RQ20-34

1. Research Title: *Combustion Enhancement in High-Speed Flows*

2. Individual Sponsor:

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3. Academic Area/Field and Education Level: Engineering Physics, Applied Physics, Mechanical Engineering, Aerospace Engineering, (MS and/or Ph.D. level)

4. Objectives: The proposed thesis topic aims to investigate methods to enhance reactivity during the limiting combustion phenomena of ignition, flame propagation, and flame stabilization, utilizing both small scale bench-top experimental platforms and high-speed environments such as supersonic combustion ramjets (scramjets).

5. Description: Presently, the harsh and restrictive reactive environments within high-speed propulsion systems, such as scramjets, can be limiting factors for their development and practical implementation. Typically, these limitations lie in the ability to ignite, propagate, and stabilize a flame near flammability limits, at low temperatures and pressures, and within short residence times, therefore necessitating some form of energy addition, specifically plasma. There is a need to better understand the fundamental interactions involved in enhancement, such as the effect of specific plasma-produced species or how to efficiently couple energy into a high-speed and highly-turbulent reactive flow. The DAGSI masters or Ph.D. student and faculty member will utilize the Aerospace Systems Directorate's (AFRL/RQ) variable pressure combustion platform, wind-tunnels (including direct-connect scramjet tunnels) and a variety of optical and laser diagnostic assets, such as planar laser-induced fluorescence (PLIF), particle image velocimetry (PIV), and high-speed imaging (100,000 frames per second), to study these phenomena. Some of the topics could include the following:

a. Quantify the effect of specific plasma-produced species on combustion enhancement to provide a database for detailed chemical kinetic mechanism development and validation that can be used for predictive capabilities in computational fluid dynamics of reactive flows. Work to date has included studies of excited oxygen species on flame propagation.
b. Study different forms of energy addition to a reactive flow, whether it is chemical energy, electrical energy, or a combination of both, to enhance ignition and flame stabilization. Work to date has included the application of high-frequency nanosecond pulsed discharges to highly-turbulent flows for ignition and flame holding.

6. Research Classification/Restrictions: 6.1 basic research.

7. Eligible Research Institutions: DAGSI.