

**S&T Campaign: Materials Research
Energy & Power
Thermal Science**

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Research Objective

- Utilize innovations in thermal transport and thermodynamic energy conversion to overcome heat and energy challenges facing ground, airborne, and soldier platforms
- Leverage nonlinear material properties, interfacial effects, and transient phenomena to improve thermal control and platform efficiency

Thermal and power-limited Warfighter systems and platforms



Challenges

THERMAL TRANSPORT

- Micro- and nanoscale heat generation and propagation in electronic devices
- Physics of thermal transport across dissimilar solid, liquid, and gaseous contacts and interfaces
- Non-ideal transient phase change behavior, mitigation, active and passive transient thermal control, and novel materials

THERMOFLUIDICS

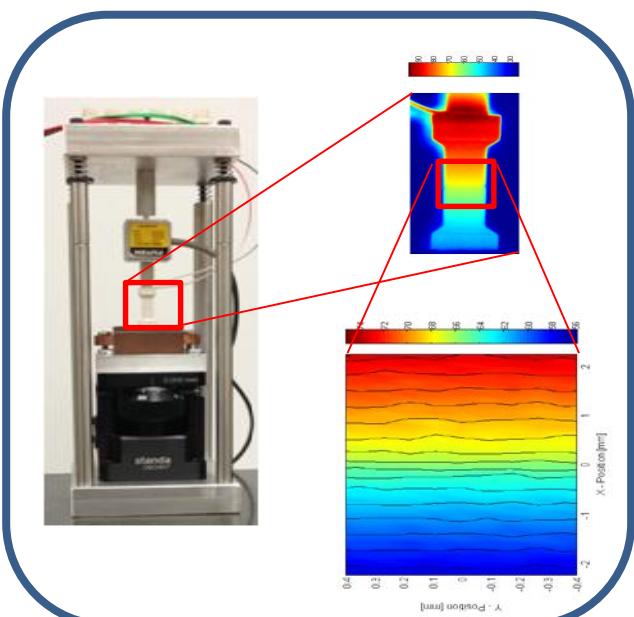
- Boiling system behavior under transient load and flow conditions
- Multi-constituent fluid behavior in two-phase flows, system design impacts, and potential to leverage behavior with unique designs

SOLID STATE THERMAL CONVERSION

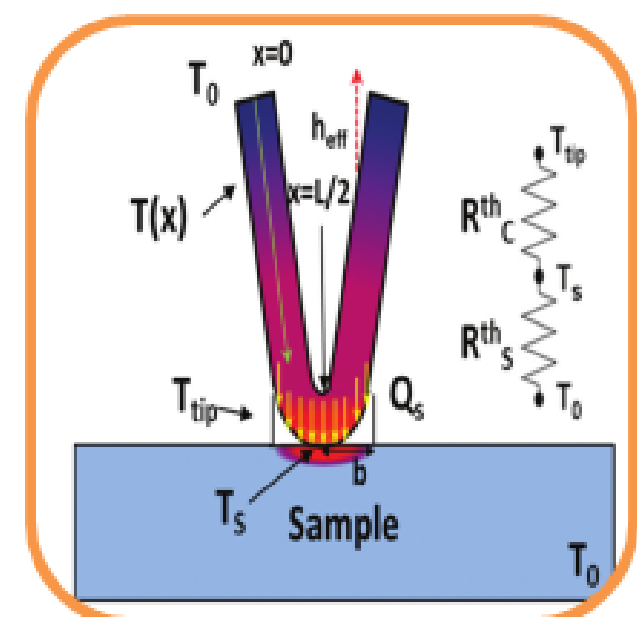
- High figure of merit thermoelectric, elastocaloric, pyroelectric materials, and implementation strategies
- Efficient thermal-to-electric conversion under large spatial and transient thermal variations
- Solid-state heat-pumping for compact cryogenics

ARL Facilities/Capabilities Available to Support Collaborative Research

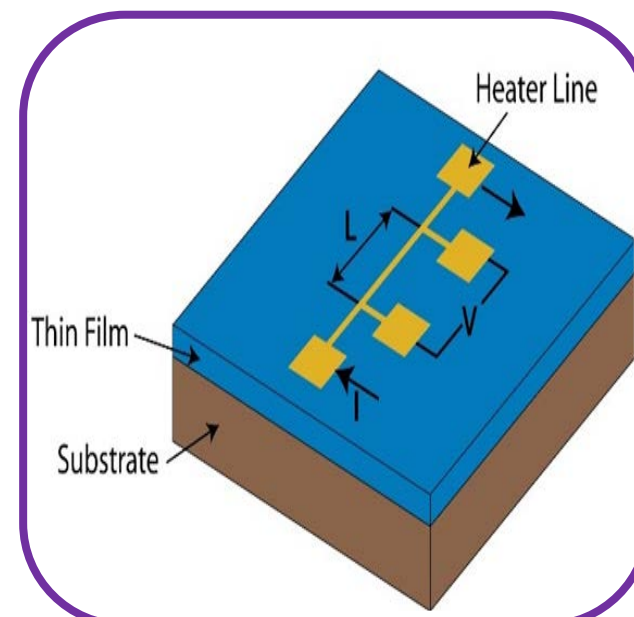
Thermal Characterization



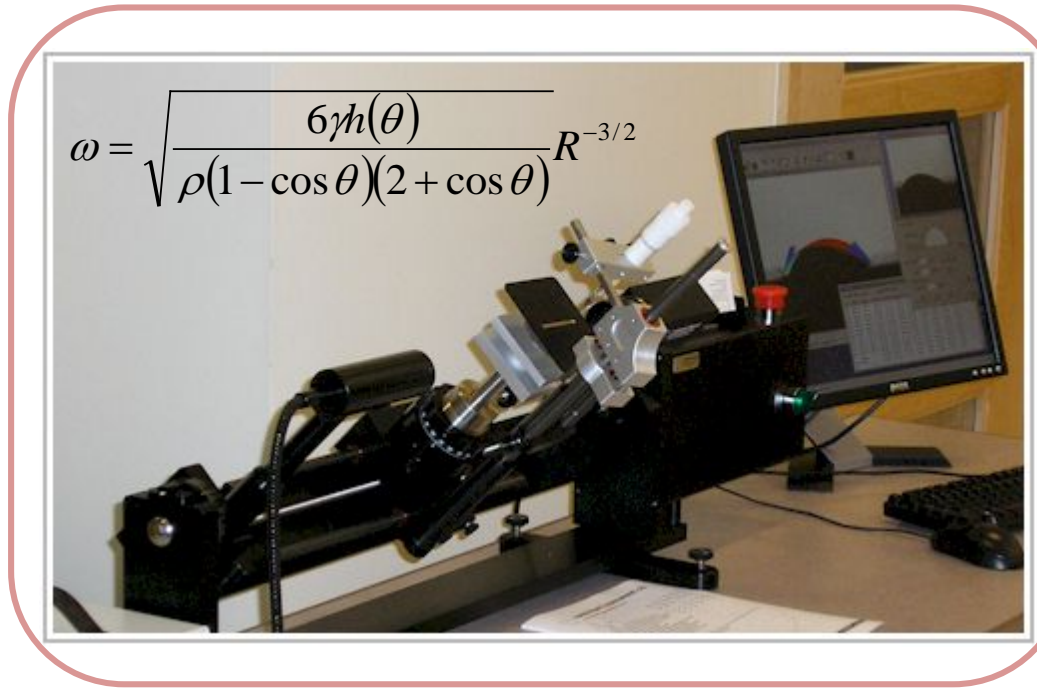
Sub-Scale, 1D
Steady-State Tester



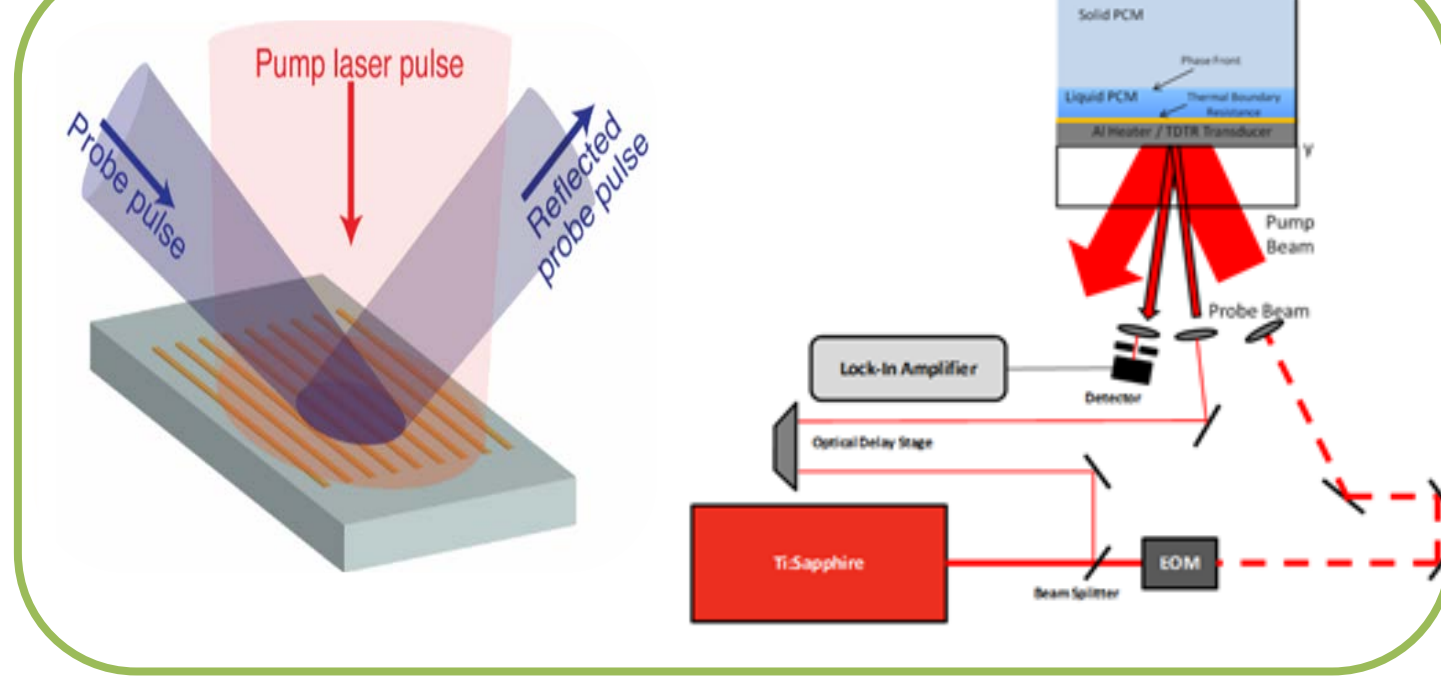
Scanning probe
thermal microscopy



Hot-wire 3-omega

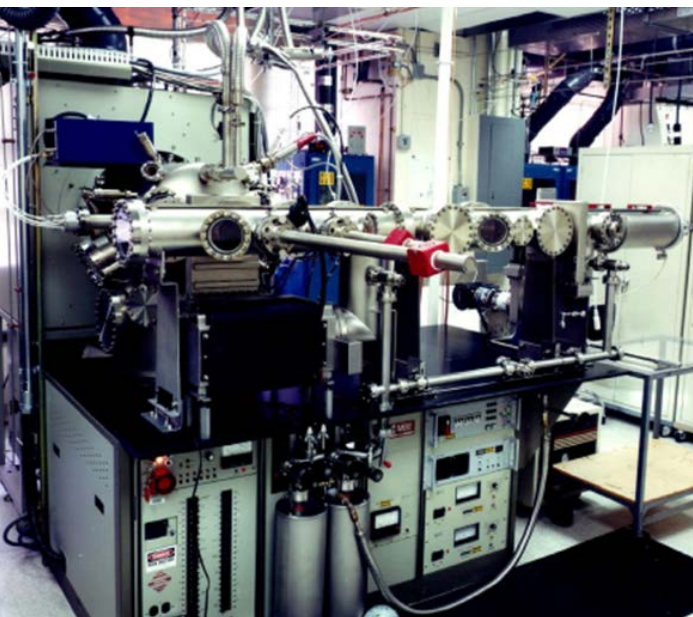


Goniometer

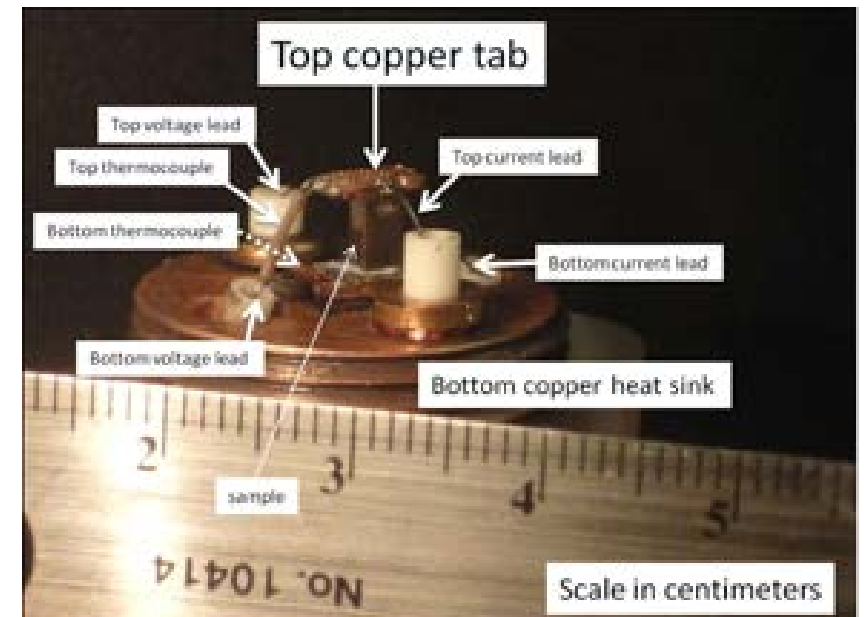


Time domain Thermoreflectance

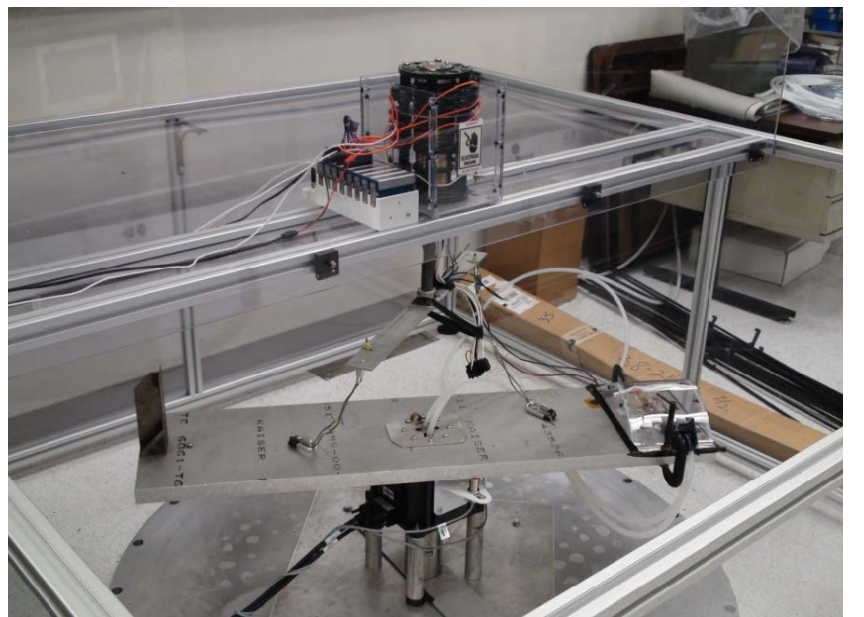
Fabrication and Test Facilities



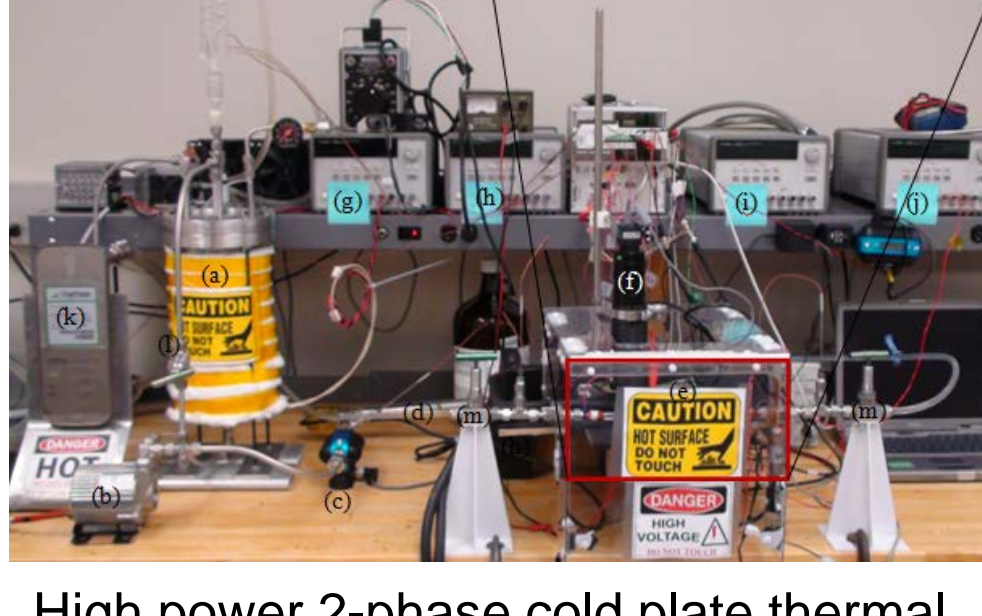
High growth rate MBE for TE
materials and superlattices




Thermoelectric material and
module property tester



High-G electro-thermal centrifuge



High power 2-phase cold plate thermal
evaluation test loop



ALC SEMASC facility

Complementary Expertise/Facilities/Capabilities Sought in Collaboration

- Knowledge of multiphase thermofluidics, physics of complex fluids
- Expertise in physical and electrochemical nucleation enhancement mechanisms applicable to thermal energy storage
- Knowledge in air-side heat exchange enhancement
- Theory of micro- and nanoscale dry contact mechanics and heat transfer
- Established phase change material solid and liquid state thermal characterization capabilities
- Novel high figure of merit solid-state low and high temperature thermodynamic materials