IGEM Grant Report

X Progress (due January 1) ☐ Annual (due July 31) ☐ Final (due August 31)

IGEM Grant # IGEM26-006 Principal Investigator: Krishnan S Raja

Name/Full Title of Project: Joining of Non-Oxide Ceramic Components Used in Extreme Environments

Submission Date: 12/19/2025 Primary Institution: University of Idaho

Section 1: Summary: Non-oxide ceramics are used in extreme environments due to their high melting points, high-temperature mechanical strengths, and chemical inertness. Manufacturing of complex shapes requires joining of several sections. Achieving direct bonding without any filler material will be game-changing because the joint is no longer the weakest link. The proposed research will use electric-field-assisted processes to join ceramic materials (SiC or ZrB_2) without an interlayer. The joining process will be further enhanced through modification of the surfaces (one end is metal/metalloid terminated (Si, or Zr), and the other end to be joined is non-metal (boron or carbon) terminated) to promote Zr-B or Si-C reactive bonding.

Section 2: Summary of project accomplishments: Milestone 1: Preparation of surface-modified samples is completed. Carbon-terminated surfaces of SiC samples have been demonstrated by vacuum annealing at 1400 – 1700 °C. Raman spectra show the formation of D and G bands of the graphitic layer. One graduate student was trained to use the spark plasma sintering unit available at the CAES.
Plan for the upcoming period: Perform the electric-field-assisted joining process on the surface-modified SiC samples at the private industry, Astratomica LLC, in Idaho Falls. Characterize the joint's microstructure and mechanical properties.

Section 3: Summary of budget expenditures: As of 12/10/2025, the total expenditure was $40,713.95, salary commitment: $25,128, and balance: $91,658.05. We plan to spend $50,130 on spark plasma joining trials when our request is approved.

Section 4: We are collaborating with Astratomica LLC, a local business, on electric-field-assisted joining of SiC and ZrB_2. The small business will employ two engineers to work on this project. One graduate student will be trained. We are writing a research grant proposal on the same topic as this research to be submitted to DOE-NEUP and DOE SBIR/STTR calls in collaboration with Astratomica LLC.

Section 5: Two faculty members and two students work on this project. The students are involved in experimental tasks such as surface modification and the characterization of the surface using XRD and Raman spectroscopy. One student was trained to operate the SPS machine at CAES.

Section 6: A pre-application for seeking DOE-NEUP funding will be submitted on 01/.28/26

Section 7: Expenditure Report – Attached below

	Budgeted, $	Spent, $	Balance, $	% Remaining
Salary	96,066.53	51,908.21	44,158.32	45.97
Fringe	11,233.47	9,117.90	2,115.57	18.83
Materials & Supplies	22,600.00	4816	17,784.16	78.69
Tuition	27,600.00	0	27,600.00	100.00
Total	157,500.00	65842	91,658.05	58.20