**Maine EPSCoR FY19-24 NSF EPSCoR RII Track-1**

**Proposal Development Process**

**Phase I – Research Concept Papers**

To prepare for the next round of NSF EPSCoR RII Track-1 funding, Maine EPSCoR is executing a formal proposal development process.

For Phase I, researchers from Maine are invited to submit a concept paper that describes a current research problem/need for the state that might be applicable for the next Maine NSF EPSCoR RII Track-1 project.

Note that the Track-1 grant is required to address a comprehensive, integrated, trans-disciplinary, statewide focus that creates a substantial academic research infrastructure and involves participants from colleges and universities throughout the state. It is not designed for individual, single institution, or small group faculty research.

**INSTRUCTIONS:**

Please fill in the template below, using standard NSF font size requirements. The allowable maximum is two pages. If you require additional space, you may delete unused lines in the Senior Personnel section, or blank lines in the document - please do not delete any other lines or instructions.

Sections:

1. Indicate the general focus area of the research that you are proposing (i.e., aquaculture, alternative energy, etc.).
2. Indicate the contact person for this concept.
3. Indicate potential key personnel who could be part of the effort to address this research concept.
4. Intellectual Merit – please provide a brief description in each of the sections, relating it to the research focus that you have identified as a current problem/need for Maine.
5. Broader Impacts – please provide a brief description in each of the sections.

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| --- | --- |
| **Due by:** | **February 15, 2017** |
| **Submit to:** | [shane.moeykens@maine.edu](mailto:shane.moeykens@maine.edu)(as pdf or Word doc) |

By submitting this concept paper, Maine researchers are giving permission to post this document on the Maine EPSCoR website in order to encourage statewide discussions and potential collaborative engagement prior to the next phase of the RII Track-1 project development process.

Personnel from each submitted concept paper are encouraged to look over the other submitted concept papers for potential synergy, and to contact others as applicable.

For more information see: <https://umaine.edu/epscor/track-1-rii-development-process/>

<https://www.nsf.gov/pubs/2016/nsf16557/nsf16557.htm>



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| 1. **Proposed Research Focus:** | | | **Forest Nanomaterials in Advanced Manufacturing** | | | | | | |
| 1. **Primary Contact Person:** | | | | | | | | | |
| **Name:** | | **Institution:** | **Title:** | **Dept.** | | **E-mail:** | | **Phone:** | |
| Doug Bousfield | | UMaine | Professor | Chem. & Bio. Eng. | | bousfld@maine.edu | | 581-2300 | |
| Doug Gardner | | UMaine | Professor | SFR, FBRI, Composites Center | | douglasg@maine.edu | | 581-2846 | |
| 1. **Potential Key Senior Personnel:** | | | | | | | | | |
| **Name:** | | **Institution:** | **Title:** | | **Dept.** | **E-mail:** | | |  |
| **University of Maine:** Dr. Habib Dagher, Composites Center; Dr. Mike Bilodeau, Process Development Center; Dr. William Gramlich, Chemistry; Dr. Mehdi Tajvidi, Forest Resources; Dr. Roberto Lopez-Anido, Civil Engineering, Composites Center; Laura Wilson, Cooperative Extension: 4-H; Dr. Mike Mason, Chemistry and Biological Engineering; Dr. Mindy Crandall, SFR and Economics; Dr. Stephen Shaler, SFR; Dr. Eric Landis, Civil Engineering; Dr. Hemant Pendse, FBRI; Dr. Jonathan Rubin, Margaret Chase Smith Policy Center; Dr. Kathleen Bell, Economics; Dr. Jessica Leahy, College of NSFA, SFR; Dr. David Neivandt, Chemical & Bio. Eng.; Dr. Caitlin Howell, Chem & Bio Eng, Prof. Carl Tripp, LASST | | | | | | | | | |
| Ryan Wallace | University of Southern ME | | | Director, Center Bus. & Econ Res. | | | Ryan.d.wallace@maine.edu | | |
| Doug Currie | University of Southern ME | | | Chair, Dept. of Biology | | | [douglas.currie@maine.edu](mailto:douglas.currie@maine.edu) | | |
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| Dr. Jinwu Wang | U.S. Forest Products Lab | | | Research Technologist | | | jinwuwang@fs.fed.us | | |
| Nadir Yildirim | Revolution Research Inc. | | | CEO | | | nadir@revolutionresearchinc | | |
| Sean Ireland | Fiberlean | | | VP of Business Development | | | sean.ireland@fiberlean.com | | |
| Mike Daley | Univ. of New England | | | Economics | | | [mdaley@une.edu](mailto:mdaley@une.edu) | | |
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| Eric Kingsley | Innovative Natural Resource Solutions LLC | | | Director | | | Kingsley@inrsllc.com | | |
| Mike Harm | Twin Rivers | | | R&D Director | | | Mike.Harm@twinriverspaper.com | | |
| Thomas Doak | Small Woodlot Owners of ME | | | Executive Director | | | tom@swoam.com | | |
| Dana Doran | Prof. Logging Contractors of ME | | | Executive Director | | | executivedirector@maineloggers.com | | |
| 1. **Intellectual Merit: (the research focus)** | | | | | | | | | |  |  | 1. **Intellectual Merit: (the research focus)** |
| ***A. Need:***Production of nano-scale materials, such as cellulose nanofibers, derived from low-value wood has been an important subject of research the University of Maine. These materials have great potential for use in a number of next generation products including packaging, bio-medical devices, and structural systems. Because of the projected economic importance these materials, there is currently an international race to develop these applications in various markets. Research is needed to understand methods to modify these materials, process them into products, predict product performance, and design advanced applications. The State of Maine has a substantial and sustainable source of wood, and is uniquely positioned to be the technology leader in the development of novel nanomaterial applications. Recently, the U.S. Economic Development Administration, in partnership with state leaders, initiated an Economic Development Assessment Team (EDAT) for the forest products industry. In their final Jan 2017 report, EDAT commented that “immediate action is necessary to preserve local employment opportunities and the sustainable use of natural resources, while encouraging economic diversification of the state’s forest economy.” The development of technologies that use low value biomass would create jobs, improve returns to forestry overall, including loggers and existing mills. In addition to technology, the project will include understanding of the supply chain, "sustainable products" market drivers and the social science component of acceptability. | | | | | | | | | |
| ***B. Research Goal & Objectives:*** *describe the overall project goal to address this problem/need, and 1-3 key research objectives.*  The overall project goal is to develop nanomaterials derived from low-value wood for advanced manufacturing of 1) advanced infrastructure, 2) next generation packaging and 3) biomedical devices. To achieve these goals two cross-cutting themes will be employed; a) create technologies that are capable of producing, characterizing, and modifying nanomaterials derived from low-value wood, and b) perform market, social, economic and ecological analyses to balance commercial development and forest sustainability. All work will be aligned with market needs to translate fundamental research into commercial development. Rapid cycles of product design, prototyping and optimization will be used.  Cellulose nanofibers (CNF) in its various forms have remarkable potential for use in civil infrastructure, packaging, and biomedical applications. Recent studies have demonstrated that CNF has low toxicity, excellent biocompatibility, and biodegradability. Coupling these favorable properties with tunable mechanical properties and the ability to be chemically functionalized, positions these materials as the logical platform for a host of biomedical applications. Proposed research will explore the potential to use these nano-scale materials for synthetic bone, peripheral nerve regeneration devices, surgical bone scaffolds, spacers, bone and bone-to-tissue grafting implements, plates, screws, pins, encapsulating materials for drug release, embolization therapies, injectable biomaterials, and substrates for tissue growth.  Smart packaging concepts are potentially enabled by forest derived nanomaterials including the creation of barrier papers that have good oxygen and water vapor barrier properties, super-absorbent pads to extend shelf life of foods, clam shell packaging that recycles with the paper stream and reduce the use of aluminum foil. All of these applications open up huge markets for this renewable and sustainable forest derived nanomaterial.  With the potential availability of large amounts of low cost, highly controlled renewable and sustainable nanofibers, the potential additive manufacturing to tailor the physical properties of construction materials to meet design specifications exists. The proposed research will develop multi‐scale modeling and experimental techniques that explicitly incorporate micro‐ and nano‐structural features of nanomaterials in the process simulation and engineering design for structural applications. The resulting design framework will streamline manufacturing methods, characterize material properties, and predict strength and durability.  Well controlled and tunable production of nano-scale materials from the forest will be critical for all product themes. Cross-cutting research projects will determine how various isolation methods feedstocks impact material characteristics. A number of process variables are expected to be important. The size distribution and morphology of nanoparticles will be characterized as well as surface chemistry with advanced methods. Surface modification of the fibers is expected to improve the nanomaterials matrix interface and enhance stress transfer and the final properties in nanocomposite applications.  It is estimated that by 2020 that the global market for products incorporating nanotechnology will be $ 3 Trillion annually. Current studies show renewable nanotechnology to have a significantly lower environmental footprint and toxicity than many other nanomaterials. It is estimated that tens of millions of tons per year of wood-derived nanomaterials would be used, if developed, and have the potential to add 800,000 direct jobs in rural America and $200 billion to GDP in the U.S. The proposed research program is in line with the vision of the 2010 Maine Science and Technology Action Plan “Create an environment where science, technology, innovation and entrepreneurship stimulate Maine’s economy.” | | | | | | | | | |
| ***C. Research Actions:***The key research actions needed to meet the needs are 1) development of a forest derived nanoparticle characterization laboratory to determine key physical and chemical properties, 2) creation of a rapid prototyping facility to enable researchers to reduce product concepts to practice and facilitate fast cycle times of creation, testing and modification; 3) enhancement of infrastructure for modeling, design and processing to enable efficient scale-up of laboratory processes or products to the pilot scale, and 4) establishment of a commercialization group for evaluation of markets, costs, and the social impact. | | | | | | | | | |
| ***D. Priority:*** The proposed research clearly addresses key strategies identified by the EDAT team through developing new markets for products derived from forest resources. In addition, the proposed research aligns with many of Maine’s technology sectors as detailed in the new MIEAB Science and Technology plan (Forestry Products and Agriculture, Composites and Advanced Materials, Biotechnology, Precision Manufacturing etc.). New products will be produced by existing paper or lumber companies in cooperation with new spin-off companies or industries, dramatically boosting the economy and workforce of the State of Maine. | | | | | | | | | |
| 1. **Broader Impacts: (related to the research focus)** | | | | | | | | | |
| 1. ***Impacts****: potential to benefit society and contribute to the achievement of specific, desired societal outcomes.*   Incorporation of forest derived nanomaterials into next generation products, structures, and packaging, will have a significant impact on society. Advances in packaging materials will increase recyclability of products used throughout the country, reducing our environmental impact. New biomedical applications will speed recovery and enhance clinical outcomes via drug delivery, implantable devices, wound repair, and tissue engineering. New materials with precisely tailored physical properties obtained by incorporation of forest derived nanomaterials will enable previously unobtainable infrastructure outcomes. | | | | | | | | | |
| 1. ***Impacts****: potential economic development as a result of this research.*   The incorporation of forest derived nanomaterials into various products will expand existing markets and open up new markets. Pulp and Paper mills will have value added product streams to complement their traditional outputs, and new companies will be formed to capitalize on the economic opportunities. One priority recommendation of the EDAT team is to “invest in the research, development and commercialization of emerging wood technologies…for the utilization of low value fiber”. The economic impacts of the development of these technologies would be many-fold. In employment, new jobs would be created and sustained; direct employment in new technologies would also support additional indirect and induced employment and wages. The creation of markets for low value material would improve landowner profitability and improve returns to forestry overall, including improving profitability for loggers and existing mills. In addition, many of these benefits would be realized in small, rural communities, struggling with high unemployment and decreased economic opportunities following mill closures. | | | | | | | | | |
| 1. ***Impacts****: potential for statewide workforce development in this research area*   Maine’s forest has supported families for centuries. By demonstrating the connections for Maine K-12 youth between this renewable resource and the jobs of the future, we’ll develop an interest and pipeline for future engineers, scientists, and practitioners. Our implementation model will consist of a combination of bringing youth to campus, and of training undergraduate and graduate students (4-H STEM Ambassadors), teachers, and volunteers to facilitate related STEM activities/design challenges with youth in schools, after school programs, and other learning environments. Youth will learn about science and engineering, innovation and entrepreneurship and be better able to make informed decisions regarding higher education. This will lead to more students strengthening Maine’s STEM pipeline, leading to an increase student enrollment in Science, Technology, Engineering, Art/ Design, and Mathematics (STEAM) disciplines, a goal referenced in the Maine Innovation Economy Action Plan. The proposed research will strengthen connections between the forest product industry and academia as well as provide training for wood materials researchers. | | | | | | | | | |
| 1. ***Impacts****: potential to provide infrastructure that grows the state’s academic research and education capacity.*   The proposed work will lead to infrastructure investments in terms of human capital and equipment. Faculty hires will be made in research areas complementary to UMaine existing expertise, and will span the engineering, physical science and social science disciplines. Postdoctoral Fellow and Graduate and Undergraduate students will be recruited to perform the research and outreach activities. Students will be charged with a statewide mission with mentors in both academic and industrial sectors. Equipment purchases will complement the states existing physical infrastructure which is comprehensive, but fill identified niche gaps. | | | | | | | | | |