

Nanocrystalline Soft Magnetics Workshop 2023

Introduction and AMPED Overview

August 17th, 2023

Prof. Paul R. Ohodnicki, Jr.,
Director, Advanced Magnetics for Power and Energy
Development Consortium (AMPED)
RK Mellon Faculty Fellow in Energy
University of Pittsburgh

Prof. Subhashish Bhattacharya, AMPED Director (NCSU)
Prof. Brandon Grainger, AMPED Co-Director (Pitt)



Part I : Welcome and Introduction

Welcome!

Niobium Nb

Nanocrystalline Soft Magnetic materials Workshop

Advanced technologies for efficient power electronics systems

REGISTER NOW

Attendance is by invitation only

 **16 -17 August**

Energy Innovation Center, Pittsburgh, PA, USA



Topics Include:

- Increase awareness of the latest technical advances in nanocrystalline soft magnetic materials and their applications in electric power conversion technologies.
- Identify key challenges (technical, business, standards, workforce, regulatory, etc.) that currently are preventing broader commercial adoption of nanocrystalline soft magnetics.
- Establish and strengthen collaborations between the participating institutions focused on advancing and adopting nanocrystalline soft magnetics technologies broadly by addressing the challenges identified by the workshop attendees.

Organizers

FREEDM
SYSTEMS CENTER

AMPED ADVANCED MAGNETICS FOR POWER & ENERGY DEVELOPMENT

 UNIVERSITY OF CAMBRIDGE

 | Niobium Nb

 ASPIRE
NSF Engineering Research Center

PITT | SWANSON ENGINEERING

Agenda (Morning)

- 8:00 – 9:00 AM : Registration and Networking
- 9:00 – 9:30 AM : Welcome and AMPED Introduction
- 9:15 – 9:45 AM : CBMM Overview on Nanocrystalline Magnetics (R. Bharadwaj, CBMM)
- 9:45 – 10:15 AM : Keynote (M. Ohta, Proterials)
- 10:15 – 10:30 AM : Break
- 10:45 – 11:45 AM : Nanocrystalline Soft Magnetics Industrial Perspective - Panel
- 11:45 – 12:45 PM : Lunch

Agenda (Afternoon)

12:45 – 1:45 PM

: Testing and Measurement Needs
Including Standardization - Panel

1:30 – 2:30 PM

: Presentations from Meeting Organizers
FREEDM, ASPIRE, Cambridge

2:30 – 3:00 PM

: Networking and Break

3:00 – 4:00 PM

: Nanocrystalline Soft Magnetics
Emerging Applications - Panel

4:00 – 5:00 PM

: Nanocrystalline Soft Magnetics
Industry Next Steps

5:00 – 5:30 PM

: Closing Remarks

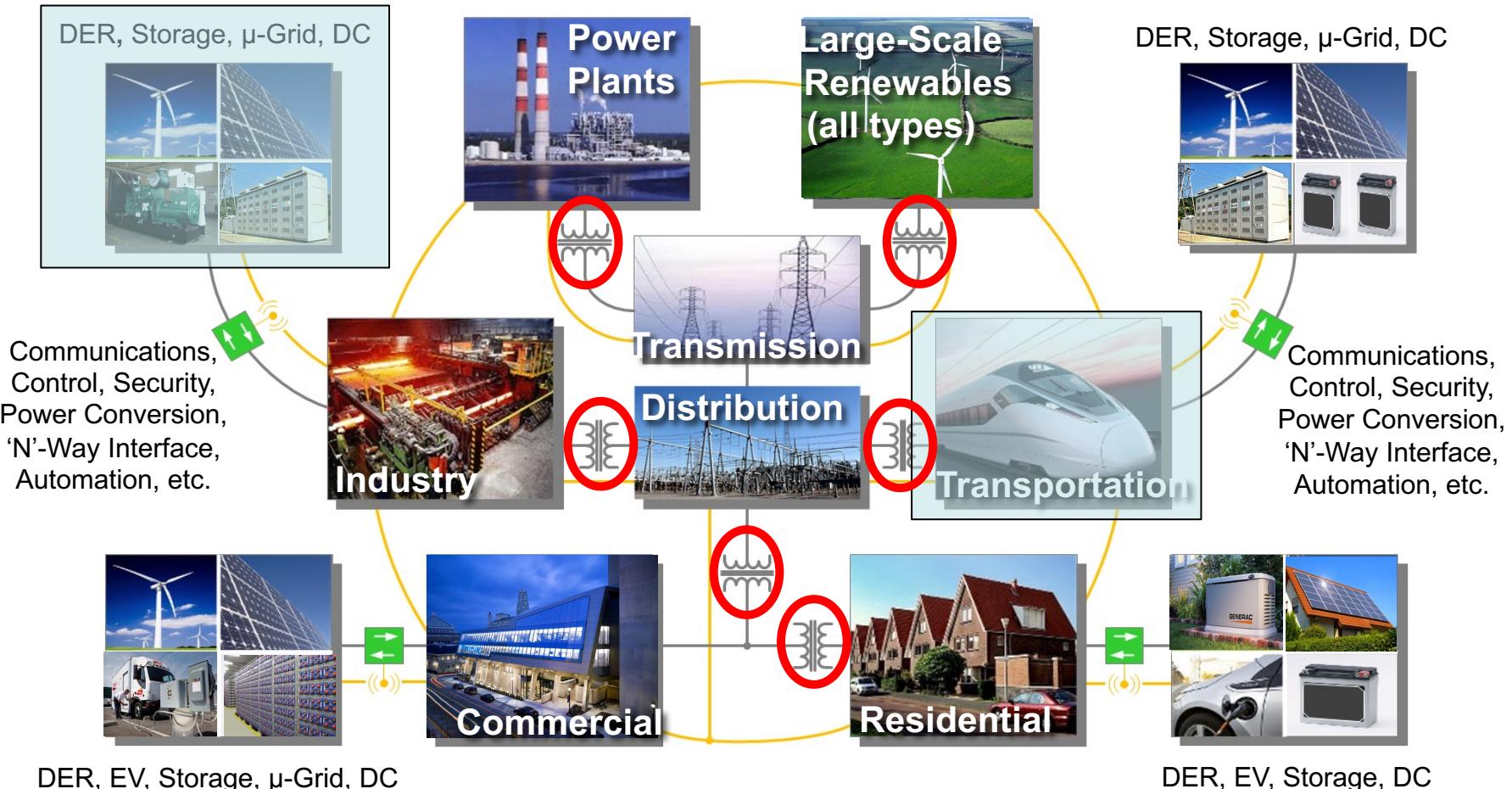
5:30 – 6:30 PM

: Social Hour and Poster Session

Part II:

What is the AMPED Consortium?

Motivation: Electrification in the 21st Century



Challenge: A Need Exists for a Next Generation, Interdisciplinary Workforce and Targeted Research Support of Magnetic Devices (Transformers, Inductors and Electric Vehicle Motors)

Advanced Magnetics for Power and Energy Development (AMPED)

Mission Statement

To develop an innovation ecosystem and educational programs for advancing soft magnetic materials and component technologies spanning fundamental science to end-use application in collaboration with various agencies, offices, and programs.

Example:

Pitt Programs

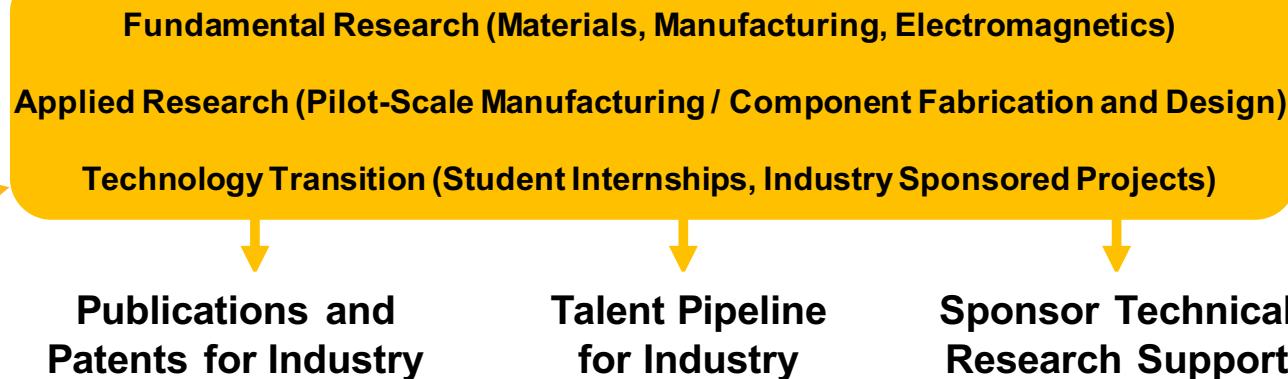
Engineering Science Program

Electric Power Engineering Program

Federal Government
(DOE, DOD, NASA)

Industry Member Funding

Proposals and Other Sources



Overall Vision / Prioritization...

Advanced Magnetics for Power and Energy Development (AMPED)

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Example:

Pitt Programs

Engineering Science Program

Electric Power Engineering Program

Federal Government
(DOE, DOD, NASA)

Formalized Participation

Industry Member Funding

Proposals and Other Sources

Fundamental Research (Materials, Manufacturing, Electromagnetics)

Applied Research (Pilot-Scale Manufacturing / Component Fabrication and Design)

Technology Transition (Student Internships, Industry Sponsored Projects)

Publications and Patents for Industry

Talent Pipeline for Industry

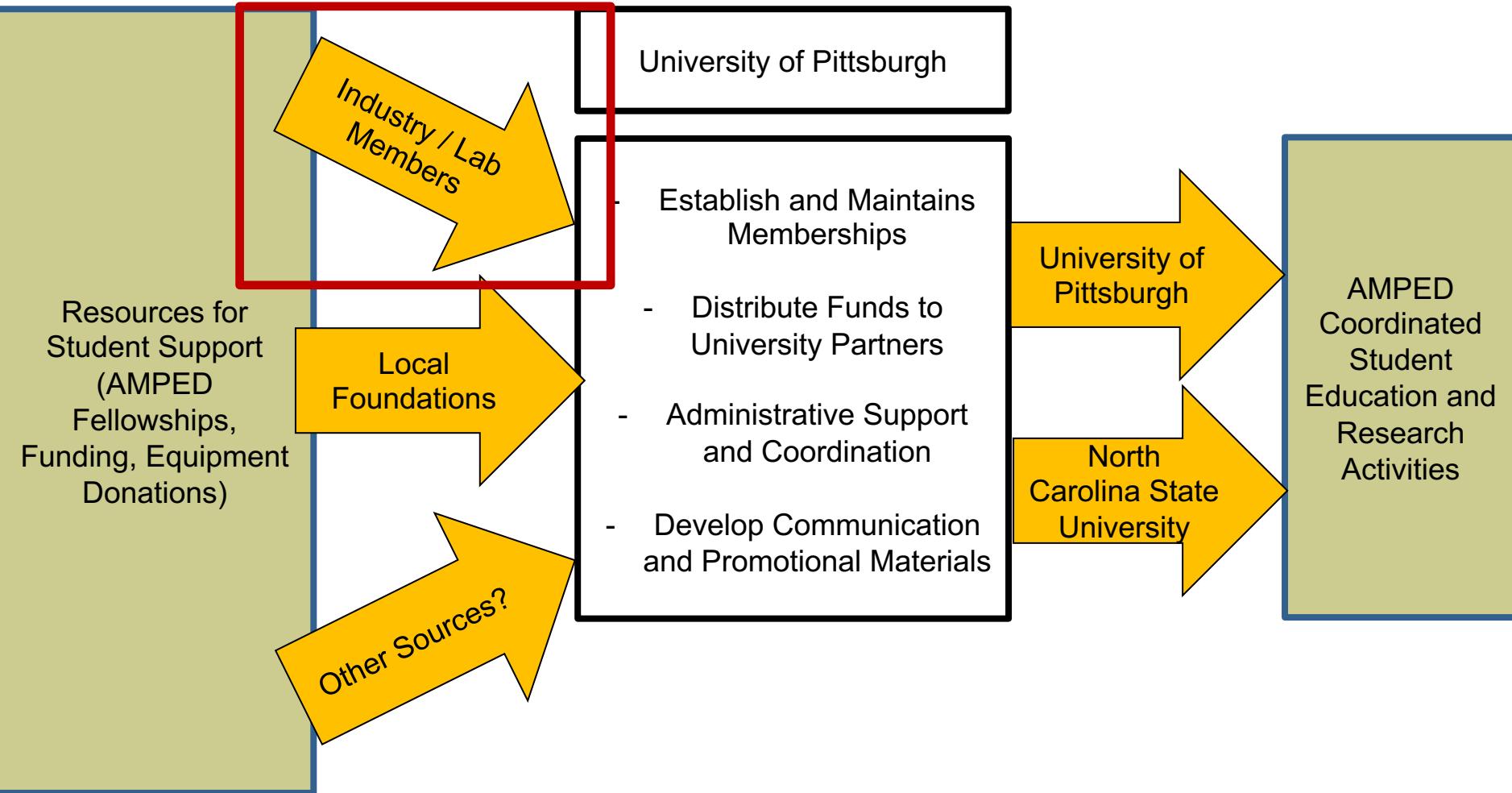
Sponsor Technical Research Support

Student Internships and Coops

A Formal Participation Option is Available for Partners

Near-Term Structure and Execution of AMPED

Formalized Participation



Integrated Research Effort with a Single Point of Entry

How Can You Get Involved?

| Full Participant - \$10/20k | Consortium Advisor | Charitable Contributors |
|---|--|---|
| <ul style="list-style-type: none"> • Participant Agreement Signed along with Participation Fee • Contribution to research road mapping and center initiatives • Project voting rights, helping to direct funds to projects of most interest • Early reports on research results • Attendance at Technical Seminars • Inclusion on AMPED Website as “Founding Participant” (https://pittamped.github.io/Founding-Participants.html) | <ul style="list-style-type: none"> • Attendance at Technical Seminars • Input towards research road mapping, but no voting rights • Inclusion on AMPED Website as “Consortium Advisors” (https://pittamped.github.io/Industry-Advisors.html) | <ul style="list-style-type: none"> • Tax Benefits • Inclusion in Promotional Materials • Attendance at Technical Seminars • Inclusion on AMPED Website as “Equipment Suppliers” (https://pittamped.github.io/Equipment-suppliers.html) |

For Information About Joining Contact: amped@pitt.edu
(David Ruvolo, Administrative POC, david.ruvolo@pitt.edu)

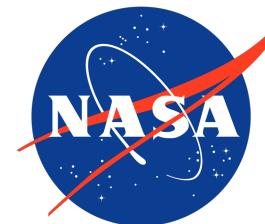
Charitable Contributors



GMW Associates



Full Participants



AMPED Consortium Industry Participants

Core Capability Focus Areas Across Universities Directly Aligned with Industry Needs

Magnetic Materials
and Manufacturing

Component Design
and Optimization

Magnetics Characterization
& Standards
(Including at MV)

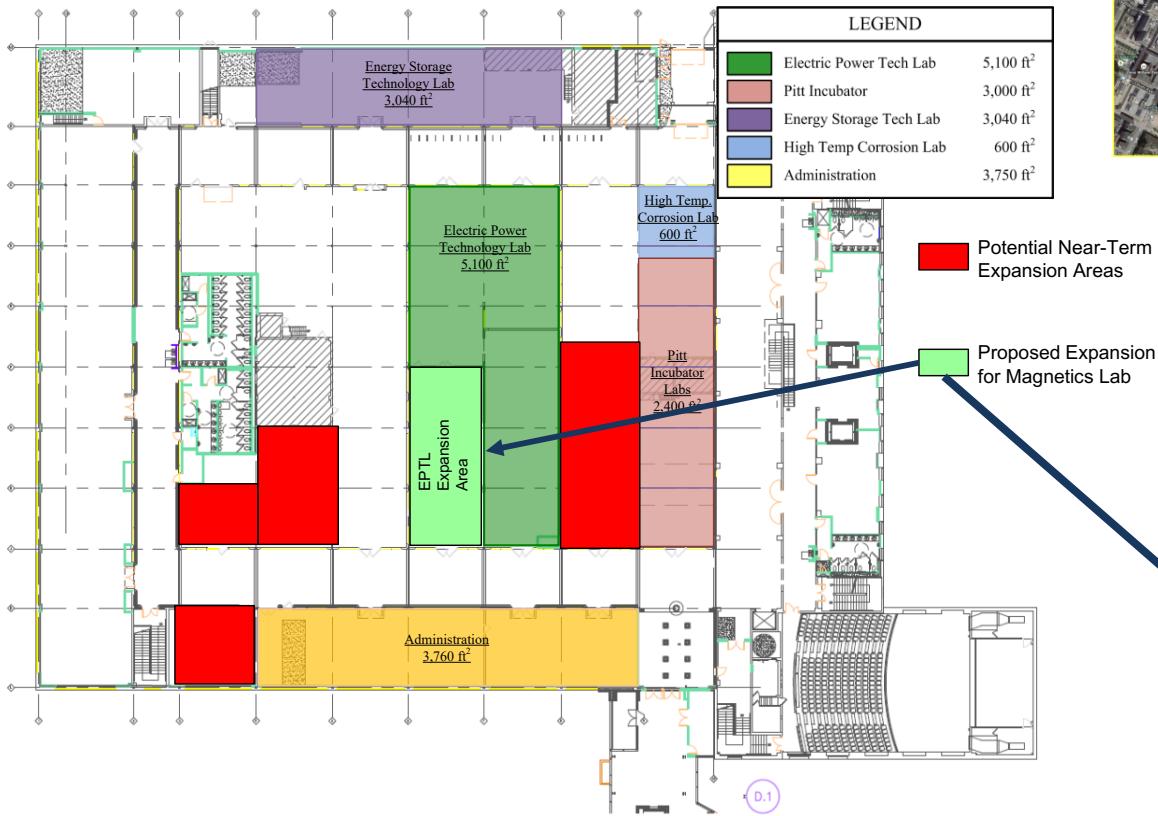
Power Electronics
Converters and Controls

Electric Motors Design
and Controls

Shared R&D Labs for the AMPED Consortium

Downtown Pittsburgh Laboratory Facilities

New Magnetics Lab to Support the AMPED Consortium



Facilities Established for Education, Research, and Fee for Service

Core Prototyping,
Manufacturing, and
Thermal Processing

Core Loss Testing
(LV and MV)

Current Status : Federal R&D Collaborations

Basic Research : Grant



FASTWATT

- Ravisekhar Raju



University of Pittsburgh – FastWatt, LLC

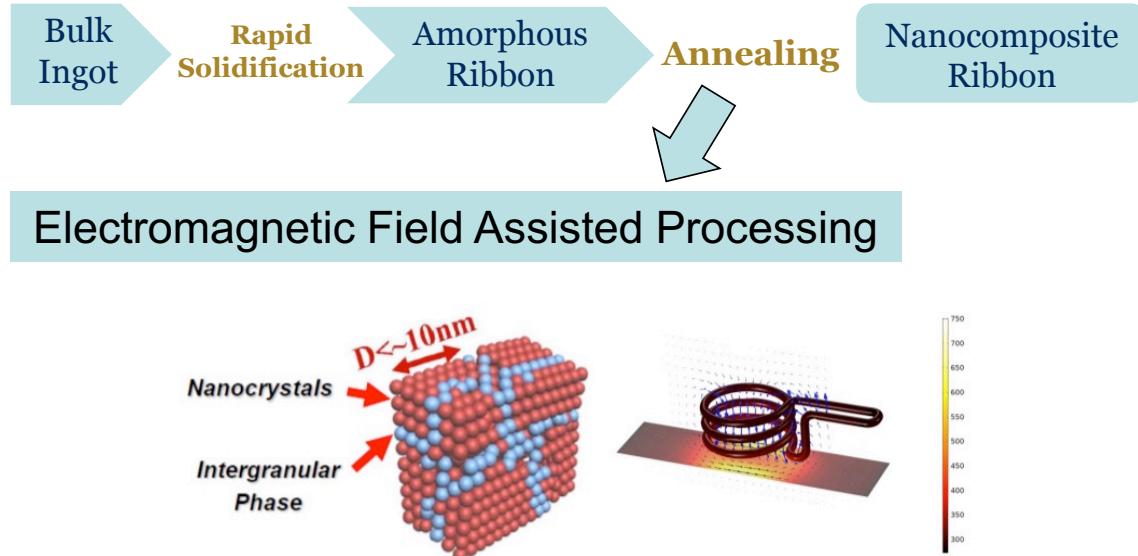
- Exploring New Materials and Manufacturing Techniques for Ferrites
- Inductor and Transformer Design Methods and Applications of Ferrites

Current Status : Federal R&D Collaborations

DOE Laboratory Subcontract



- Jagannath Devkota



Univ. of Pittsburgh – North Carolina State Univ. – NETL

- Developing New Reel-to-Reel Manufacturing Processes of Amorphous Alloys
 - Characterization of Magnetic Cores and Components for Applications

Current Status : Federal R&D Collaborations

Phase I & II : STTR Program



University of Pittsburgh



POWDERMET
ENGINEERED POWDER TECHNOLOGIES

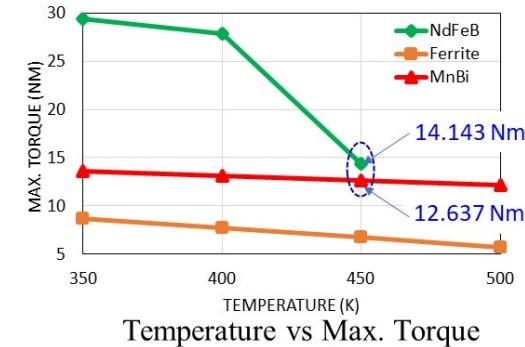
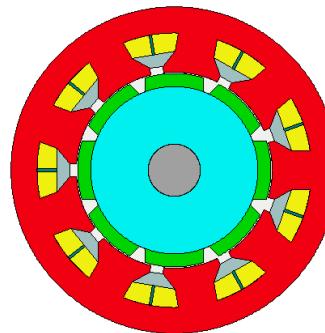
- Andrew Sherman
- Nicholas Krywopusk
- Benjamin Pratt



- Jun Cui

U.S. DEPARTMENT OF
ENERGY

VEHICLE TECHNOLOGIES OFFICE



| Materials | Max. Temp (Real data) | Max. Temp (~vary up to) | Electrical Resistivity (ohm.m) | Br (20 C) (T) | Relative Permeability (ur) | Temp. Coefficient Br (%/C) |
|----------------|-----------------------|-------------------------|--------------------------------|---------------|----------------------------|----------------------------|
| NdFeB (N48_AM) | 393.15 K (120 C) | 500 K (226.85 C) | 1.40E-06 | 1.39 | 1.04 | -0.12 |
| MnBi | 373.15 K (100 C) | 500 K (226.85 C) | 100 | 0.41 | 1.08 | -0.2 |
| Ferrite (Y32) | 453.15 K (180 C) | 500 K (226.85 C) | 6.85E-06 | 0.5928 | 1.057 | -0.06965 |

Powdermet – Ames Laboratory – University of Pittsburgh

- Seeking Commercialization of Ames Lab Developed REE Permanent Magnets
- University of Pittsburgh / AMPED Role : Design of REE-Free PM Motors

Current Status : Federal R&D Collaborations

Basic Research : Grant

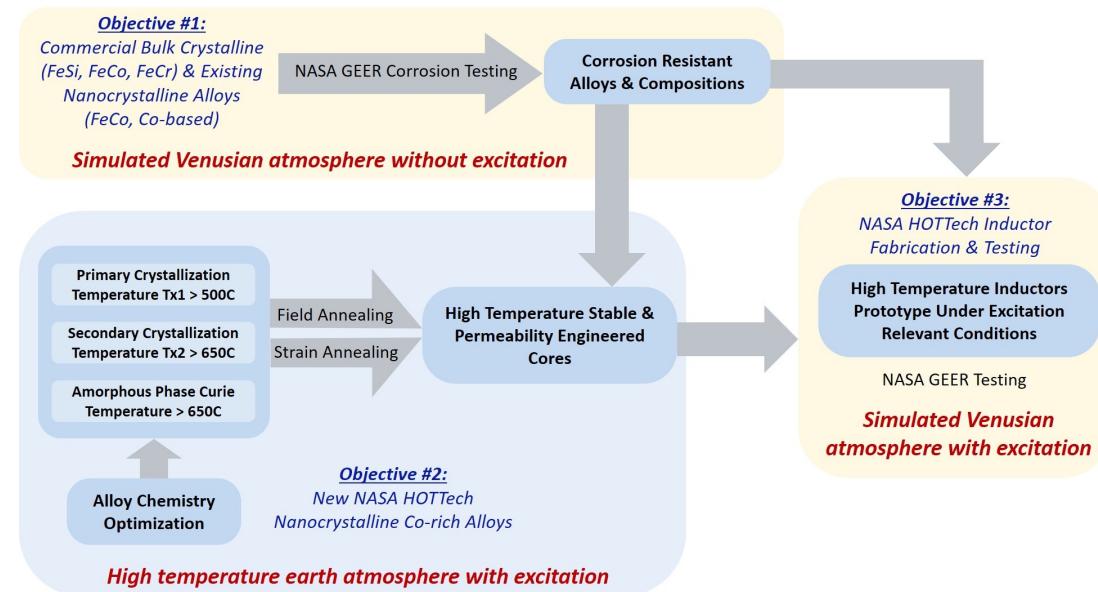


- Alex Leary
- Lei Xing
- Ronald Noebe



- Kevin Byerly
- Sam Kernion

NASA HOTTech Program



NASA – Raytheon – CorePower – Univ. of Pittsburgh

- Extreme Temperature and Extreme Environment Soft Magnetics
- Target Demonstrating Inductor Material and Technology at T=500C

Current Status : Federal Design Collaborations

Magnetic Component Design

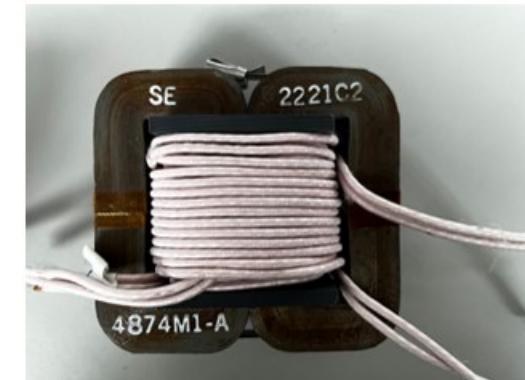


University of
Pittsburgh



Bechtel Plant Machinery, Inc.[®]
Quality, Integrity, Excellence

- Sean Dowhy



University of Pittsburgh – BPMI

- Advanced Magnetic Component Designs for Naval Applications
- Benchmarking of Existing Technologies and Engaging with Various Vendors

Current Status : State R&D Collaborations

Technology Transfer Program



- Natan Aronhime

University of Pittsburgh – Carnegie Mellon - Carpenter

- Exploring New Processing Methods and Techniques for Hiperco Laminations
 - Intellectual Property Filed at University of Pittsburgh Being Explored

Current Status : Foundation Donations

AMPED Program Support

**AMPED**

Workforce Development and Seed Funding for National Growth



University of Pittsburgh – Hillman Foundation

- New Materials and Manufacturing Research of Ferrites and Nanocomposites
- Power Electronics and Motor Technology Design, Development and Testing

Current Status : Industrial Collaborations

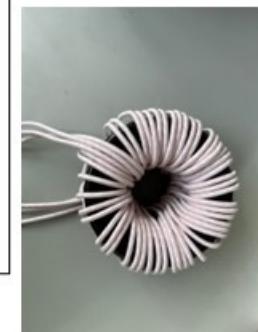
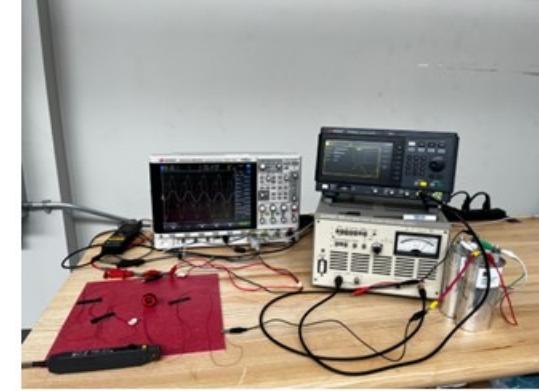
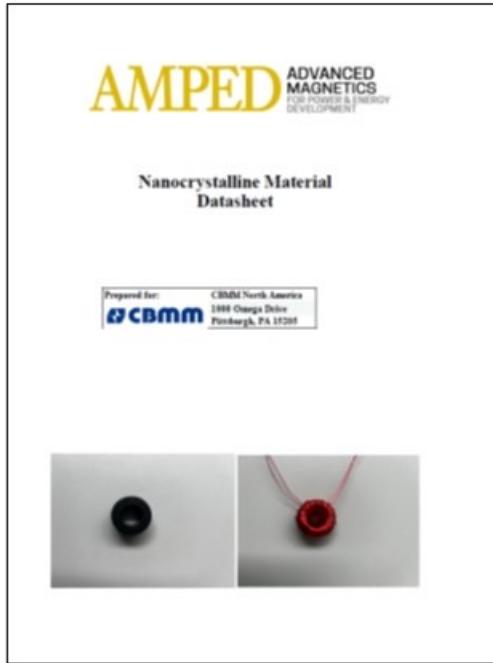
Data Sheet Development



University of
Pittsburgh



- Bharadwaj Reddy Andapally
- Mariana Perez de Olivera



University of Pittsburgh – CBMM

- Standardized Testing of Materials and Electromagnetic Components
- Benchmarking of Nanocrystalline Soft Magnetic Cores vs. Industry Standard

Consider Becoming a Part of Our Community!



Email : AMPED@pitt.edu

<http://engineering.pitt.edu/AMPED>



Our Priority is Focused on Workforce Development, Collaborate with Us to Support Your Needs in Talent Development!