1. **Research Title:** Oxidation and mechanical performance of ceramics and ceramic matrix composites from ambient air to vacuum

2. **Individual Sponsor:**

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3. **Academic Area/Field and Education Level**
Materials Science and Engineering, Mechanical Engineering, Aerospace Engineering, or related field (MS or PhD level)

4. **Objectives:** To characterize the effect of oxidative environments—from ambient air to vacuum—on the performance of high-temperature ceramics and ceramic matrix composites (CMCs) by: 1) exposing ceramics and ceramic matrix composites (CMCs) to high-temperature environments with varying atmospheric compositions and pressures, 2) utilizing imaging and spectroscopy techniques (optical, SEM, X-ray CT, XRD) to characterize material degradation, and 3) performing mechanical testing to determine the effect of environmental exposure on mechanical performance.

5. **Description:** The Space Force requires development and qualification of high-temperature materials able to withstand the harsh Space environment. This proposed work focuses on high-temperature ceramics and CMCs for space propulsion, whose performance is critically dependent on the surrounding atmosphere's pressure and composition. High-temperature oxidation behavior in ambient air during ground testing can be fundamentally different from that in a vacuum environment. At high pressures (in air), these materials tend to undergo passive oxidation, forming a stable, protective oxide layer. In contrast, a vacuum environment promotes degradation through two primary mechanisms: active oxidation, driven by low oxygen partial pressure, and sublimation, driven by low total pressure. Both processes lead to material loss and surface degradation. This study will systematically expose these materials to laboratory-simulated environments with varying temperatures and atmospheric pressures. Post-exposure analysis will utilize a suite of characterization techniques (e.g., optical microscopy, SEM, XCT, XRD) to identify dominant degradation mechanisms and link them to changes in mechanical performance. If time permits, the experimental data will be used to develop a computational model linking the observed microstructural changes to the material's mechanical response. This research will generate critical data for material lifetime and performance models and provide a foundational understanding for qualifying these advanced materials for future aerospace systems.

6. **Research Classification/Restrictions:** U.S. citizenship required.

7. **Eligible Research Institutions:** All DAGSI institutions

8. **PA Approval #:** AFRL-2025-4274