Session Overview: Flame Synthesis

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Flame synthesis of functional nanomaterials is an emerging research field. Yet the flame synthesis work led by the combustion community is benefitted by its longstanding interest in soot formation from hydrocarbon flames. Compared to traditional material synthesis methods, flame synthesis offers a range of advantages. Notably, flame processes are usually scalable and offer inexpensive routes to nanomaterial fabrication. At the same time, flame synthesis is also a challenging research area. The design of suitable synthesis routes usually requires a joint consideration of gas-phase chemistry, heterogeneous reaction kinetics and materials thermodynamics and kinetics. A successful flame synthesis route to a particular material is often the result of finessing complex interactions of flame dynamics, fluid mechanics, mass transport and gas-phase chemistry to create local thermodynamic driving force tuned for the growth of this material controllably and reproducibly.

The series of talks highlights some of the most advanced topics in combustion-related synthesis methods for fundamental nanostructured materials. They illustrate the versatility of flame synthesis and show ordered structures, from the one-dimensional carbon nanotubes and metal-oxide nanotudes encapsulated in carbon, to higher-dimensional structures including nanolayered carbide and mesoporous metal oxide films, can be synthesized in an otherwise high-entropy, high-temperature environment in a controlled manner. The potential applications of these materials are equally impressive and range from catalysis to renewable energy conversion.

To facilitate the rapid advance of this research field, it is beneficial to have a vertically integrated experimental capability that can be used, among other purposes, to establish the relationship among synthesis condition, material properties, and device-level performance for at least several critical applications. Advanced photon tools are exceptionally valuable in this regard. The talks of the current session will thus convey the needs for in-situ diagnostics during flame synthesis and post-synthesis characterization of the resulting materials.