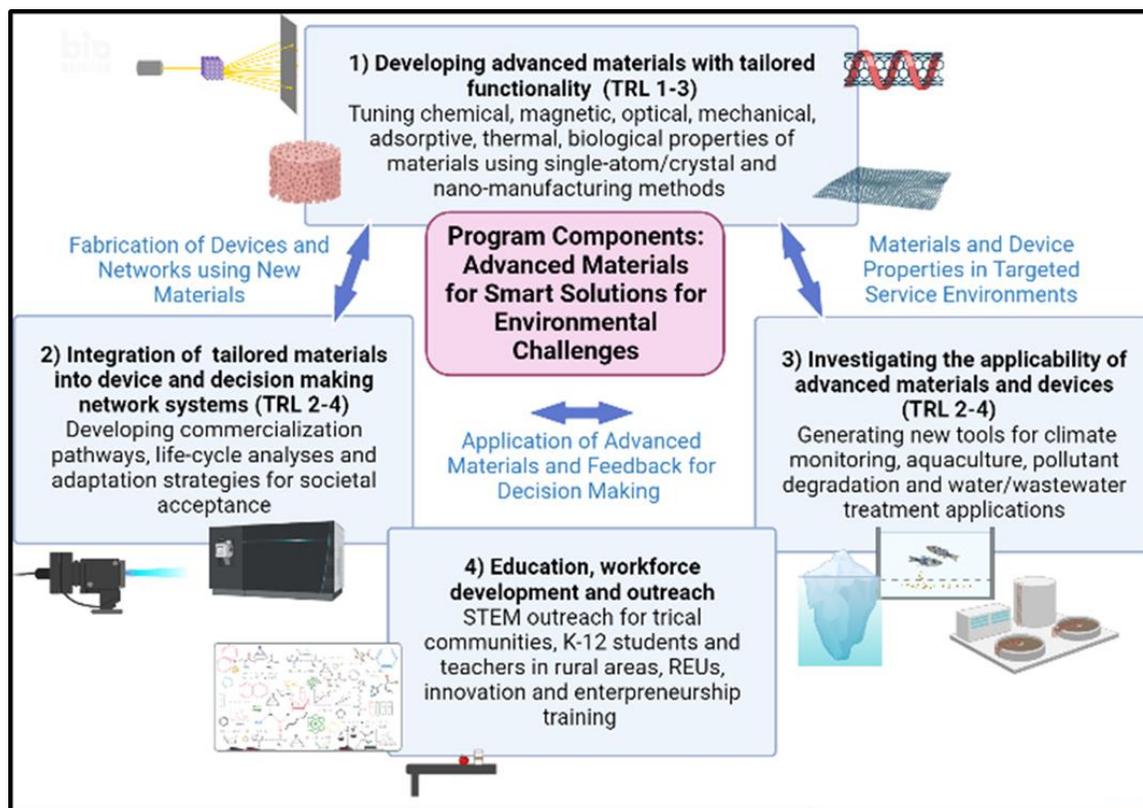


Proposal Development Process Phase I – Research Concept Paper

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|---|--------------|---|----------------|---------------------------------|---------------|
| 1) Proposed Research Focus: | | Advanced Materials and Smart Solutions for Climate Change Adaptation | | | |
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| 4) Intellectual Merit: | | | | | |
| <p>A. <u>Need:</u> According to the Maine Climate Council, all sectors of Maine’s economy, from energy to agriculture, forestry, fishing, and tourism, are impacted by climate change. Therefore, an advanced research infrastructure in smart technologies for climate monitoring and adaptation can not only help address our local and global environmental challenges, but also develop new business and attract high-paying jobs to Maine. A large number of these technologies depend on advanced materials with tailored functional properties, and there is strong need for a cross-disciplinary program that develops materials science & engineering skills for systems-level solutions to the climate-impacted industries listed above. Moreover, several global companies as well as smaller high tech companies with operations in Maine have articulated a strong need for materials-related expertise in this region, which can be addressed by collaborative workforce training, internship and R&D programs. This concept paper is designed to address these needs by catalyzing and nurturing an innovation hub in the foundational area of advanced materials for climate, environment, energy and infrastructure solutions, and for strengthening research-education-industry collaborations for scientific discovery, innovation, public acceptance, and knowledge-based prosperity.</p> | | | | | |
| <p>B. <u>Research Goal & Objectives:</u> The overall goal of this project is to build a research, development and educational infrastructure centered on advanced nano-enabled materials (such as atomic-scale or nano-scale materials integrated into macro-scale solids and devices) to provide smart multi-faceted solutions for adaptation to a changing climate. This project has three objectives that will synergistically lead to new devices and sensor networks optimized for real-time detection, risk assessment, and mitigation of key environmental variables such as humidity, temperature, chemical/ biological pollutants or structural damage. The first objective is to investigate robust, reusable atomic and nano-scale materials that can lead to multifunctional platforms for eco-friendly devices. The second related objective is to integrate these materials into smarter devices, develop scale-up and commercialization strategies, perform lifecycle analyses for a circular economy (cradle-to-cradle), and improve the acceptance of these technologies in policy and decision-making. The third objective is to investigate deployment of the above emerging materials and devices for field applications related to aquaculture, oceanography, environmental engineering and climate studies in rural, urban and extreme environments.</p> | | | | | |
| <p>C. <u>Research Actions:</u> The research actions are aimed at development, scientific insights and new technologies applicable to environmental sustainability such as materials for detection, monitoring, and mitigation of emerging environmental threats. An overview of the inter-connected components is shown in the schematic below:</p> | | | | | |



Innovations will target three research focus areas with well-coordinated feedback loops: (i) Designing advanced functional materials with desired properties (electrical, thermal, adsorptive, mechanical, biomedical, magnetic or multi-functional properties) for environmental catalysts, adsorbents, sensors, hybrid components and smart structures; (ii) Integration of precisely tailored materials into device and decision making network systems, and developing commercialization pathways, life-cycle analyses and adaptation strategies for societal acceptance; and (iii) Investigating the applicability of advanced materials and devices into new tools for climate monitoring, aquaculture, pollutant degradation and water/wastewater treatment applications.

Educational initiatives generated by this research program will seamlessly integrate the following activities: (i) STEM training for indigenous communities through creative programs such as sustainable science in indigenous homelands and integrating indigenous and western science through applied aquaculture research, (ii) Hands-on activities for rural K-12 programs, (iii) Research experience for undergraduates and (iv) Innovation/ Entrepreneurship training in the area of emerging materials and devices for climate resilience.

D. **Priority:**

This research is directly aligned with four of the eight NSF Administration Priorities Summary listed in the FY22 Budget request to Congress ([FY2022 budget request to Congress](#)): Advanced Manufacturing, Advanced Wireless, Clean Energy Technology, and Microelectronics. Additionally, three areas for Multi-Agency R&D Priorities identified in the [White House 2021 R&D priorities memo](#) will be aligned with this project. In particular, the following priorities articulated within the “Tackling Climate Change” section will be directly addressed: (i) Climate adaptation and resilience, (ii) Innovation in clean-energy technologies and infrastructure, and (iii) Monitoring and measurement.

In the Maine Economic Development Strategy ([Maine Economic Development Strategy 2020-2029](#)), action items G1 and G2 point to identification of gaps for local hubs of excellence and of supply chain opportunities. A new Hub of Excellence in Advanced Materials for Smart Solutions to Extreme Climate Challenges can not only strengthen the existing hubs in Maine related to forest, aquaculture, climate monitoring and clean energy industries, but also create a cohort of Materials Science & Engineering experts to facilitate a physical and intellectual supply chain for these industries. Moreover, Maine Governor's Office of Policy Innovation and the Future is stressing the need for research and outreach to guide climate adaptation planning, and this project will strengthen our local expertise in this area.

5) Broader Impacts:

E. In-state collaborations:

Potential collaborations within the State of Maine are the following:

- Higher Education: Univ. of Southern Maine, Bates, Bowdoin, & Colby Colleges, Bigelow Laboratory.
- Governmental Sectors: Maine DEP, Maine DMR, USGS, National Park Service (Acadia)
- For Profit Companies: IDEXX Laboratories, ON Semiconductor, bluShift Aerospace, ETC2 (subsidiary of Montrose Environmental Group), Environetix, bluShift Aerospace, and Orono Spectral Solutions.
- The Climate Challenge Consortium (C³) at the University of Maine is conducting a survey to provide a framework for combining local strengths and identifying gap areas. This exercise is expected to provide a local/national/international framework by joining University of Maine System strengths with other organizations under climate challenge themes. Therefore, more synergies and collaborations may be identified in the near future,

F. Regional/National collaborations:

Potential collaborations outside the State of Maine are the following:

- US Environmental Protection Agency: Investigators from Air, Climate & Energy, Chemical Safety and Sustainability, and Safe and Sustainable Water Resources Programs.
- Oak Ridge National Lab: Chemical Sciences; Systems Engineering and Cybernetics.
- Air Force Institute of Technology: Graduate School of Engineering and Management
- Air Force Research Laboratory: Materials & Manufacturing and Propulsion Directorates
- NASA- Ames and Glenn Research Centers
- Idaho National Laboratory

G. Economic development:

This project opens up opportunities for Maine to lead research globally in several key areas, including future technologies for sustainable space, ocean, and deep earth (1-2 km) explorations. Immediate economic development projects envisioned are the following:

- New technologies through novel innovations in materials and devices.
- Seed funding for R&D and commercialization.
- Joint R&D activities and job creation with industry.
- Emphasis on entrepreneurship and business development around emerging technologies.
- Global partnership on sustainability to evaluate cradle-to-grave impact of the new technologies.

H. Workforce Development:

The following activities in this project will help develop a highly-skilled and diverse workforce in Maine:

- Option to extend classroom knowledge through internship opportunities at participating organizations.
- Undergraduate projects: Stipends for undergraduate research experience and outreach activities centered on water testing and purification, sustainability, and environmental mitigation technologies.
- “Self-Reflection Portfolio” based learning, similar to the National Academy of Engineering Grand Challenges Program aimed at increasing multicultural and multidisciplinary thinking and community outreach skills.
- Education, outreach and application of the climate challenge findings identified through the Climate Change Consortium survey.
- Environmental equity training: Projects to work with impacted underserved communities through Centers and Institutes at University of Maine that are fully focused on water availability, water quality sustainability and climate change monitoring.

I. Infrastructure:

The State of Maine does not have a consolidated program and required infrastructure in the foundational area of advanced materials for devices and technologies targeted at future climate induced needs. This infrastructure will add this important dimension to our existing strengths in forestry, fisheries, agriculture, and renewable energy. This project will establish the following:

- (i) A state-wide interconnected infrastructure of research laboratories.
- (ii) Network infrastructure of sensor and decision-making protocols.
- (iii) A University-Industry-Federal Laboratory consortium and necessary infrastructure for collaborative workforce development of cross-disciplinary professionals.