footprint. Advanced ceramic materials and multiscale ceramic integration technologies will dramatically impact the energy and environment landscape due to their wide scale applications in all aspects of alternative and renewable energy production, storage, distribution, conservation, and efficiency. Examples include fuel cells, thermoelectrics, gas turbine systems, distribution and transmission systems based on superconductors, nuclear power generation, NO_x and CO_x reduction technologies, and a wide variety of green and energy efficient manufacturing processes and technologies. Affordable and reliable solar energy technologies could play key role in sustainable development around the globe without major impact on environment since solar power is a clean, renewable, and sustainable energy source. However, revolutionary approaches for thermal energy storage (TES) system at elevated temperatures (>700 °C) for concentrated solar power (CSP) are needed for reliable energy supply. Integration technologies are key to making these systems a reality. The development of robust and reliable integrated systems with optimum performance requires the understanding of many thermochemical and thermomechanical factors, particularly for high temperature applications. In this presentation, various challenges and opportunities in design, fabrication, and testing of integrated systems will be discussed. Specific examples will be given for integration of fuel cell systems, thermal management, and thermal energy storage devices. Potential opportunities and need for the development of innovative design philosophies, approaches, and integrated system testing under simulated conditions will also be discussed.