zintellect
climb higher

Opportunity Title: Advanced High Temperature Thermoelectric Materials Research
Opportunity Reference Code: 0099-NPP-NOV23-JPL-PlanetSci

Organization National Aeronautics and Space Administration (NASA)

Reference Code 0099-NPP-NOV23-JPL-PlanetSci

Application Deadline 11/1/2023 6:00:59 PM Eastern Time Zone

Description NASA‘s Science Mission Directorate is developing the next generation of technologies that will lead to significant increases in both thermal-to-electric conversion efficiency and specific power of future radioisotope power systems, in support of potential future deep space and planetary science and exploration missions (Strategic Goal 3). This technology could also be attractive to several terrestrial applications opportunities in the areas of waste heat recovery, energy harvesting and auxiliary power units (Strategic Goals 3 and 4).

NASA/JPL is leading a collaborative multi-prong research effort to identify and characterize advanced bulk thermoelectric (TE) materials with dimensionless TE figure of merit (ZT) values of up to 2.0 across the entire temperature range of 1275 K to 500 K, and capable of long term high temperature operation in a vacuum or inert atmosphere environment (at least 17 years). This would represent a “factor of 3“ improvement over current proven heritage technology [1].

The first research area concerns mostly families of refractory complex structure compounds, including a number of ternary Zintl phases and materials related to $La_{3-x}Te_4$, which exhibit an attractive combination of very low lattice thermal conductivity and good electrical transport properties at elevated temperatures [2]. This research area covers a wide phase space and effective theoretical guidance through first principle electronic structure calculations is being actively pursued. The other two materials research areas focus on synthesizing bulk 3-D nanostructures that emulate results obtained on low dimensional superlattices through “force engineering“ and “self-assembling“ techniques. Such materials present orders of magnitude increases in the density of interfaces, thus scattering phonons very effectively and leading to very large reductions in lattice thermal conductivity values. In addition, careful control of the charge carrier concentration and energy has been predicted to lead to an enhanced carrier mobility and Seebeck coefficient. Promising results have been obtained for $Si/Si_{1-x}Ge_x$ or silicide nanocomposites prepared from $Si_{1-x}Ge_x$ nanoparticles and random “self-assembled“ nanostructures based on telluride TE materials. Other materials of interest include compounds that can “host“ nanoscale features such as Si- and Ge-based clathrates, skutterudite antimonides and PbTe-based chalcogenides. The scope of the Advanced TE Task also includes proof-of-principle device-level demonstrations of the improved conversion efficiency of the most promising materials.

[1] J.P. Fleurial, “Thermoelectric Power Generation Materials: Technology and Application Opportunities“, JOM, 61, 4, 79-85, (2009).
[2] G. J. Snyder and E. Toberer, “Complex Thermoelectric Materials“, Nature Materials, 7, 105 - 114 (2008)

Opportunity Title: Advanced High Temperature Thermoelectric Materials Research
Opportunity Reference Code: 0099-NPP-NOV23-JPL-PlanetSci

Location:
Jet Propulsion Laboratory
Pasadena, California

Field of Science: Planetary Science

Advisors:
Jean-Pierre Fleurial
Jean-Pierre.Fleurial@jpl.nasa.gov
818-354-4144

Applications with citizens from Designated Countries will not be accepted at this time, unless they are Legal Permanent Residents of the United States. A complete list of Designated Countries can be found at: https://www.nasa.gov/oiir/export-control.

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

Eligibility Requirements

- **Degree:** Doctoral Degree.