FMA (Fellow-Mentor-Advisor) Program

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Project: MEMS-based thermal energy conversion

High-temperature materials, nano- and micro-engineering, and micro vacuum encapsulation are essential to realizing energy conversion concepts such as photon-enhanced thermionic emission (PETE) and thermionic energy conversion (TEC). Thermally isolated tungsten microstructures are an attractive route for cathodes for thermionic converters. Utilizing finite element analysis software, tungsten cathodes have been designed to maximize thermionic energy conversion while maintaining structural integrity.

Currently, we are fabricating tungsten cathodes with thin CVD-deposited tungsten films. These cathodes serve as both a beginning for the design of thermionic energy converters and also as a test-bed for the design of later PETE-based energy converters. The goal of this project is to develop novel thermionic energy converters that take advantage of small anode-cathode gaps to convert energy at much higher efficiencies than traditional thermionic devices. To achieve this goal, we have harnessed modern MEMS fabrication technology in pursuit of cathodes with large, flat absorbing areas and long legs to allow current flow while retaining heat in the absorbing area.

The TEC devices fabricated using this technology could be used in a number of applications where heat-to-electric conversion is required including but not limited to combined heat-and-power (CHP) generation, conversion of waste heat from hot water heaters, and conversion of energy from high-temperature gas burners.