Opportunity Title: Inorganic and ductile thermoelectric materials for development of efficient thermal blankets and powering sensors
Opportunity Reference Code: 0044-NPP-JUL24-LRC-TechDev

Organization National Aeronautics and Space Administration (NASA)

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Application Deadline 7/1/2024 6:00:59 PM Eastern Time Zone

Description Surviving lunar winters is a challenging endeavor for long-duration lunar surface exploration activities. Several thermal protection technologies including advanced radio isotopes and material composites have been proposed to survive extreme conditions. Establishing continual presence on the lunar surface requires surviving harsh conditions of lunar nights. As such, there is an urgent need for the development of efficient, rugged, and lightweight thermal blankets for the Artemis and follow-on lunar missions.

Thermoelectric devices, being solid-state with no moving parts, are extremely reliable, noise-free, and low-maintenance devices, which can provide consistent cooling and or generate power depending upon the mode of operation. Flexibility, weight, and thermoelectric performance are key parameters in developing efficient thermal blankets for thermal management solutions or electrical power generation from fluctuating thermal environments in lunar missions.

Most of the state-of-the-art thermoelectric materials are inorganic semiconductors and are brittle due to the directional covalent or ionic bonding, and repulsive interaction appears when atoms slide. This leads to typical thermoelectric materials with poor deformability prohibiting their applications on curved surfaces or development of flexible and thin profile modules. Moreover, these materials need to demonstrate high performance near the temperatures of interest and material stability against temperature cycles. Development of these materials may enable efficient thermal management of space vehicles or lunar surface vehicles. Also, these materials have potential to provide much desired local power generation using the temperature fluctuations in the lunar surfaces to power sensors or electronics.

With the recent discovery of ductile and inorganic thermoelectric alloys, it opens the door for developing efficient and flexible thermal management solutions. Traditional approaches using organic thermoelectric materials suffer from low materials figure-of-merit (zT) and instability thereby limiting their applications. Silver chalcogenide based ductile thermoelectric alloys have shown exceptional ductility and excellent thermoelectric performance near room temperature. Not only have these materials been shown to exhibit excellent zT, but they can also handle more than 50% strain without a crack. These materials can be made into a stand-alone film with thickness as small as 25 microns. There is an urgent need to further explore and develop these materials in both p- and n-type materials. Contact metallization and device fabrication are equally important in the development of high-performance modules in desired form factors. Also, their bonding techniques and thermal cycling stability need to be understood so that these devices can be deployed in space missions for power generation or thermal management such as flexible and lightweight

thermal blanket development.

Candidates with relevant backgrounds and interest in this research area are encouraged to apply.

Location:
Langley Research Center
Hampton, Virginia

Field of Science: Technology Development

Advisors:

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Eligibility is currently open to:

- U.S. Citizens;
- U.S. Lawful Permanent Residents (LPR);
- Foreign Nationals eligible for an Exchange Visitor J-1 visa status; and,
- Applicants for LPR, asylees, or refugees in the U.S. at the time of application with 1) a valid EAD card and 2) I-485 or I-589 forms in pending status

Qualifications Ph.D. in Materials Science, Electrical Engineering, or Physics

Eligibility Requirements

- **Degree:** Doctoral Degree.