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Near-Field (Nano-Gap) Concentrated Solar Thermophotovoltaic Microsystem

Abstract.

Advances in micro and nanostructure fabrication, along with the ever increasing desire for miniaturized, lightweight and compact consumer portable electronics, remote sensing devices, and on-chip medical diagnosis, have led to interest and research in stand-alone and autonomous micro and nanosystems. In order to enable these technologies, considerable effort must be dedicated to research and design of nano/micro fabricated power generation devices. Mechanical engines' poor performance at the microscale leaves solid-state energy conversion via thermophotovoltaics as one of the few reliable and promising enabling technologies for stand-alone and autonomous micro and nanosystems. In this proposal, the investigator proposes the bold and innovative design and experimental investigation of a near-field (nano-gap) concentrated solar thermophotovoltaic (Nano-gap STPV) microsystem. The proposed design is expected to have conversion efficiencies above 10% without waste heat recovery.

The first stage of the proposed research consists of the design and integration and experimental demonstration of the nano-gap STPV (e.g., solar concentrator, selective absorber and emitter, filter, PV cells, MPPT, and cooling system). The second stage will implement thermal storage for nighttime usage and waste heat recovery for improved efficiency. Finally, the third stage will explore the use of the principle of modular scaling to scale-up the nano-gap STPV to large-scale solar-based electricity production for residential buildings and transportation. Besides demonstrating the feasibility and practicality of a Nano-gap STPV, this research effort will also develop a novel experimental method for measuring near-field radiative heat transfer.