Helping the marine and hydrokinetics industry with materials and protective coatings challenges

http://www.yachtsurvey.com/glassboats-1.jpg
http://www.racerocks.ca/

ICIT & EMEC
Project Overview

Marine and Hydrokinetics Advanced Materials Program:

Support the marine and hydrokinetics (MHK) industry through applied research and guidance on materials and coatings to enable viability, lower the cost of energy (COE), and accelerate commercialization.

The Challenge: Proper structural/component materials and coatings are critical to reducing engineering barriers, COE, and commercialization time

• Structure Design and Component: (LOADS! uncertainty in composite/design)
• Environmental Exposure Issues
• Cost (manufacture, O&M, reliability)
• Safety and Certification

Partners:

• Sandia National Laboratories (Lead): Materials Evaluation & Coatings
• Pacific Northwest National Laboratory: Biofouling & Environmental Exposure
• Montana State University: Composite Materials Evaluation & Development
• North Dakota State University: Antifouling Coatings & Biofouling Evaluation
• Brigham Young University: Antifouling Coatings
### Program Strategic Priorities

#### Technology Maturity
- Test and demonstrate prototypes
- Develop cost effective approaches for installation, grid integration, operations and maintenance
- **Conduct R&D for Innovative MHK systems & components**
- Develop tools to optimize device and array performance and reliability
- Develop and apply quantitative metrics to advance MHK technologies

#### Deployment Barriers
- Identify potential improvements to regulatory processes and requirements
- Support research focused on retiring or mitigating environmental risks and reducing costs
- Build awareness of MHK technologies
- Ensure MHK interests are considered in coastal and marine planning processes
- Evaluate deployment infrastructure needs and possible approaches to bridge gaps

#### Market Development
- Support project demonstrations to reduce risk and build investor confidence
- Assess and communicate potential MHK market opportunities, including off-grid and non-electric
- Inform incentives and policy measures
- Develop, maintain and communicate our national strategy
- Support development of standards
- Expand MHK technical and research community

#### Crosscutting Approaches
- Enable access to testing facilities that help accelerate the pace of technology development
- Improve resource characterization to optimize technologies, reduce deployment risks and identify promising markets
- **Exchange of data information and expertise**
Technology Maturity

- Test and demonstrate prototypes
- Develop cost effective approaches for installation, grid integration, operations and maintenance
- Conduct R&D for innovative MHK systems & components
- Develop tools to optimize device and array performance and reliability
- Develop and apply quantitative metrics to advance MHK technologies

The Impact: Our R&D tests supply chain products and novel solutions to (1) validate performance and (2) lower risk for design/manufacturer.

- **U.S. DOE MHK Composite Materials and Structures Database:** Benefits: open source, industry advised, backed with publications

  - **Composite Workshop:** Identify barriers (short-, mid-, long-term goals)
  - **Protective Coatings Performance Validation:** MHK-specific coatings identified.
Determine Environmental Exposure Effects on Commercial and Sandia MHK-specific Coatings.
Evaluate under static and flow conditions with unfiltered natural seawater.
- MHK not operating under shipping conditions!
Engineering designs of MHK devices have difficult, although not unique, materials challenges. Lightweight, yet stiff; strong and durable; can resist environmental degradation; and are inexpensive and easy to integrate into manufacturing.

Bridge the technology gaps and knowledge that span across all four of these materials challenges through....

- **Host Workshop to Identify Composite Related Barriers** – What are the composite materials-related manufacturing science and engineering barriers that increase the cost of construction, deployment, and operation?

- Worked with MHK community, supply chain, composite/coatings manufacturers, U.S. Navy, oil and gas, and marine industries to understand needs and available resources to support MHK stakeholders.

- Delivered open-source resources for MHK industry to use to further their design development, improve deployment, and manufacture.

- Provided leadership, R&D also supported student pipeline and STEM initiatives.
Project Plan & Schedule

• Project initiated on October 2014, and project planned completion was September 2016
• Slipped schedule in FY 14 due to coatings synthesis delays in scale up. First time team scaled up mg to Kg quantities to support environmental exposure coupon testing. This pushed testing back in to FY 15.
• Go/No-Go decision points FY16: During workshop, industrial advisors to review new database parameters to determine if content is valued and research worthy of continued development.
Sandia subcontracted to Montana State University, North Dakota State University, and Brigham Young University.
Additional $50K in FY 15 was sent to Pacific Northwest National Laboratory (PNNL) to support remaining environmental exposure characterization.
All funds from FY14 through FY16 have been used.
Other funding sources: None
Partners, Subcontractors, and Collaborators: Lead: Sandia National Laboratories (Hernandez-Sanchez, Denton, Hibbs); Biofouling Partners: Pacific Northwest National Laboratories (Bonheyo, Park, Jeters); North Dakota State University (Stafslien); Brigham Young University (Savage); Composites Partners: Montana State University (Miller)

Communications and Technology Transfer:

Journal Publications:

In preparation or submitted :
4. Yubo Li, Xiaobo Gu, Jiyeon Park, Bernadette A. Hernandez-Sanchez, George Bonheyo, Paul B. Savage “Ceragenin-containing coatings for use in inhibiting marine biofouling” (in preparation)

Presentations:
Antifouling Coatings For Marine Energy Applications: Criteria, Challenges, and Analysis

Workshops: Marine and Hydrokinetic Energy Composite Materials Workshop, May 2015, Sandia National Laboratories, Albuquerque, New Mexico,

Next Steps and Future Research

FY17/Current research: Material Design Tools for Marine and Hydrokinetic Composite Structures

**Objective:** Helping MHK industry reduce uncertainty in using composites in their designs

- Mitigating composite biofouling/environmental effects and metal-carbon fiber interconnect corrosion in saltwater
- Examining MHK load challenges on composite material and substructure performance to improve design

**Proposed future research:**

**Support Domestic Manufacturing**

- Expand on substructure to full-scale testing at NREL
- Expand on composites manufacturing process with developers to examine component/materials reliability
- Include near or full-scale process demonstrations and validation for candidate manufacturing methods
- Develop MHK non-destructive inspection guidelines for quality assurance (manufacturing, transport, operation, maintenance).