

# COOLING TECHNOLOGIES RESEARCH CENTER

*A Graduated NSF Industry/University Cooperative Research Center at Purdue University*



*The CTRC addresses pre-competitive research and development needs of industry members from diverse industries and product lines in the area of high-performance heat removal from compact spaces through member-directed investigations with a product-oriented focus.*

## TARGET INDUSTRY

The need for continued miniaturization and diversification of electronic components and devices, with expanded functionality, challenges the viability of products across a broad spectrum of industry applications. Extreme performance and efficiency requirements associated with the current trends in storage, communication, and processing of data, increasing electrification of transportation and other systems, and the prevalence of interconnected computing devices are all central drivers.

## RESEARCH APPROACH

One of the distinctive features is that the research agenda for the Center is set by industry, with projects identified and selected by the members on a yearly basis. The strategic research direction is articulated based on the technology needs conveyed by members. The Center brings together a faculty team with expertise in diverse fields to address these member needs. State-of-the-art laboratories are available for the conduct of projects in the Center, and faculty have access to unique equipment and shared spaces available at facilities including the Birck Nanotechnology Center, Herrick Laboratories, and the Flex Lab at Purdue.

## CORE FEATURES

- Industry members set directions for core CTRC research projects
- Members received access to frequent detailed updates from all CTRC projects
- Leverage of more than 25:1 for each member company's contribution
- Beneficial cross-industry interactions brought about by the diversity of members
- Collaborative work results in follow-on applied research projects with Center faculty
- Availability of students trained in relevant topic areas for internships and hiring

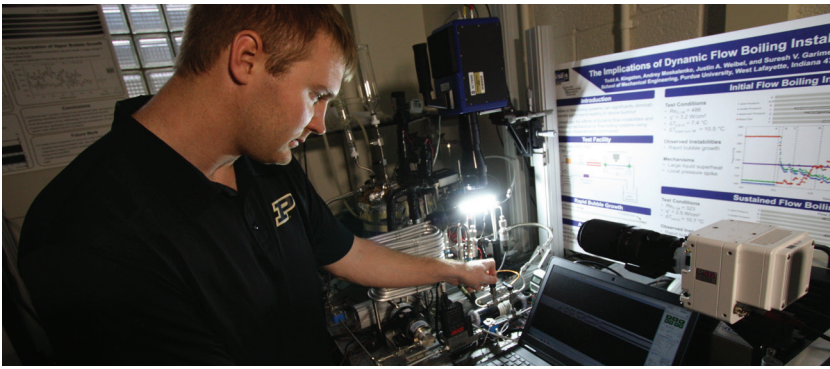
**100+  
TOTAL  
PROJECTS  
COMPLETED**

**100+  
STUDENTS  
GRADUATED  
FROM THE  
CENTER**

**600+  
JOURNAL &  
CONFERENCE  
PUBLICATIONS**

**60+  
STUDENTS  
PLACED WITH  
MEMBER  
COMPANIES**

**25 ALUMNI  
IN FACULTY  
POSITIONS**



## CENTER OPERATION AND MEMBERSHIP

The CTCR was established in 1999, operated as a National Science Foundation (NSF) Industry/University Cooperative Research Centers (I/UCRC) for all three phases of operation from 2002-2017, and continues to operate as a graduated Center that is self-sustaining with industry membership funding. Center funds directly support research by the Center faculty, students, and researchers. The current member companies and full list of additional sponsors and collaborators are listed on the Center website. The Center continues to follow the NSF I/UCRC framework for partnership between universities and industry, featuring high-quality, industrially relevant fundamental research, strong industrial collaboration, and direct transfer of results to the participating industry members. In recognition of its accomplishments, the Center was awarded by NSF the Alexander Schwarzkopf Prize for Technology Innovation.

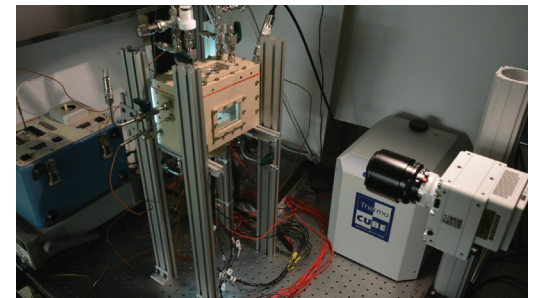


## CENTER REVIEW MEETINGS

The Center meets to present and review project progress at the twice-yearly review meetings, which attract 30+ industry attendees representing all of the members for this two-day conference at Purdue University. All research results are presented by the students associated with CTCR, and the technical approach and relevance to each member company are assessed in real time. The members play an active role in the meeting through discussion of the project portfolio and proposals, participation on industry discussion panels, and presenting on their own transition of technologies. The CTCR hosts a student poster and networking session during the Center review meetings. In addition to the core CTCR projects, this poster session invites over 20 students to present related work that is of interest to the Center members.

## RESEARCH AREAS

- High heat flux and hotspot cooling
- Single- and two-phase microchannels
- Micropumping and electro-wetting
- Thermoelectrics
- Compact natural convection cooling
- Ultra-thin heat spreaders
- Advanced manufacturing & packaging
- Miniature refrigeration systems
- Thermal contact resistance
- Coatings-based radiative cooling
- Tunable conductivity materials
- Piezoelectric fans; synthetic jets
- Phase change energy storage
- Low-noise fans and blowers
- Waste-heat recovery
- Battery thermal management
- High-performance thermal interface materials
- Unconventional and miniaturized heat pipes
- Heat transfer in composites and wick structures
- Jet impingement; spray cooling
- Immersion cooling & boiling enhancement
- Heat transfer in compact heat exchangers
- Heat sink design and optimization
- Novel micro- and nano-scale diagnostics



## CONTACT INFORMATION

Justin A. Weibel,  
*CTRC Director*  
 jaweibel@purdue.edu

Center website  
<https://engineering.purdue.edu/CTRC>