COMBUSTION WEBINAR

High-Speed Combustion for Hypersonic Propulsion

Speaker: Prof. Hyungrok Do, Seoul National University

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Biography: Hyungrok Do is a professor of Mechanical Engineering at Seoul National University (SNU). Before he joined SNU in 2015, he was an assistant professor of Aerospace and Mechanical Engineering at University of Notre Dame, IN, United States. He earned his Ph.D. (2009) and M.S. (2006) degrees from Stanford University, CA, United States, and B.S. (2002) from SNU. His current research activities are mostly focused on the development of hypersonic propulsion systems including hypersonic vehicle design, high-speed combustion stabilization, and laser diagnostics in high-speed compressible flows. He has received 2019 GPPS (Global Power and Propulsion Society) Early Career Award and Air Force YIP (Young Investigator Program) in 2015.

Abstract: In this webinar, recent experimental investigations on high-speed combustion phenomena essential for hypersonic flights and relevant critical design considerations of hypersonic vehicles will be introduced. Recently developed air-breathing hypersonic propulsion systems, e.g., powered by scramjets, fly at relatively low altitude below 50 km to capture sufficient air for generating thrust. Different from rockets, the scramjet engine performance is highly sensitive to the atmospheric condition and flight trajectory. This is because the vehicle takes oxygen from the atmosphere and there is no compressor regulating the combustor inlet flow; flight Mach number, altitude, angle of attack, and bank angle significantly affect the combustor inlet condition. Therefore, flight trajectories and inlet compression performance at various flight conditions should be considered prior to designing a scramjet combustor. In general, due to the short flow residence time in scramjet combustors, local recirculation regions in cavity flameholders or behind struts and fuel jets have been utilized to stabilize the combustion reactions. In addition, gaseous fuels of low volumetric energy density have been injected for minimizing the time required for combustion heat release while it is inevitable to use high density liquid fuels for long-range hypersonic flights. Liquid fuels should be atomized and evaporated before burning, which take extra time and combustor volume to make the combustion stabilization in the supersonic combustor even more challenging. Regenerative cooling technique for fast fuel evaporation and decomposition as well as for engine cooling has been proposed for reliable scramjet engine operation.

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