Next-Generation Thermionic Solar Energy Conversion
SLAC National Accelerator Laboratory

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PROJECT OBJECTIVES

Goal: This project will create a new solid-state energy conversion technology based on photon-enhanced thermionic energy converters (PTECs) which, when used as a topping cycle in concentrated solar thermal electricity generation, can enable system efficiencies in excess of 50%.

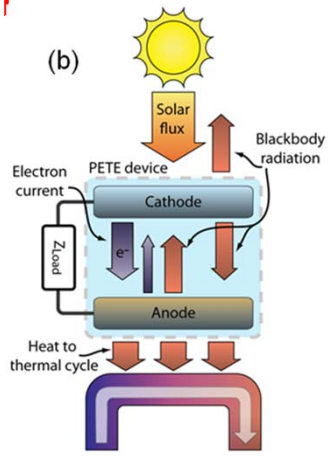
Innovation: Through the novel application of appropriately designed and fabricated semiconductor heterostructure cathodes, 15% efficiency will be demonstrated though the Photon Enhanced Thermionic Emission process enabling higher voltage devices to operate at CSP compatible temperatures..

Milestones: No Q2 milestone. Q3 milestone of 50% QE PETE cathode demonstration. 50% complete.

J. W. Schwede, et al, Nat. Mater., 2010, 9, 762–767. DOI : 10.1038/nmat2814

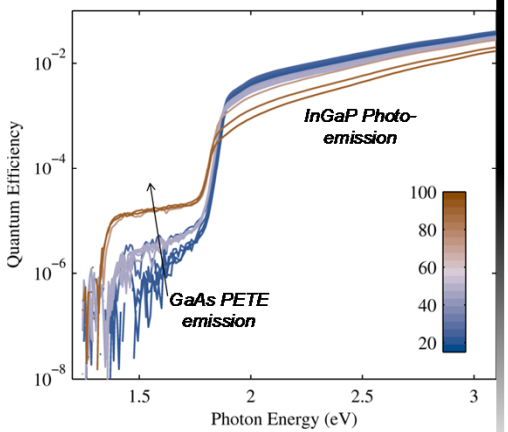
APPROACH

- Fabricate heterostructure semiconductor cathodes based on active layer absorbers such as GaAs and similar materials with the addition of band engineered passivating layers such as GaN to demonstrate high quantum efficiency Photon Enhanced Thermionic Emitters.
- Identification of high-temperature-stable thermionic cathode materials and testing under CSP compatible conditions.



KEY RESULTS AND OUTCOMES

- Demonstrated PETE on GaAs/InGaP heterostructures. Results fit well with PETE model
- InGaN photoemission stability up to 300C demonstrated with closed Cs hot wall cell. This cell will be a platform for all future high temperature testing of PETE cathodes.
- GaN on GaAs, GaN on InGaN, and InGaP on GaAs coated materials all show evidence of passivation/stability enhancements.



NEXT MILESTONES

- Q3 milestone of 50% QE PETE cathode demonstration.
- Known risks and mitigation strategies: Instability of GaAs and related III-V materials mitigated by the parallel development of alternate semiconductor materials which are known to be high temperature stable but have not been developed yet as PETE cathodes. E.g. SiC and InGaN