



Alternative Energy



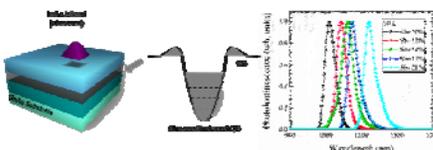
S&T Campaign: Materials Research Power and Energy

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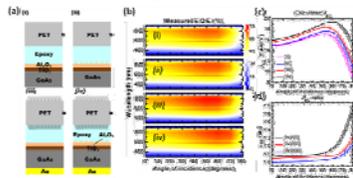
Research Objectives

- Develop compact, portable power sources that can sustain long mission times (>72hrs) while reducing the physical burden to the Warfighter.
- Reduce logistic resupply of fuel by producing fuel on the battlefield with readily available resources.
- Improve overall operational energy efficiency (OEF) by converting waste and freely available resources to energy.

• **Extend the spectral range using nano-enhanced absorber materials:**

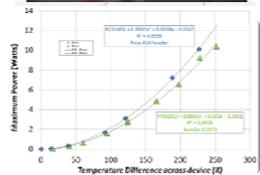


• **Eliminate the need for bulky light tracking systems with integrated optical nanostructures:**



PHOTOVOLTAICS

• **Develop Higher Operating Temperature Active Converter Materials: $P_{out} \sim \Delta T^2$**



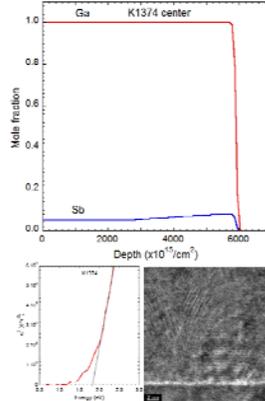
• **Very High Power Density Values:**
= 10 Watts/0.0016m2 ~ >5000 Watts/m2

THERMOELECTRICS

ARL Facilities and Capabilities Available to Support Collaborative Research

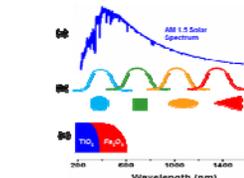
- State of the art III-V MBE system for PV, PEC materials and IV-VI MBE system for TE materials.
- Ultrahigh vacuum variable temperature STM for tunneling spectroscopy and atomic imaging.
- Device processing and characterization.
- Unique Thermoelectric materials zT characterization and device efficiency/power-density evaluation
- Full electrochemical characterization including in-situ AFM

• **Highly mismatched GaSb alloys for water splitting:**

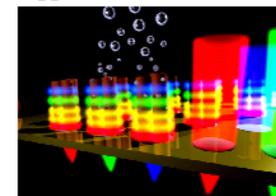


ALTERNATE ROUTES TO FUELS

• **Tuning plasmon for harvesting solar light**



• **Plasmonic photoelectro-chemical cell for H₂ generation**



Challenges

- Enhancing performance at normal incidence while improving the transmission at wider angles of incidence (PV).
- Increasing spectral bandwidth while maintaining high absorption strength (PV).
- Developing materials having larger thermoelectric zT at higher T (TE).
- Integrating topological insulator phenomena to enhance zT across broad temperature range (TE).
- Identify effective photocatalysts for harvesting solar energy for conversion to chemical fuels.
- Transfer plasmonic energy from a metal to a semiconductor.
- Developing tunable wide bandgap semiconductors to split water that have suitable bandgap and band edge energies that are stable to photocorrosion

Complementary Expertise/ Facilities/ Capabilities Sought in Collaboration

- Time-resolved photoluminescence up to 2 micron
- Angle-Resolved Photoelectron Spectroscopy
- High resolution SIMS
- Sophisticated optical modeling of nanostructure-based devices

Material Synthesis & Analytical Tools
ALTERNATIVE ENERGY FACILITY
Device Characterization