Plenary speaker: Pavel Neuzil, Northwestern Polytechnical University in Xi'an, China - ***Advanced Microcalorimetric Analysis using Stationary Droplets and Flow-through Systems***

Prof. Pavel Neuzil is with the School of Mechanical Engineering at Northwestern Polytechnical University in Xi'an, China. With a Ph.D. in Electrical Engineering from the Czech Technical University in Prague, he has over three decades of experience in microfluidics, MEMS, and biosensors. Dr. Neuzil's work has significantly advanced microfluidics, bolometers, and calorimeters. His pioneering research in microfluidics has led to the development of sophisticated lab-on-a-chip devices crucial for various biomedical applications, including diagnostics and therapeutic monitoring. In bolometers, Dr. Neuzil has focused on enhancing the sensitivity and accuracy of these devices and their instrumentation, which are essential for detecting minute temperature changes. His work on microcalorimeters has similarly pushed the boundaries of thermal analysis, enabling precise measurements of thermal properties and phase transitions in small sample volumes, which is particularly relevant for studying complex processes such as crystallization. Dr. Neuzil leads a dynamic research group at Northwestern Polytechnical University to develop innovative micro- and nanoscale devices for biomedical and environmental applications. His recent work includes a novel continuous heat pulse measurement (CHPM) technique, providing deeper insights into various materials' thermal properties and phase transitions. Prof. Neuzil has over 150 journal publications, has authored several book chapters, and holds numerous patents in microtechnology.

Abstract: Microcalorimetry has long been established to measure thermal power, enthalpy, and heat capacity. Our work focuses on the crystallization processes of water and KCl solution droplets using two calorimeters: a droplet-based microcalorimeter and a flow-through calorimeter. Real-time temperature changes in sessile droplets exposed to periodic heat pulses from an LED source were recorded and analyzed with high accuracy and minimal variation. Experiments involved dispensing a 400 nL droplet onto the microcalorimeter surface, observing dynamic heat capacitance (Cp) values and thermal power (P) data, and gaining detailed insights into phase transitions and energy transfer mechanisms during evaporation and crystallization. The flow-through calorimeter further complemented these observations by enabling continuous monitoring of thermal properties in flowing samples. During the evaporation of water and KCl solution droplets, the endothermic process of water evaporation and the exothermic crystallization of KCl were distinguishable. These findings highlight the study's potential in understanding complex crystallization dynamics. Decoupling thermal events during these processes is particularly beneficial for various fields such as materials science, biochemical analysis, and pharmaceutical manufacturing. This research underscores the significant role of microcalorimetry in studying crystallization, offering a robust method for dynamic thermal analysis and contributing to the broader understanding of material behavior. Comprehensive insights into the thermodynamic properties of materials facilitate advancements in energy storage, thermal management, and material characterization.