

Multifunctional Materials Researchers Envision Aircraft Powered By Solar, Heat Energies

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ARLINGTON, Va. — The Air Force Office of Scientific Research recently awarded the University of Washington and three partner universities a five-year grant worth approximately \$6 million to study the design of air vehicles capable of collecting and storing solar and heat energies.

One of the goals of the research is to enhance Air Force air vehicle systems, but there are many potential applications in other areas such as space platforms. The MURI grant – or Multidisciplinary University Research Initiative – was presented in Seattle at the University of Washington (UW), the lead university for this grant. Under the grant, UW will collaborate with the University of Colorado, the University of California at Los Angeles, and the Virginia Polytechnic Institute.

“While running air vehicles or space platforms, there are presently three main sources for harvesting energy with non-fossil origins – sunlight, heat, and vibration,” said Dr. B. L. “Les” Lee, program manager at AFOSR’s Aerospace and Materials Sciences Directorate. “The source of the heat energy, can be aerodynamic heating caused by high flying speed or the recycling of waste heat around an aircraft cabin or engine.”

Each of the three sources, he explained, is capable of generating electricity, but sunlight and heat energies show the greatest potential in terms of significant power output. As a result, the proposed research will focus primarily on these two energy sources.

Researchers will explore a variety of topics concerning materials and micro devices associated with so-called photovoltaic energy – or electricity generated from light sources – and thermoelectric energy – or electricity generated from heat sources. Once fully developed, these systems may one day enable air vehicles to fly solely on solar energy and aerodynamic heat. The systems may also find application in cabin operation on commercial airplanes.

“For integration of energy harvesting and storage devices into air vehicles with minimal increase of weight, we hope to create a new generation of multi-functional materials that can, for example, maintain structural integrity in flight while at the same time serve as energy collectors and storage units,” Dr. Lee said. The goal is challenging because of the interaction of many different disciplines of sciences involved in this study. Another interesting aspect of the research is an enhanced approach to technology development and system integration.

“Electronic communities are always looking to improve energy-generating efficiencies of devices while structural communities made up of mechanical and materials engineers who are looking to improve aircraft design in terms of weight and mechanical performance,” Dr. Lee said. “Essentially, our research attempts to do

both in a single step. We consider this a really futuristic way of doing business with higher efficiency.”

Drs. Joan Fuller and Victor Giurgiutiu, who are also AFOSR program managers, are assisting Dr. Lee in management of the MURI. Research progress will be periodically reviewed by experts throughout the Air Force Research Lab, Army Research Lab, Naval Research Lab, Office of Naval Research, and the Defense Advanced Research Projects Agency.

The principal investigator of this program, Dr. Minoru Taya, is a professor in the department of mechanical engineering at the University of Washington. Dr. Taya said he looks forward to helping the Air Force expand its technological edge.

“Our goal is to develop fundamental knowledge on new energy harvesting and storage systems for future Air Force vehicles,” Dr. Taya said. The UW study will simultaneously focus on three areas. The first area covers lightweight, energy-harvesting materials and compounds that could be infused into aircraft skin. In the second area, the team will study energy storage systems capable of remaining airborne for indefinite periods of time. Thirdly, the team will explore system integration of components into a seamless unit with much less wiring than current components. The research offers unlimited opportunities to collaborate.

“We have a great partnership with all universities involved in this study,” Dr. Taya said. “While we (UW) conduct studies on core energy harvesting and storage materials, the University of Colorado team will examine hierarchical modeling of multifunctional materials and structures.” Additionally, the UCLA team will study how various materials and devices may affect aircraft structures and the VPI team will look at integrating the various systems into a single unit, at the same time.

“Energy harvesting is a hot subject now, but its applications specific to Air Force needs give us lots of high-level technology challenges,” Dr. Taya said. “For example, any component and integrated system developed must be airborne, capable and durable so we all are excited to work in this high-hurdle technology area.”

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