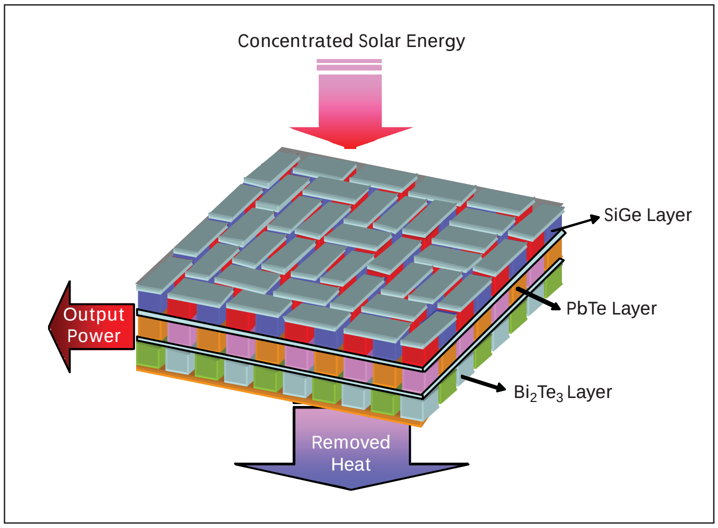
Green Design

Thermoelectric Energy Conversion Technology for High-Altitude Airships

Applications include surveillance for homeland security, and Earth observation for weather monitoring.

Langley Research Center, Hampton, Virginia

The High Altitude Airship (HAA) has various application potential and mission scenarios that require onboard energy harvesting and power distribution systems. The power technology for HAA maneuverability and mission-oriented applications must come from its surroundings, e.g. solar power. The energy harvesting system considered for HAA is based on the advanced thermoelectric (ATE) materials being developed at NASA Langley Research Center. The materials selected for ATE are silicon germanium (SiGe) and bismuth telluride (Bi_2Te_3), in multiple layers. The layered structure of the advanced TE materials is specifically engineered to provide maximum efficiency for the corresponding range of operational temperatures. For three layers of the advanced TE materials that operate at high, medium, and low temperatures, correspondingly in a tandem mode, the cascaded efficiency is estimated to be greater than 60 percent.



The **ATE Energy Conversion Device** consists of triple layers of p-n-junction arrays in a tandem mode. The first layer is built from the array of SiGe, while the second and third layers are built from PbTe and Bi_2Te_3, respectively, as regenerative cycles. Such an arrangement allows effective energy harvesting from a heat source.

The first layer is built from the array of SiGe, while the second and third layers are respectively built from PbTe and Bi_2Te_3 as regenerative cycles. Such an arrangement allows effective energy harvesting from a heat source. First, solar flux is concentrated and heats up the first layer, which is built with high-temperature SiGe. The unused thermal energy from the first layer is subsequently used by the second layer, which is built with mid-temperature PbTe. The third layer of Bi_2Te_3 uses the unused energy from the second layer to maximize the conversion of the energy that is otherwise dumped away. In this fashion, the ATE devices become more effective than solar cells because the performance of solar cells is monolithically tied to band-gap energy structure, so that they only couple with certain spectral lines.

For nighttime, the power required must be augmented from the on-board fuel cells, battery, and a rectenna array that is attached at the bottom surface of HAA. These systems combined provide at least a megawatt level of power for the intermittent operation.

Commercial applications include monitoring and controlling the ever-increasing complexities of aerial and maritime transportation and telecommunication networks. Military applications include close and persistent surveillance of adversarial elements, possibly controlling enemy infiltrations through open air and sea and shooting down enemy missiles during their boosting phase.

This work was done by Sang H. Choi, James R. Elliott, Glen C. King, Yeonjoon Park, Jae-Woo Kim, and Sang-Hyon Chu of Langley Research Center. Further information is contained in a TSP (see page 1). **LAR-17213-1**

Combustor Computations for CO_2-Neutral Aviation

This method can be used to determine synthetic and biological fuels and blends.

John H. Glenn Research Center, Cleveland, Ohio

Knowing the pure component C_p^0 or mixture C_p^0 as computed by a flexible code such as NIST-STRAPP or McBride-Gordon, one can, within reasonable accuracy, determine the thermophysical properties necessary to predict the combustion characteristics when there are no tabulated or computed data for those fluid mixtures 3or limited results for lower temperatures. (Note: C_p^0 is molar heat capacity at constant pressure.) The method can be used in the determination of synthetic and biological fuels and blends using the NIST code to compute the C_p^0 of the mixture.

In this work, the values of the heat ca-