



NEPTUNE Center for Power and Energy Research at Purdue

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Chem Eng



Peter Bermel
Elec Comp Eng



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Mech Eng



Hilka Kenttamaa
Chemistry



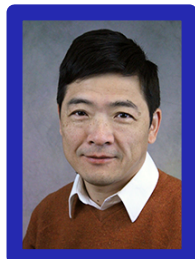
Gozdem Kilaz
Aviation
Technology



Vilas Pol
Chem Eng



Gary Cheng
Indust Eng



Peide Ye
Elec Comp Eng



Timothee Pourpoint
Aero Astro Eng



Vikas Tomar
Aero Astro Eng



Rodney Trice
Mat Eng



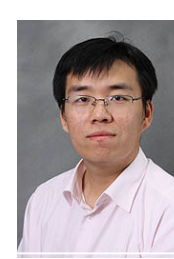
Justin Weibel
Mech Eng



Dongyan Xu
Comp Sci



Xiangyu Zhang
Comp Sci



Kejie Zhao
Mech Eng



Jeffrey Youngblood
Mat Eng

Technology Quality & Capability

Current staff, funding and equipment

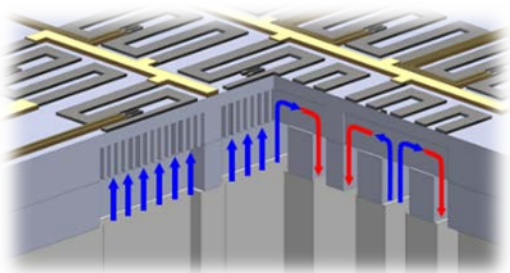
- 12 faculty, 16 Graduate students, 9 Undergraduate students, 6 ROTC students, 2 Postdoctoral/Staff
- All necessary resources are in place

Technology readiness levels vary 1 to 4, project by project

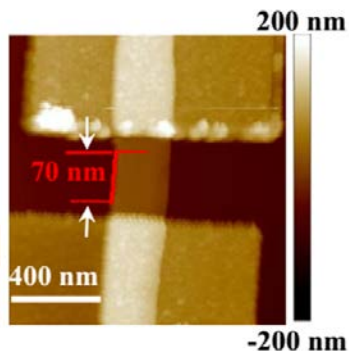
Project characteristics

- Interdisciplinary team science
 - Innovation at the interface of disciplines
 - Use-inspired discovery
-

Technology Quality & Capability: our research innovation



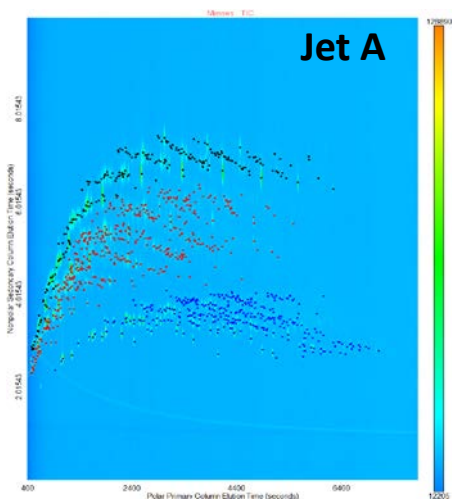
New “embedded cooling” paradigm for thermal management in power electronics



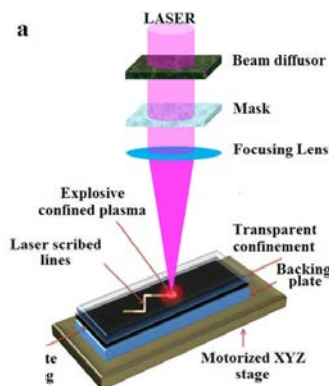
High-performance power electronics devices enabled by atomic layer epitaxy



Non-destructive battery testing by nanomechanical Raman spectroscopy

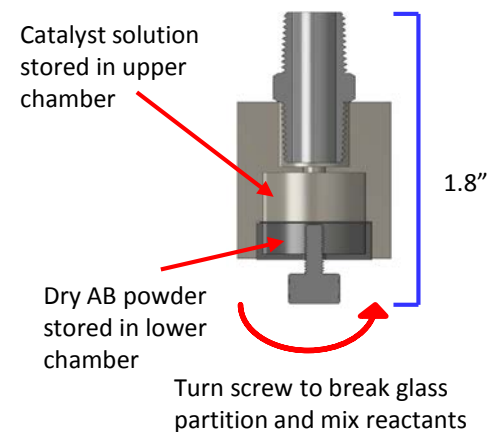


Unprecedented understanding of fuel compositions by mass spectrometry to enable fuel design



LbL graphene/Si NPs

Better batteries by laser manufacturing innovation



Low-weight, low-cost, high-reliability portable fuel cells

Relevance to the warfighter

- **Increased efficiency and power density on platforms and reduced weight for personal power through advanced materials, devices and architectures**
- **Low-cost catalyst for portable hydrogen generation and on-demand power**
- Unlocking the chemistry of the amine-thiol universal solvent system for solution-processed, flexible electronic devices
- **Efficient power conversion, switching, distribution, control and thermal management**
- **Energy storage, switching and control systems/ Thermal management**
- Heterogeneous surface wettability for manipulation of dryout hydrodynamics and bubble departure during high-heat-flux boiling processes
- **Ultra-Wide Bandgap Semiconductor b-Ga₂O₃ Interface Engineering for Naval Power Electronics Applications via Atomic Layer Epitaxy**
- **Reliability of Next-Generation Thermal Management Systems for High-Power Naval Electronics**
- **Alternative and renewable energy sources for naval operations**
- **Issues associated with the logistics and compatibility of future alternative fuels**
- **Design of Next Generation Renewable Fuels**
- **Resilient power networks and systems for platforms and shore-based infrastructure**
- Towards vetted sensing and control system firmware and software
- **Electrochemical, thermal, dielectric and kinetic energy storage**
- Development of low-cost, high-performance electrode materials for Na-ion batteries
- **In-Situ Examination of Thermal Runaway in Lithium Ion Batteries under Dynamic Loading and at High Temperatures Using Nanomechanical Raman Spectroscopy**
- **Laser Assisted Large-Scale Manufacturing of 2D/0D Nanocomposites for High Energy Density and High Power Output Li-ion Batteries**

Efficient power and energy systems; Energy security: High energy and pulsed power

<http://www.navy.mil/strategic/2015-Naval-Strategy-final-web.pdf>



Partnerships and Synergistic Activities



- Aviation Fuel Research and Development with Drs Luning-Prak, Cowart, Trulove and Harrison, USNA
- Thermal Management with Dr Ron Warzoha, Mechanical Engineering Department, USNA



- 2D Nanomaterials for Energy Storage with Dr John Michopoulos, Computational Multi-physics Systems Lab., NRL
- Battery Research with Dr Corey Love, Chemistry Division, NRL



- Fuel composition and testing with Dr Rick Kamin



- Battery Material Research with Dr Jonathon Phillips, Department of Physics, NPS and Dr Claudia Luhrs, Department of Mechanical/Aerospace Engineering, NPS

- Fuel cell device development with Protonex

Partnerships and Synergistic Activities

- Research Co-I Thomas Adams, Power and Energy Division, NSWC Crane working on battery safety
- Navy Cooperative Research and Development Agreement (CRADA) with NSWC Crane for developing advanced thermal management techniques for Navy high-power radio frequency applications. Dr. Brian Olson at NSWC Crane is technical POC.
- Naval Engineering Education Consortium project in collaboration with NSWC Crane
- Purdue PhD Student is currently a Pathways Intern at NSWC Crane



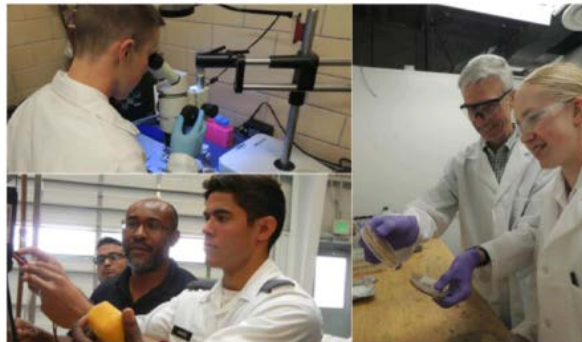
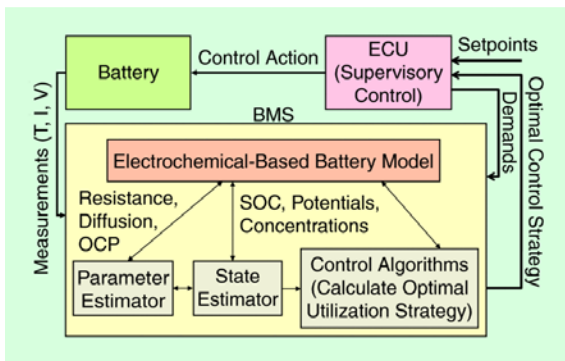
June 22, 2017

New agreements build on Purdue, NSWC Crane strategic partnership

WEST LAFAYETTE, Ind. — Saving lives through improved communications and defense of U.S. Navy fleets and eliminating dangerous counterfeit laptops and other electronics are the goal of two new cooperative agreements between **Purdue University** (<http://www.purdue.edu/>) researchers and the **Naval Surface Warfare Center Crane Division** (<http://www.navsea.navy.mil/nswc/crane/default.aspx>) (NSWC Crane).

Power and Energy, onshore and afloat: A STEM program to inspire leadership in S and T for the workforce of the future fleet

- Upper-level course for undergraduates and graduate students in the Colleges of Science, Technology and Engineering
- Modular structure for transition to online delivery
- A cohort of students with deep domain expertise; exposure to interdisciplinary “team science”; mirroring societal diversity: exposed to Navy culture
- Engages guest speakers from DoD, NSWC Crane, industry
- Incorporates field trip to NSWC Crane and Battery Innovation Center
- Navy-relevant student projects



Navy and Marine Corps STEM outreach and workforce program; \$600,000; 3 years

McCann, Dietz, Sharma

Funding provided under grant number N00014-15-1-2420.

Veteran & Military Participation and Engagement

Veteran Participation

- David Kortge, PhD Student, Purdue
- Oluseye Akomolede, PhD Student, Purdue
- Bruce Nguyen, undergraduate, Purdue

Navy & Military Participation

- MIDN Nicholas Stovall-Kurtz (USNA)
- MIDN Nicholas Vu (USNA)
- MIDN Feder Orlov (USNA)
- MIDN Gabriel Weigelt (USNA)
- MIDN Ammon Okazaki (USNA)
- MIDN Andrew Campbell (Purdue ROTC)
- MIDN Gabby Feldman (Purdue ROTC)
- MIDN William Kellerhals (Purdue ROTC)
- CDT Keegan Crow (USMA)
- CDT Jafr Kazmi (USMA)
- CDT Megan Kinsey (USMA)
- CDT Thomas Williams (USMA)
- CDT Pankaja Dissanayake (USFA)

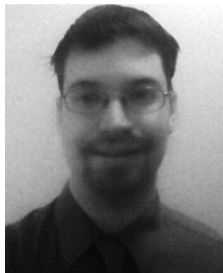


Additional Recent Military Participation in Pls' Labs

- CDT Gonzalo Cacho (USMA)
- CPT Dan Konopa, (now USMA faculty)
- MIDN Emani Alston (USNA)
- Zach Juliot (Purdue Navy ROTC)
- Julie Martin (Purdue Navy ROTC)
- Nathaniel Roe (Purdue Navy ROTC)
- Elon Keating (Purdue Navy ROTC)
- John Healy (Purdue Navy ROTC)
- Alex Gordon (Purdue Navy ROTC)
- Andrey Moskalenko (Purdue, US Army Reserves)

Recruitment to Naval Research Laboratories:

- Jim Moore, PhD, Spring 2016



Purdue's interest and participation

- Strategic partnership with NSWC Crane (IP management; Battery Innovation Center)
- Military Family Institute; Military Research Initiative; Homeland Security Institute; Institute for Global Security and Defense Innovation; Entrepreneurship Bootcamp for Veterans with Disabilities



- Energy
- Power electronics and power systems
- Propulsion
- Air-sea battle management
- Cyber security/ information assurance
- Graduate and undergraduate education and technology transition expertise

Navy-relevant signature strengths at Purdue

PURDUE UNIVERSITY
Discovery Park Energy Center

Over 200 faculty engaged in interdisciplinary energy science and engineering

- **Research strengths in transportation** (biofuels, aviation engine testing, electric vehicles, ground vehicle power, improved oil recovery, transportation systems)
- **Power generation and transmission** (solar, wind, nuclear, smart grid, energy efficiency, state utility forecasting)



Discovery Park is Purdue's hub for interdisciplinary and translational research, conceived as a place where scholars from all disciplines could work together to define whole new areas of research and solve grand challenges.