Department of Electrical and Computer Engineering

TEXAS TECH UNIVERSITY
Edward E. Whitacre Jr.
College *of* Engineering

Spring 2025 Seminar Series

Seminar Title: ***Multidisciplinary thermal management for energy efficiency: from power generation to end-use application***

Time: 2:00-2:50 PM, Monday, Mar 24, 2025
Location: ECE 101

Speaker:
Lyu Zhou
University of Texas at Dallas

Abstract:
Effective thermal management is the key to improving energy efficiency across various sectors in energy flow, ranging from power generation to end-use applications. Waste heat generation not only causes energy loss but also accelerates material degradation, reduces system performance, and leads to premature device failures, particularly in energy-intensive systems such as power electronics, renewable energy technologies, and data centers. For instance, in crystalline silicon solar panels, every 1 ℃ increase in operating temperature leads to a 0.5% drop in efficiency. Moreover, thermal management also consumes substantial energy. In the building sector, heating, ventilation, and air conditioning (HVAC) systems account for nearly 40% of total energy consumption, a share that is even higher in data centers due to high-performance computing. Addressing these challenges with innovative thermal management solutions is therefore crucial for advancing an affordable and sustainable energy infrastructure.
This seminar will discuss multidisciplinary thermal management strategies to improve energy efficiency through material innovation. First, I will introduce thermal photonics, which leverages resonance and interference in ordered structure to achieve spectral selectivity. By engineering microstructural configurations, I have developed thermal photonic materials with distinct spectral response in a broad wavelength range from the visible to infrared, based on which I demonstrated various applications for natural thermal energy harvesting, thermal camouflage, and structural coloration. Next, I will discuss advanced building thermal regulations through radiative cooling and thermal energy storage. Radiative cooling passively reduces surface temperatures by reflecting sunlight and emitting thermal radiation, yet constrained by the overcooling in cold climates and insufficient cooling in extreme heat. To address this issue, I combine radiative cooling with thermal energy storage, which harnesses waste heat as latent heat in phase change materials. The synergy of these two effects ensures effective cooling under warm daylight while also enabling waste heat recovery for heating at night, offering significant benefits for building thermal comfort. Last, I will present my research on thermochemical energy storage to support power generation in concentrated solar plant systems. My work reveals the microstructural degradation in calcium carbonate sorbents that are responsible for the progressive decay in energy storage. Based on the understanding, I proposed a moisture hydration method to regenerate the degraded sorbents and optimized the protocol to achieve high energy storage capacity over extended cycles, providing a cost-effective solution for energy storage in concentrated solar plant systems.

Speaker Bio:

Dr. Lyu Zhou is a postdoctoral researcher in the Department of Mechanical Engineering at the University of Texas at Dallas. He earned his bachelor's degree from the School of Optoelectronic Science and Engineering at the University of Electronic Science and Technology of China in 2011 and his M.S. and Ph.D. from the Department of Electrical Engineering at the State University of New York at Buffalo in 2018 and 2022, respectively. His research focuses on advanced thermal management, specializing in thermal photonics, nanocomposite, radiative cooling, and thermal energy storage.