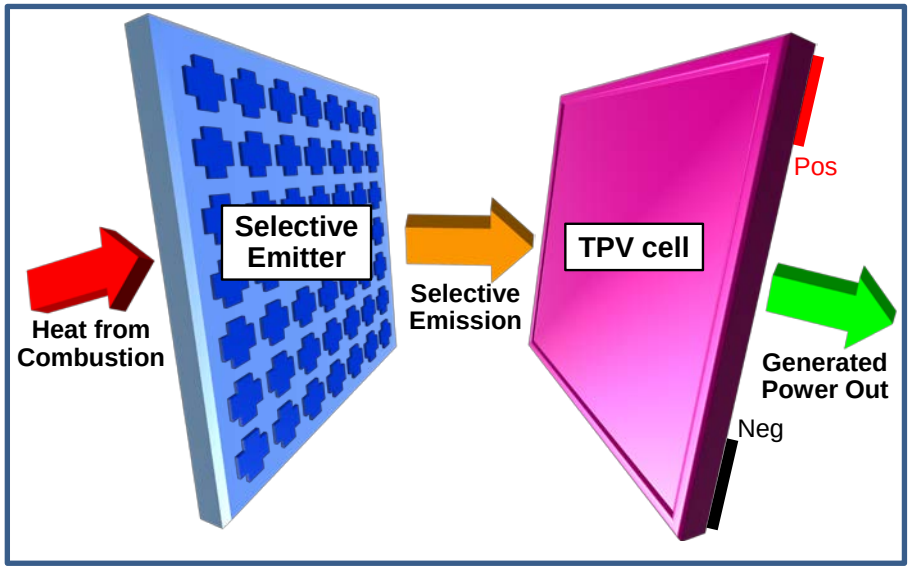
Enhanced Efficiency Emitter for Thermophotovoltaic (TPV) Power Generation

Physical Sciences Inc.



Unique features and Capabilities

- No moving parts
- Silent operation
- Adaptable to multiple fuel sources
- Scalable for residential and small industrial use: 200W to 20kW
- TPV cooling and combustor waste heat useful for water heating

Innovations

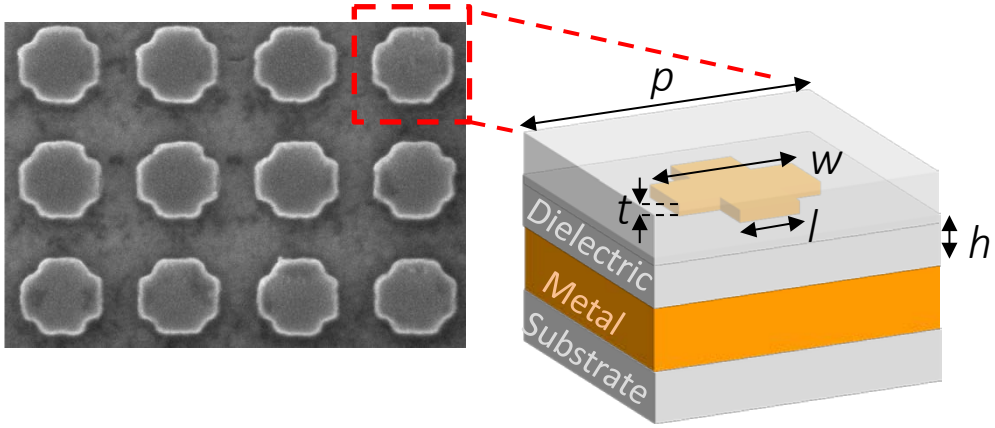
- Low band-gap InGaAs TPV cells
- High temperature metamaterial emitter operating up to 1500K
  - Tailors blackbody emission to better TPV cell
  - Boosts TPV efficiency from ~13% to >**37%** at 1500K
  - Power density ~**4.8 W/cm²** (46% spectral efficiency)

- Co-developed by PSI and Sandia through DoD STTR program

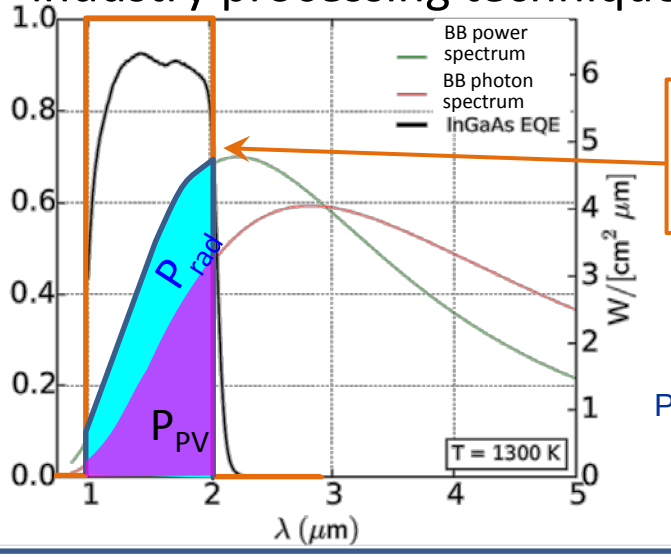
Sandia National Laboratories

Novel Emitter

- Thin film of sub-wavelength features patterned on surface
- Pattern controls emissivity spectrum



- Materials choice allows high-T operation
- Fabrication uses standard semiconductor industry processing techniques → low cost



Ideal selective emitter

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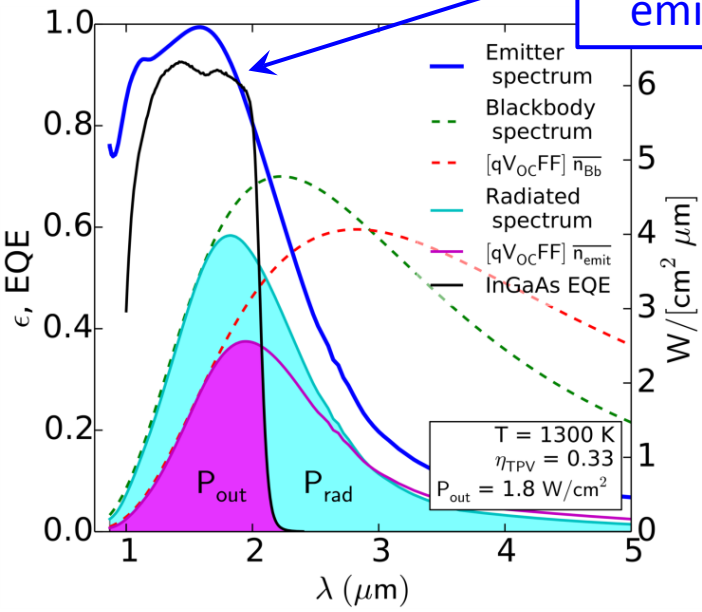
Current Status

- Selective emitter fabricated
- Emissivity well matched to TPV
- Survives exposure to 1300K

Performance

PSI/Sandia selective emitter



TPV Material	Band Gap (eV)	1300 K		1500 K	
		η_{TPV}	P_{out} (W/cm²)	η_{TPV}	P_{out} (W/cm²)
InGaAs	**0.60**	**0.32**	**1.8**	**0.37**	**4.8**
InGaAs	0.55	0.36	2.1	0.42	5.4
InGaAs	0.50	0.35	2.0	0.40	5.1
InGaAsSb	0.52	0.41	2.5	0.45	6.0

Development Needs

- Integrate combustor with selective emitter + TPV
- Incorporate high-efficiency combustor
- Demonstrate >30% conversion efficiency, power density
- Manage waste heat
- Electrical power conditioning
- Address manufacturability
  - Qualify reliable source for TPV material