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JOINT COMMITTEE ON FINANCE

MEMORANDUM

To: Members
Joint Committee on Finance

From: Senator Alberta Darling
Representative John Nygren

Date: November 18, 2019

Re: UWS Report to JFC

Attached is the 2017-19 Report on Industrial and Economic Development Funds from the University of Wisconsin System, pursuant to s. 36.25(25), Stats.

This report is being provided for your information only. No action by the Committee is required. Please feel free to contact us if you have any questions.

Attachments

AD:JN:jm

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November 14, 2019

To: Senator Alberta Darling, Co-Chair
Representative John Nygren, Co-Chair
Joint Committee on Finance

From: Ray Cross, President

Re: 2017-19 Report on Industrial and Economic Development Funds

With an economic impact of over $24 billion annually, the University of Wisconsin System (UW) is continuously engaged in economic growth for the state. One of the tools the UW uses to ensure its research mission translates into economic success is the Industrial and Economic Development Research Fund (IEDRF).

The funding for this program is distributed through two channels: 1) the Applied Research Program and 2) the Industrial and Economic Development Research/State Economic Engagement and Development (SEED) Program. These initiatives are intended to promote technology transfer and collaborative projects that stimulate economic development in Wisconsin.

Wis. Stats. s.36.25(25) (c) requires the University of Wisconsin System to report biennially to the Joint Committee on Finance regarding projects funded as part of the industrial and economic development research program in the previous fiscal biennium. The enclosed report is submitted for your review.

If you require any additional information regarding the Report on Industrial and Economic Development Funds, please contact Lisa McQueen (lmcqueen@uwsa.edu or 608-800-6717).

Enclosure

cc: UW System Board of Regents
David Brukardt, Interim VP for Corporate Relations & Economic Engagement
Rob Cramer, Vice President for Administration
Anny Morrobel-Sosa, Vice President for Academic & Student Affairs
Sean Nelson, Vice President for Finance
Dave Loppnow, Legislative Fiscal Bureau

Industrial and Economic Development Research Fund
2017-2019 Biennial Report

The Industrial and Economic Development Research Fund (IEDRF) was established in 1987 to enhance the relationship between UW System institutional research and Wisconsin industrial practices in an effort to promote the state's economic growth. Through the years, it has supported projects which have assisted a wide range of Wisconsin enterprises. These projects continue to improve the competitive position of Wisconsin businesses.

This report describes the activities supported by the IEDRF for the 2017-18 and 2018-19 fiscal years. The report is divided into two narrative sections and six appendices. The first narrative section details the Industrial and Economic Development Research Program (IEDR), which has also been referred to as the SEED (State Economic Engagement and Development) program since 2014. This program provides grants to faculty and staff at UW-Madison. The second section provides an overview of the Applied Research Program administered by the UW System Office of Academic and Student Affairs. These funds provide grants to faculty throughout UW System. .

Both the IEDR/SEED program and the Applied Research Program provide grants which are competitively awarded. Researchers are encouraged to submit technically innovative proposals that are of interest to a broad economic sector and that will immediately benefit Wisconsin's industrial and economic development. All projects are selected based on a combination of scientific merit and the potential for technology transfer. Grant summaries are provided in the appropriate sections.

Six appendices are attached which list all grants, investigators, campuses or departments, and the amounts funded by the IEDR/SEED and Applied Research programs. .

A. Industrial and Economic Development Research (IEDR) and State Economic Engagement and Development (SEED) Program – UW-Madison

The Office of the Vice Chancellor for Research and Graduate Education administers the IEDR/SEED program for the University of Wisconsin-Madison. The IEDR/SEED program seeks to stimulate and enhance research collaborations between UW-Madison and Wisconsin firms and to promote economic development in the state. University faculty and staff researchers submit proposals that are subject to a competitive selection process. A selection panel comprised of faculty, past entrepreneurs, representatives from technology transfer, and business development experts select technically innovative projects that will benefit Wisconsin businesses. The panel reviews each proposal for scientific and technical merit, while also taking into consideration the impact the research will have on the identified sector of the Wisconsin economy. Applicants for this program must have a financial or management interest in a company that has spun out of research performed at UW-Madison.

The IEDR/SEED program funded four projects during the fiscal year ending June 30, 2018 ($562,698) and five projects during the fiscal year ending June 30, 2019 ($600,000). Research titles for individual projects are listed in this report. The following points highlight some noteworthy facts and outcomes resulting from IEDR/SEED research program:

- Over the 2017-2019 biennium, IEDR/SEED funding supported collaborative research between UW-Madison scientists and Wisconsin businesses in Dane County.

- Faculty indicated that IEDR/SEED funding fundamentally demonstrates state and university commitment to translational research, solidifies research collaborations with companies, and leverages awards into further funding opportunities. Several faculty members noted the scarcity of such funding to directly support product development, making it unlikely that the research would have been undertaken without support from IEDR/SEED. Some specific feedback received includes:

    - Early stage funding through the SEED grant was vital in driving future commercial development of this technology in addition to academic research funds. Since the SEED grant was funded, the company has successfully competed for nearly $400,000 in additional funds. The Principal Investigator (PI) has also gone on to successfully compete for a nearly $1 million academic training grant. (Dr. Brian Johnson)
    - Funding provided to support this project played a critical role in achieving the research and development results outlined in this report. The funding supported research scientists as well as graduate students at UW-Madison during the 2017-2018 fiscal year, and their ability to focus on these efforts relied heavily on the availability of this funding source. (Dr. Mikko Lipasti)
    - Earlier support by the SEED program allowed design and initial purchase of the pilot electrodialysis stack and was invaluable. Other grant funding typically restricts this type of capital expenditure. The SEED grant concluded in June 2019 supported the creation of an outdoor pilot container with electrical hookups. This unit can be transported to wastewater treatment plants for future pilots, again invaluable. SBIR Phase I grants come with more limitations than SEED, which makes the SEED grant all the more valuable. (Dr. Phillip Barak)
    - The support of the Office of the Vice Chancellor for Research and Graduate Education (VCRGE) was critically important for our partner company Voximetry, Inc. Voximetry greatly benefited from the resources, infrastructure and scientific expertise available at UW-Madison. The support from VCGRE allowed Voximetry to complete critical aspects of product development and helped fill a funding gap between initial bootstrapping efforts and obtaining private equity investments. (Dr. Bryan Bednarz)
    - VCRGE funding support was extremely useful for gathering critical data that otherwise is not easily obtainable for individual investigators and small start-ups. For example, producing data that shows the ability to mill the lyophilized matrix into consistent dimensions is a vital step toward injectability experiments, large animal efficacy studies and FDA Chemistry, Manufacturing and Controls documentation required to enable Investigational New Drug human trials. In our extensive past experience, these are not the kinds of "development task oriented" experiments and optimization steps that are readily fundable from the NIH, American Heart Association, WARF or the regional/national investment community. (Dr. Amish Raval)
    - Successful completion of this SEED project will enable Synesis Nutrition, Inc. to specifically address investor concerns over de-risking early stage research, improving the company's ability to raise the necessary capital for successful commercialization of their enteral nutrition formula (Phytality™). (Dr. Jess Reed)
    - The SEED grant allowed us to further validate our technology and further demonstrate its utility in a broader range of therapeutic applications. The data produced and collaborations started in this work have a substantial potential for impact. (Dr. William Murphy)

- Data from IEDR/SEED projects allowed several faculty members to apply for and receive large research grants directly from federal agencies and subcontracts with partnering companies, which also received SBIR grants.

- As a result of IEDR/SEED research, some collaborating companies will achieve cost savings, plan to hire additional staff, and are in better positions to manufacture and market their products. This provides an economic boost directly to the State of Wisconsin.

- In addition to faculty and academic staff, several graduate and undergraduate students, as well as postdoctoral fellows worked on these projects. Many of these trainees received training for high-tech jobs and subsequently moved from UW-Madison to jobs in technology companies.

- Researchers have already submitted or published 14 research papers in peer-reviewed journals and conference proceedings. Additional papers are either in progress or planned.

B. Applied Research Programs

The University of Wisconsin System (UW System) Office of Academic Programs and Educational Innovation (APEI), in collaboration with WiSys, offers three Applied Research grant programs to UW System faculty and academic staff. These grants support the creation and transfer of innovations from the UW System to the marketplace with the aim of building a culture of innovation for a better future. WiSys Technology Foundation (WiSys), a 501 (c)(3) supporting organization of the UW System, administers these grant programs on behalf of UW System. UW System makes final decisions on grant funding.

The goals of the Applied Research programs are to develop advanced human potential and the knowledge economy that employs that potential. In particular, the Applied Research Grant (ARG) and Applied Research-WiSys Technology Advancement Grant (AR-WiTAG) programs help to promote technology transfer and economic development throughout Wisconsin and provide for broader impact beyond the state. The purpose of the ARG and AR-WiTAG programs is to encourage faculty and academic staff to apply their expertise and scholarship to the economic development of Wisconsin. The Prototype Development Fund (PDF) grant program supports research and development intended to advance the commercial potential of technologies developed through the UW System and assigned to WiSys.

The ARG and AR-WiTAG programs are competitive. Principal investigators from UW System institutions submit proposals documenting their realizable applied research goals and objectives, a detailed work plan, and funding requirements to achieve outcomes that may result in societal and/or economic impact to the state including intellectual property protection, technology transfer, business expansion and profitability, and job creation. A panel comprised of representatives from the private sector with expertise in business and technology, a representative from WiSys, and a representative from APEI reviewed and rated proposals.

For the 2017-18 and 2018-19 programs, 94 applications were received with requests for more than $4 million in funding. Thirty-six (36) awards were made over the two fiscal year cycles including 10 ARGs, 13 AR-WiTAGs, and 13 PDF grants (Figure 1). A total of $1,121,458 was awarded to institutions across the UW System, with 30 of 36 going to four-year comprehensive campuses.

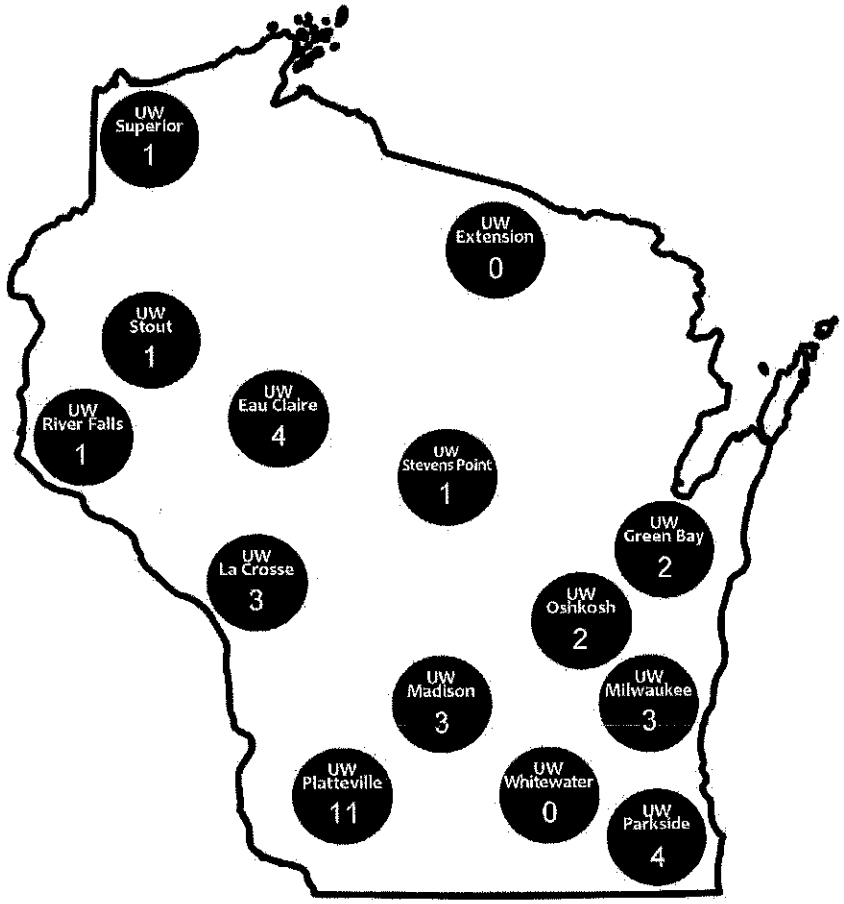

Figure 1. 2017-18 and 2018-19 ARG, AR-WiTAG and PDF projects funded by campus

Specifically, in 2018-19, the grant programs received 53 applications for funding, requesting a total of $2,228,752. Four (4) ARG proposals were funded by UW System in the total amount of $163,216. Seven (7) AR-WiTAG proposals were funded by UW System in the total amount of $300,056. UW System provided further funding to support seven (7) Prototype Development Fund grants totaling $90,588. In addition, UW System provided a stipend of $80,029.94 to WiSys to cover patenting and licensing costs for technologies developed with the support of the Applied Research grant programs.

In 2017-18, the grant programs received 41 applications for funding, requesting a total of $1,853,119. Six (6) ARG proposals were funded by UW System in the total amount of $247,960. Six (6) AR-WiTAG proposals were funded by UW System in the total amount of $243,531. UW System provided further

funding to support six (6) Prototype Development Fund grants totaling $76,107. In addition, UW System provided WiSys a stipend of $65,634.96 to cover patenting and licensing costs for technologies developed with the support of the Applied Research grant programs.

While outcomes from the 2018-19 program are being finalized, the above funding from the 2017-18 Applied Research programs resulted in the following:

- Twelve invention disclosures, five U.S. patent applications and one international patent application;
- Eleven scientific publications in peer reviewed journals; nine student posters and two faculty conference presentations;
- Two industry collaborations with commercial partners RSoft and Ximbio;
- Job creation, providing support to 41 undergraduate students (7,681 hours), three post-doctoral associates, and 29 months of summer salary for faculty; and
- Submission of further applied research grants for follow-on funding from these agencies/programs: National Dairy Council, Wisconsin Humanities Council, NSF CAREER program, and NIEHS R21 program. $50,000 in UW System Regent Scholar funding awarded to UW Oshkosh faculty Dr. Yijun Tang for his work on novel glucose sensors. $750,000 in funding secured for UW-Platteville award recipient Muthu Venkateshwaran for his work on volatile organic compounds.

Applied Research Program (ARG) Awards, Fiscal Year 2018-19

See Appendix E for a list of investigators, institutions, project titles, and amounts of the awards.

1. Moderators of the Effects of Social Isolation, Loneliness, and Work-Family Conflict on Long Haul Driver Well-Being and Turnover,
   (PI: Heather Clarke, UW-Green Bay)

   Turnover rates in the trucking industry are perpetually high. With a ninety-day rate in excess of 300% and an annualized rate of 95%, turnover poses a serious threat to competitive advantage in this industry. Neither current best practices in the industry nor the Department of Transportation's safety compliance program address psychosocial phenomena such as social isolation, loneliness, and work-family conflict, despite the demonstrated negative impact of these stressors on health and well-being. The proposed project aims to examine social isolation, loneliness, and work-family conflict experienced by long-haul truckers and their effects on driver health and well-being and turnover. Further, this research will identify both individual- and organizational-level variables that might buffer the effects of these stressors, with a view to developing a set of recommendations and a concomitant implementation plan.

2. ROS-Activated Prodrugs that Target Cancer Cells,
   (PI: Xiaohua Peng, UW-Milwaukee)

   A major problem of cancer chemotherapy is host toxicity. To overcome this problem, the development of anticancer drugs that exploit the unique biochemical alterations within cancer cells is an attractive approach to achieve therapeutics selectivity. The high oxidative stress found in cancer cells compared to their normal counterparts allows for anticancer prodrugs to be activated to a toxic form only when exposed to the cancer cell's internal milieu. The overall objective of this research is to develop a novel class of selective anticancer prodrugs to treat breast cancer. The team's approach focused on chemically optimizing drug candidates with selective reactive oxygen species (ROS)-triggered DNA alkylation efficacy to improve their metabolic stability and pharmacokinetic properties. In addition, xenograft and transgenic mouse models will be used to demonstrate the antitumor effects of optimized drug candidates. This work will establish the feasibility of H_2O_2-activated anticancer prodrugs in relevant animal models and set the stage for future development as a breast cancer therapy. As the global market for breast cancer drugs reached $11.97 billion in 2016 and is anticipated to reach $22.35 billion by 2023, this novel approach that specifically targets cancer cells is expected to have a great economic impact in Wisconsin.

3. Developing Assessment Measures for Women's Building Construction Trade Pre-Apprenticeship Andragogy,
   (PI: Heidi Wagner, UW-Madison)

   The proposed project aims to investigate best practices to support women's entry and success in the building construction trades. The inquiry will investigate optimal procedures for recruitment of women for the building construction trades; how best to rapidly train and orient women to acquire jobs and find success in the construction industry (looking at job acquisition timelines and retention); and what contributes to women's job acquisition and retention. The applied research project proposes creating a four-weekend (44 hour) pilot pre-apprenticeship program supporting women's entry into the building construction trades. The pre-apprenticeship program will initially run in the Madison area. The

curriculum will provide a general orientation to different career opportunities, connections to local building trade union representatives, tradeswomen, and contractors as well as hands-on building activities including experience with at least three different trades.

4. Development of Secure Secret/Private Key Management Method for the Edge Nodes of the Internet of Things (IoT) Networks,
(PI: Weizhong Wang, UW-Milwaukee)

   The proposed project aims to develop a new security function for IoT devices by leveraging a fundamental physical property inside existing semiconductor integrated circuit (IC) chips. The developed technology will provide a novel security solution by developing a means of storing encryption keys inside existing Field Programmable Gate Array (FPGA) IC chips both securely and secretly. By implementing into existing systems, companies will benefit from the added security function without having to incur additional hardware costs. The proposed research aims to demonstrate the feasibility across multiple FPGA models, technology nodes and reliabilities against device aging.

Applied Research-WiSys Technology Advancement Grant (AR-WiTAG) Awards, Fiscal Year 2018-19

See Appendix E for a list of investigators, institutions, project titles, and amounts of the awards.

1. Wireless Devices for School Security,
(PI: Sergei Bezroukov, UW-Superior)

   School security is a large area of concern and consideration. This project aims to address a need identified by teachers within the Superior School District. In the school setting, there are problematic situations that can challenge staff and require additional help, such as behavioral problems, health issues and security concerns. Although there are commercial security devices available to schools, these are often very expensive and do not meet the wide array of needs identified by educators. The proposed project aims to adopt a new top-notch technology that is easy to operate, lightweight and more affordable than the existing commercial products available. The project aims to design a lightweight, long-range, high-power wireless system for sending alarms from various school facilities directly to the administration office, and to develop a Bluetooth mesh network connecting short range, low-power personal alarm transmitters to propagate within a building through the network and send a call for help.

2. Continuous Monitoring of Airborne Silica for Worker Safety and OSHA Compliance,
(PI: James Boulter, UW-Eau Claire)

   This project entails the establishment of a novel analytical method and development of an instrument to quantify respirable, airborne silicon-containing particles. Analysis techniques for particulate silica currently meeting federal standards require that an 8-hour sample be collected by filter, potentially imposing time delays of days to weeks between silica quantification and any response to prevent exceeding the new federal standard and to mitigate negative health impacts of workers. The proposed project aims to develop an instrument to monitor particulate silica on-site and in real-time that could be integrated into engineering controls, encouraged in the recent OSHA regulations, to respond to and suppress elevated levels of respirable silica particles. In Wisconsin, just the industrial sand mining and processing industry has been estimated to employ on the order of 3,000 Wisconsin workers and

contribute to millions of dollars to state tax revenues annually. Workers exposed to respirable particulate silica may acquire chronic respiratory diseases most commonly including silicosis, lung cancer, chronic pulmonary obstructive disease and kidney disease that lead to disability, respiratory failure and premature death.

3. Stimuli-Responsive Polymer Dispersants for Architectural Coating Applications,
(PI: Elizabeth Glogowski, UW-Eau Claire)

Properties of stimuli-responsive polymers change dramatically in response to a small change in an external stimulus such as temperature or pH. The stimuli-responsive properties of poly [(2-dimethylamino) ethyl methacrylate] or PDMAEMA, including solubility, viscosity, and interfacial activity, can be controlled by changing the polymer structure. PDMAEMA-based copolymers will be investigated for their use as stimuli-responsive polymer dispersants. Combining stimuli-responsive behavior with polymer dispersant functionality will improve applications where controlled dispersion is critical. Potential applications range from catalyst systems to filler and abrasive materials. This project will focus on using these stimuli-responsive polymer dispersants for architecture coating applications, such as interior house paints and deck stains. Adding stimuli-responsive behavior to architectural coatings will potentially improve current dispersant technology. Preliminary results have shown that PDMAEMA-containing copolymers have unique stimuli-responsive viscosity and interfacial activity properties can be synthesized in a more environmentally friendly and cost-saving way. The proposed project aims to test the effectiveness of different PDMAEMA copolymer structures for architectural coating applications.

4. Mechanically Integrated Wind Power Generation Systems,
(PI: Md Maruf Hossain, UW-Green Bay)

Wind-powered energy generation currently lacks optimized energy output due to the constraints of the need for a 1-to-1 wind turbine-to-single electrical power generator. This project aims to create a system of mechanically integrated vertical axis wind turbines (VAWTs) that will connect to a single unit generator and electronic interface to more efficiently and cost-effectively produce electricity. Energy generation efficiency and operational cost-savings will be realized by powering the network of wind turbines from one single generator, connecting the VAWT system to a single drive train from a remote single generator allowing for a reduction in the size and weight of each turbine; and reducing the size and weight of the overall VAWT system to increase efficiency by reducing the inertia of each turbine. The proposed project will develop a prototype to demonstrate the increased capacity of wind power of the proposed integrated VAWTs system over the conventional single unit VAWT.

5. Development of a Non-Destructive Technique for Interior Cracking Detection and Stress Evaluation for Concrete Structures Based on Diffuse Ultrasound Coda-wave Interferometry and Three-Dimensional Imaging,
(PI: Hanwan Jiang, UW-Platteville)

The objective of the proposed project is to develop a comprehensive approach that is sensitive to weak changes in concrete structures and capable of imaging multiple crack locations and depth, as well as stress change distributions. Currently, most non-destructive testing (NDT) techniques available in the market are either not sensitive to minor interior changes in concrete such as small cracking and stress changes, or not applicable to full size structures on site. Furthermore, there are no mature products currently available that are capable of imaging multiple cracks and evaluating stress in concrete structures. The proposed project aims to integrate code-wave interferometry, ultrasound diffusion

theory, and inversion-based imaging technology into a comprehensive method to locate interior cracks and evaluate stress change in a concrete structure. The proposed research will lead to more economical, efficient, and quality solutions for the detection of internal cracks and stress of concrete members, so the early-stage damage of bridges can be recognized and the remaining capacity could be evaluated in a non-destructive and cost-effective way, enabling responsible agencies in Wisconsin and further afield to repair bridges early and at a lower cost.

6. Microbe-Facilitated Anthocyanin Extraction of Fruit Waste,
(PI: Francis Mann, UW-Parkside)

   A significant percentage of antioxidant natural products are retained in the pulp, skin, and seeds of fruits and vegetables after processing. Preliminary studies have examined the microbial digestion of fruit pulp as a mechanism for passively extracting high value natural products from agricultural waste products. Bacteria and fungi known to secrete enzymes capable of degrading the fruit waste matrix were incubated with fruit waste and the aqueous component was monitored for antioxidant content. The effect of microbial digestion on cranberry and cherry pulp resulted in improved aqueous extraction of the anthocyanins cyanidin and malvidin over controls. The proposed project aims to establish a baseline of metrics for technology comparison (e.g. enzymatic vs. microbial extraction); optimize and scale system for industrial application, and analyze extracted fruit waste for downstream utility, assessing total carbon and nitrogen content.

7. Development of Thermoplastic Biocomposite for 3D Printing,
(PI: John Obielodan, UW-Platteville)

   The proposed project aims to develop a proprietary formulation and processing method for blending two bio-based resources, polylactic acid (PLA) and organosolv lignin, to produce polymeric filaments for 3D printing applications. This formulation is anticipated to achieve at least 50wt% lignin loading in PLA, which represents a 900% increase from experimental Kraft-lignin based filaments (~5wt%), with less chemical processing steps than previously published results. Development of a biodegradable and bio renewable polylactic acid/organosolv lignin filament will create a low-cost, yet marketable multifaceted 3D printing filament. This new technology is expected to overcome the cost barrier of materials for 3D printing, ease the solid waste concerns, and convert the once-perceived waste lignin product to a higher value commodity.

Prototype Development Fund (PDF) Awards, Fiscal Year 2018-2019

See Appendix E for a list of investigators, institutions, project titles, and amounts of the awards.

1. Shape Sensitive Molecular Sieving Using Customized Nanoporous Silicon Membranes,
(PI: Gokul Gopalakrishnan, UW-Platteville)

   The proposed project aims to fabricate and test customized nanoscale filtration membranes for macromolecular separations that are difficult to achieve using conventional separation filters. Creating filtration channels that exploit the actual structural geometry of target molecules will yield uniquely tailored protocol designs with the potential to establish a new industrial market for the production of customized molecular sieves and nanoporous filtration membranes. The first step towards the goal of producing customized separation devices is to create nanoscale channels with precise dimensional control to separate macromolecular species (e.g., proteins, carbon nanotubes or other nanoscale

systems) with differing aspect ratios from a simple binary mixture. The project aims to demonstrate a proof-of-principle separation or selective concentration of one type of species from another.

2. 1Swipe Prototype v2.0,
(PI: Gokul Gopalakrishnan, UW-Platteville)

   This project is focused on the design, manufacture, and testing of second-generation prototypes of 1Swipe, a patent-pending, full whiteboard or blackboard eraser that can be pushed across to erase everything in its path, saving time and solving the issue of inefficiency in the classroom for STEM professors. The new prototypes will be designed to overcome the weaknesses the first prototype had and to make the product more attractive commercially for potential buyers, as well as to allow professors to use it in their classrooms. In order to obtain a wide range of data from multiple products and end users, three prototypes will be manufactured and placed in three different classrooms across the UW System. Under the proposed project, the prototypes will be monitored to determine the best configurations and increase their longevity. End users will be asked to give feedback throughout the semester to further better the product.

3. Fabrication and Characterization of Zno/Graphene Nanocomposite Thin-Films,
(PI: Seth King, UW-La Crosse)

   The proposed project aims to fabricate uniform, transparent thin-films of a ZnO/Graphene nanocomposite material. While the nanocomposite nanoparticles themselves have shown utility for battery technology and/or photocatalytic devices, the fabrication of thin-films enable the materials to be used in consumer electronic devices, further expanding their market applications.

4. Enantiodivergent Synthesis of Benzybornyl Derivatives,
(PI: David Lewis, UW-Eau Claire)

   The proposed project will test a new approach to the synthesis of 3-benzylisobornylamines and their regioisomeric 2-benzylepibornylamines from a single enantiomeric form of camphor and will prepare them for testing as chiral auxiliaries and chiral organocatalysts. The aim of this research is to develop compounds that are effectively enantiomeric in their reactions at the amino group without regard to the enantiomer of camphor that is chosen as starting material, allowing the much less expensive (1R)-(+)-camphor to used. If successful, such research would allow the preparation of either "enantiomeric" diastereoisomers of chiral organocatalysts or chiral auxiliaries with opposite effective chirality from the same enantiomer of the starting ketone.

5. Development of the Prototype for a Semiconductor Quantum Dot Computer Aided Engineering (CAE) Simulator,
(PI: Wei Li, UW-Platteville)

   Quantum dot (QD) materials possess many novel applications in the electronics, photonics, renewable energy, and medical device industries. To reduce the fabrication and R&D cost involved in developing new QDs for these respective applications, a QD computer aided engineering (CAE) tool will be developed addressing an unmet need in the market for industrial and academic end-users. The objective of this project is to develop a protype for a commercial QD CAE simulator tool. The goal is to develop the CAE tool to a point where it is capable of simulating and designing QD structures with various III-IV semiconductor materials and arbitrary shapes in less than one hour with a standard HP Z840 workstation.

6. Continued Development of the Prototype for a Semiconductor Quantum Dot Computer Aided Engineering (CAE) Simulator,
(PI: Wei Li, UW-Platteville)

   Preliminary research conducted under an earlier PDF has led to the development of a semiconductor QD CAE simulator for industrial and academic end-users. The objective of this follow-up project is to continue development of the simulator while removing spurious solutions identified during earlier R&D.

7. Retrofit Peltier Device for Cooler,
(PI: William Parker, UW-Parkside)

   The proposed project is focused on the prototype development of a new retrofittable Peltier device for cooler technology. The device under development has potential to turn any insulated container into a mini refrigerator, eliminating the need for ice in a cooler. The focus of this project is to improve the energy efficiency and cost of manufacture of the device.

Applied Research Program (ARG) Awards, Fiscal Year 2017-18
See Appendix F for a list of investigators, institutions, project titles, and amounts of the awards.

1. Building Precipitation & Groundwater Forecast Tools for Wisconsin's Central Sands,
(PI: Paul Block, UW-Madison)

Numerous sectors and activities in Wisconsin's Central Sands are strongly connected to local water resources. Specifically, this project explored the implications of varying interannual hydrologic and climate conditions on agriculture and real-estate property. The first part of the project focused on designing and building season-ahead climate forecast tools to guide decision-making and planning. The second part of the project explored the relationships between precipitation, particularly wet and dry years, lake levels, and real-estate value. Clear associations between precipitation and future real-estate value are anticipated to explain expected housing market fluctuations.

The project resulted in the construction, validation, and measurement of the performance of June-August seasonal precipitation forecast models, creation of a tool to illustrate the potential utility of the forecasts in agricultural planning, and quantification of the value of interannual climate variability on lake-front and non-lake-front residential real-estate property. Results from the project yielded primary modes of atmospheric moisture transport, observed to be highest during strong La Niña events, and the precipitation forecast model performance, which was seen to be modest, however more skillful with respect to forecasting drought conditions. Analyses performed with real estate transactions and hydrologic data indicated non-lakefront residential real estate is relatively insensitive to interannual changes in hydrologic conditions whereas a relatively strong positive relationship exists between interannual changes in hydrologic conditions and lakefront real estate.

2. OnRamp: A Parallel and Distributed Computing Learning Environment,
(PI: Samantha Foley, UW-La Crosse)

OnRamp is a web portal for teaching parallel and distributed computing. It aims to make using parallel and distributed computers easier, while learning parallel and distributed computing concepts. The existing tool was primarily designed for computer science education at the university level. This project focused on expanding the existing tool to other potential users and specifically aimed to prototype implementation of OnRamp to a solid open-source project available for a wide range of uses in teaching, research, and business.

Over the course of the project, progress was made toward increased robustness, usability, security, and scalability through improvements in the web front-end and back end. A new module was created and tested that simulates a common biological growth pattern – expanding the types of applications which are included in the project.

3. Development of Protein Hydrogels-based Antibody Purification Columns,
(PI: Ionel Popa, UW-Milwaukee)

Antibody elution methods are widely used in biotechnological companies and academic research laboratories as a diagnostic and purification tool. Such methods represent a significant market share in the biological pharmaceutical market, with a value of over $50 billion. This project aimed to develop a new method to purify antibodies based on formulating hydrogels of polyprotein domains that are known to bind antibodies in vivo. Unlike the traditional surface immobilized binding site methods, this

approach produces binding sites throughout a 3D hydrogel material. Hence, it was expected to provide an improvement on the retention time and yield over current conventional antibody purification methods.

To date, this project has resulted in the engineering of all the polyprotein constructs proposed; their testing for retention capacity. Briefly, the proteins were formulated as solid hydrogel columns, which during testing, would clot after several uses. This prevented the realization of the natural pH elution approach, via mechanical force. To overcome these difficulties, the hydrogels were formulated into beads, which allowed larger aggregates to flow around, and small molecules to diffuse inside. The best results came from producing double network (DN) alginate/L_8 beads by ionically crosslinking sodium alginate using calcium chloride and covalently crosslinking the L_8 polyproteins using a gelation process. These beads are easy to formulate and control their physical properties such as stiffness, porosity and swelling behavior. Alginate/L_8 beads can operate under acidic elution conditions, and sturdy enough to withstand a high-speed centrifugation that will decrease the elution process time. Determination of optimal protein concentration that would result in better antibody retention than competing products, at a cost-effective point is underway. In addition, the chimera constructs have been engineered with antibody-binding proteins and fluorescence domains. These constructs can be turned into hydrogels that retain their fluorescence and can be used in solution to develop antibody bands in western blots.

4. Finding Their Place: A Comparative Study of Refugee Resettlement in Local Communities and Economies,
(PI: Paul Van Auken, UW Oshkosh)

Globally, 68.5 million people were forcibly displaced in 2017, setting a new record for the fifth straight year. Oshkosh welcomes the second-largest number of refugees in Wisconsin. The Oshkosh Resettlement Task Force asked that applied research be conducted around questions such as:

- How did residents with refugee background (RRBs) end up in Oshkosh?
- What factors help predict their success?
- What can help them thrive?

Under this project, surveys were collected from RRBs and in-depth interviews were conducted with RRBs and service providers. This funding enabled the team to continue the original project while expanding it to Milwaukee, Madison, and Seattle for a comparative study.

The original goals included collecting 75-100 surveys, 20 RRB interviews, and 10 service provider interviews in each of the three Wisconsin sites (Seattle was added later). RRBs are challenging to recruit because their lives are very challenging. They also often face significant language barriers. Further, refugee resettlement has become a politicized topic over the past two years. Some RRBs are hesitant to communicate with people such as researchers they do not know. Finally, it took longer than expected to successfully break into the expansion areas, though they have recently built momentum, particularly in Milwaukee. Data continues to be collected. To date, contact has been made with more than 155 RRBs who expressed interest in participating, and more than 100 RRBs have been surveyed and/or interviewed. Further, more than 30 service-provider interviews have been completed to date. In addition, the development of a photo exhibit based on the study is under way. Writing has also begun on the vision for a refugee service hub and a tool kit for refugee resettlement and it is anticipated that documents will be finalized upon completion of the data analysis.

5. Development of Materials Capable of Controlled Delivery of Volatile Organic Compounds (VOCs) to Plants for Defense against Pathogens,
(PI: Muthu Venkateshwaran, UW-Platteville)

Plant diseases are one of the major biotic stresses to plants affecting crop yields. Extensive use of fungicides in plant disease management results in resistance build up in pathogens and poses threats to human health and ecosystems. Volatile organic compounds released from plant growth promoting rhizobacteria have been shown to control plant diseases. This project identified a set of promising bacterial VOCs that are effective in activating salicylic acid- and/or jasmonic-acid-mediated plant defense signaling pathways. This project developed nanoparticles encapsulating bacterial VOCs, which can be used in the control of major crop diseases, such as white mold of soybean.

The project screened a total of 12 bacterial VOCs and two positive controls (methyl-salicylate and methyl-Jasmonate) for their ability to activate either SA or JA-mediated defense signaling pathways in Arabidopsis thaliana, Medicago truncatula and rice. RT-PCR and promoter-GUS fusion studies were utilized to monitor defense gene expressions. The antimicrobial properties of bacterial VOCs were tested on plant pathogens, such as Sclerotinia sclerotiarum, Exserohilum turcicum and Colletotrichum graminearum. The influence of test VOCs on growth and development of model plants (mentioned above) and crops (corn and soybean) was also tested. The project identified the VOCs that have inhibitory, neutral and plant-growth promoting attributes. The most promising VOCs identified in objective 1 were selected for encapsulation in biopolymer-based nanoparticles. Polymers, such as poly lactic-co-glycolic acid (PLGA), polylactic acid (PLA), polycaprolactone (PCL) were tested to develop nanoparticles to encapsulate 2-octanone, propiophenone and 1,3-butanediol. The encapsulation of VOCs in nanoparticles was verified using HPLC and observed under scanning electron microscope to measure the size and uniformity of particles for controlled release of VOCs. 40-150 µl of 2-octanone per gram of nanoparticles was encapsulated. The VOC-encapsulated nanoparticles prepared in activated the plant defense signaling pathway similar to that of un-encapsulated VOCs.

6. Development and Application of Natural Food Preservatives,
(PI: Jae-Hyuk Yu, UW-Madison)

Aflatoxin contamination and foodborne pathogens are among the most worrying problems for global food safety and public health. Aflatoxins are a group of carcinogenic and immunosuppressive fungal toxins that threaten global food supply. Over 4.5 billion people are chronically exposed to aflatoxins through their food. Every year, nearly one in five (17%) of Americans become sickened from eating food contaminated with pathogens. The resulting losses of productivity represent a significant level of economic loss. The misuse of antibiotics has resulted in the development of microorganisms that are resistant to antibiotics and tolerant to general food processing. There are crucial needs for new generation of food preservatives of "natural origin" to prevent food spoilage, toxin contamination, and foodborne illness and to meet the consumers and manufacturers demands. This project aimed to develop a heat-stable non-enzymatic based natural preservative (NP) derived from edible food grade fungus Aspergillus oryzae that has prolific antibacterial and antifungal activity against most common problematic foodborne and spoilage pathogens.

Over the course of this project, the Generally Recognized as Safe (GRAS) fungus Aspergillus oryzae was isolated, sequenced, and used to control aflatoxin contamination and foodborne pathogens. The result demonstrated that live cells of the soy-fermenting strain A. oryzae effectively inhibit aflatoxin production and proliferation of toxigenic A. flavus. Moreover, cell-free culture filtrate of A. oryzae effectively inhibited Aflatoxin B1 (AFB1) production and A. flavus growth, indicating a potential secretion of inhibitory compounds. Whole genome sequencing and comparative analyses indicate that the A. oryzae genomes are 37.9 Mbp and the isolate is lacking aflatoxin producing genes. Ethyl acetate

extract of the fermentate displayed significant anti-bacterial activity against common foodborne pathogens including Listeria monocytogenes, Staphylococcus aureus, Salmonella typhimurium, and Escherichia coli O157:H7 with minimum inhibitory concentration (MIC) of 0.78%, 1.56%, 12.5% and 25% (v/v), respectively. Furthermore, the ethyl acetate extract showed activity against Methicillin-resistant S. aureus (MRSA) (MIC=3.125%) and Candida albicans (MIC=6.25%) (v/v). Furthermore, the crude fermentate itself displayed noticeable anti-fungal activity against A. flavus (plant pathogen) an and Penicillium roqueforti (food spoilage organism). The candidate molecule(s) responsible for antimicrobial activity is a heat-stable, non-protein-based agent that exhibits strong bactericidal activity particularly against Gram-positive bacteria. Overall, this study demonstrated the possible use of A. oryzae and its cell-free culture fermentate as a biocontrol agent to control A. flavus propagation and aflatoxin contamination in fields, and food and feed. Additionally, A. oryzae fermentate produced naturally appears to provide a prolific antimicrobial potential against major foodborne and human pathogens and may be exploited further in the search for new antimicrobial compounds.

Applied Research-WiSys Technology Advancement Grant (AR-WiTAG) Awards, Fiscal Year 2017-18

See Appendix F for a list of investigators, institutions, project titles, and amounts of the awards.

1. Nanoscale Vacuum-channel Field Effect Transistors from Aligned Carbon Nanotubes,
(PI: Harold Evensen, UW-Platteville)

   This project attempted to demonstrate a proof-of-concept carbon nanotube (CNT)-based, vacuum-channel field-effect transistor (VFET). Current in a VFET comes from the transport of electrons across a vacuum. Advantages over "vacuum tubes" include easier fabrication and lower power consumption. Advantages over silicon electronics include power handling, ruggedness, and high frequencies. The devices have two electrodes separated by 200 nanometers (nm) deposited onto a monolayer of semiconducting CNTs (the third "gate" electrode is beneath the film). A 50 nm-wide vacuum channel of CNTs is cleared next to an electrode, creating a "point-plane" geometry to facilitate field emission of electrons from the CNT ends.

   Data generated to date has shown the transistors demonstrate a current tunable via a gate voltage. Achieving this involved the development and optimization of the electrode design; the multiple-step fabrication and testing process; improvements to throughput and chemistry/processing; and improvements to the test/measurement process. The VFET structures were fabricated, but they initially failed. There were two main problems: (1) currents were too small; (2) significant gate leakage occurred. These were fixed by (i) increasing the CNT network density and by increasing the width of the electrodes so there were more CNTs per device; (ii) switching to a thicker oxide layer. This is as far as the project has progressed due to the fabrication difficulties. It was later determined that the "recipe" had been developed with anomalously thick polymer; when this was replaced, it undermined the entire fabrication process. It was also learned that the new silicon wafers had very poor oxides; a change in supplier addressed this issue, and it was resolved by the end of the grant period.

2. Modular Chemical Probes for Detection of Citrulline Amino Acid,
(PI: Dmitry Kadnikov, UW-Stout)

   Citrulline is an amino acid which production in proteins is linked with development of multiple sclerosis, rheumatoid arthritis, and other autoimmune diseases. Efficient detection of this amino acid is thought to lead to a better understanding of its role in the development of the diseases, and maybe even result in the development of diagnostic tools. The overarching goal of this research is to develop new chemical methods of citrulline detection using small organic molecules as modular probes. The

specific goal of this project was to establish a feasibility of the approach to the design of the modular chemical probes and to synthesize several "proof-of-principle" probes.

The synthesis of model probes with the diketone and ketoester reactive heads was achieved. A silyl-protected benzyl chloride reagent was successfully synthesized and used to synthesize further probes. Synthesis of the remaining probes was postponed until the reaction conditions for the synthesis are optimized using the model probes. All synthesized reactive heads were successfully reacted with a model small molecule N-ethylurea demonstrating the ability of the reactive heads to attach to the urea group of the citrulline side chain. Development of the optimal conditions for the detection of protected citrulline or citrulline-containing peptides have been hindered by the difficulties in synthesizing required model compounds.

The team is currently examining the reaction of N-ethylurea under aqueous conditions and plans to continue the work with citrulline-containing peptides. The reaction conditions of the click reaction were studied using the already synthesized model system and it was discovered that the yield decreases in aqueous systems. Since the ultimate goal is to detect citrulline under physiological conditions, another model azide was synthesized, containing a more hydrophilic PEG-based linker and the team have commenced studying its click reaction with phenyl propargyl ether. The scope of the readout tags has been expanded and the PEG-based hydrophilic azide has been attached to the coumarin fluorophore and to biotin.

3. Efficient Big Data Transfer Service (BigDTS) through Networks,
(PI: Daehee Kim, UW-Stevens Point) – Project terminated, and no final report received.

Large amounts of data through networks are caused by the increase in amount and size of data. Large portions among the data are redundantly delivered through networks. The proposed study aimed to design and develop an Efficient Big Data Transfer Service (BigDTS) that removes the redundant data transfer by avoiding sending duplicate data from server to client. Thus, BidDTS aims to reduce network traffic to ISP networks, as well as increase throughput and decrease time delay at end users. BigDTS consists of a centralized controller, virtual routers (called middle boxes), and client and server programs. Servers maintain chunks of files Middles boxes cache chunks of files passing the network. Servers and middle boxes communicate with a centralized controller that has global network information and locations of chunks. With a file request from a client, the controller has servers send unique chunks and has middle-boxes (which are close to clients) send duplicate chunks to clients, removing the redundant date transfer from servers to middle-boxes (in networks).

4. Low-Cost Zinc Oxide/Graphene Nanocomposite Thin Films for use as Transparent Conductors,
(PI: Seth King, UW-La Crosse)

This project sought to find a low-cost and environmentally friendly method to fabricate nanoparticles of zinc oxide and graphene. Such nanoparticles could then be cast into thin-films for applications in consumer electronics, biological sensors, and energy harvesting.

A novel method of synthesizing ZnO/Graphene nanocomposites was developed using the thermal decomposition of zinc oxalate and graphene platelets. This process was found to be extremely successful in the production of bulk powders, and will be easily scalable. Currently, work continues to cast dispersions of these powders into uniform films.

5. Computer Aided Engineering of Semiconductor Quantum Dots: Design and Non-Destructive Characterization,
(PI: Wei Li, UW-Platteville)

The project aimed to deliver a semiconductor quantum dot (QD) computer aided engineering (CAE) simulator capable of calculating the QD electronic and optical properties accurately and efficiently, which will lead to the first commercial QD design simulation software in the market. QD geometric shapes play a critical role in the material properties. Currently, to determine the QD geometric structure, some destructive characterization techniques, such as scanning tunneling microscope (STM) method, are commonly used. This project applied the CAE tool to investigate QD optical spectra due to the geometric symmetry of QDs. From the optical spectral measurement, it is possible to inversely determine the QD geometric shapes and distributions to avoid any destructive procedure.

Based on the success of the alpha version semiconductor QD design simulator developed under earlier applied research funding, the team successful developed the beta version of the simulator. The simulator can calculate the electronic and optical properties of various QD shapes with full consideration of band mixing and lattice strain effects. The project implemented a non-destructive characterization technique in the solver. The project developed a finite element method (FEM) to calculate QD strain effects. The new method can even simulate the QD energy change due to the external force, which is of great importance for sensor related applications. As the project progressed, some spurious solutions for certain specific QD configurations were identified and progress towards solving these is currently underway.

6. Identification and Isolation of Novel and Safe Disinfectants from Sustainable Wisconsin Based Sources,
(PI: Daryl Sauer, UW-Parkside)

There are many botanicals that have been anecdotally associated with antibacterial properties (i.e., cranberries, mustard, celery seed, etc.), however, in many cases a systematic evaluation of the compounds responsible for the proposed activity has not been done, nor has the spectrum of antibacterial activity of the compounds been evaluated. As such, there is little reported research directed toward identifying suitable botanical agents as improved solid surface disinfectants. This research was directed toward identifying novel and effective botanically derived antibacterial agents that would be suitable for surface disinfection. This study aimed to utilize microwave assisted extraction which is a novel approach in this area. It has been demonstrated that microwave assisted extraction is environmentally friendly, saves time and energy, and allows for the isolation of compounds that are not obtained via traditional extraction methods.

Prototype Development Fund (PDF) Awards, Fiscal Year 2017-2018
See Appendix F for a list of investigators, institutions, project titles, and amounts of the awards.

1. Novel Chemotherapeutic Compounds that Reduce Melanoma Cancer Stem Cells,
(PI: Cheng-Chen Huang, UW-River Falls)

This project was designed to isolate compounds that specifically target cancer stem cells. The project aimed to identify novel chemotherapeutic compounds that can control the growth, metastasis, and relapse of melanoma cancer and possibly other types of cancer. The study demonstrated the therapeutic potential of two lead compounds, SK0408 and SK0459, in suppressing melanoma cell growth and metastasis by reducing melanoma stem cells through promoting melanocyte

differentiation. Using the MTT cell proliferation assay, inhibition of melanoma cell proliferation was consistently observed with treatment of SK0408 and SK0459. In addition, SK0408 and SK0459-treated melanoma both showed significant reduction in cell invasion ability.

Using the well characterized WNT signaling activity as a marker for stem cells, the study also confirmed that SK0408 and SK0459 reduced stemness by inhibiting the WNT signaling. Furthermore, when tested in MCF-7 breast cancer cells, no growth inhibition was observed, suggesting that SK0408 and SK0459 could be specific for melanoma. In additional experiments, it was further demonstrated that SK0408 and SK0459 both promote differentiation of melanoma cells, which could explain the reduction of melanoma stem cell. Further studies tested the safety of SK0408 and SK0459 using a standard mutagenicity assay called Ames test. The results showed that neither SK0408 nor SK0459 is a mutagen which holds promise for both drug candidates.

2. 3-endo-(Arylmethyl)isoborneols as Chiral Organocatalysts,
(PI: David Lewis, UW-Eau Claire)

This project investigated a number of compounds to determine their suitability as catalysts for preparing organic compounds in one of two "handed" (chiral) forms that are designated R and S. The chiral forms (i.e, just one-handed form) of such compounds can have dramatically different properties: e.g., the S form of naproxen is an excellent NSAID, but the R form causes irreversible liver damage—only the S form is sold to the public. This sought to make just one form of a wide range of pharmaceutical precursors in their chiral forms.

Unfortunately, progress on this project has been disappointing at best. It was found that the alcohol for which the study held so much hope was a complete failure in the three reactions that the study had hoped to exploit. In addition, attempts to circumvent the process and make different chiral organocatalysts by starting from camphene and α-pinene led to some interesting chemistry, but no functional chiral organocatalysts. With the failure of the alcohol to give the desired organocatalytic effects, the study turned to the possibility of incorporating a nitrogen atom in the place of the alcohol oxygen, in the hope that this would provide a more strongly basic site for the electrophile to interact with. These attempts failed: the project was unable to prepare the hydrazone, the phenyl hydrazone, or substituted phenylhydrazones of 3-endi-cbenzylcamphor, which was planned to reduce by catalytic hydrogenation. A new approach that shows some potential involves the Kishner cyclopropane synthesis and then a cyclopropane ring opening by nitrosyl chloride to give a suitable precursor. It is anticipated that this further work will be explored under a new grant.

3. Development of a Mineral-Dye Composite with Improved Fluorescent Properties for Phenol Detection,
(PI: Zhaohui Li, UW-Parkside)

The objective of the project was to develop a clay-dye composite for phenol detection and quantification using a fluorescence dye and a host swelling clay mineral. The project aimed to optimize the best fabrication condition (pretreatment of clay, initial dye concentration, and loading of activated microcrystalline cellulose) for the composite and evaluate various types of contaminants to be detected by the composite.

Maximum fluorescence of the composite was achieved at an initial dye concentration of 0.1 mM and a ratio of activated microcrystalline cellulose (AMC) to dye/clay of 1:1.2 maximum. More than a dozen contaminants in aqueous solution were tested for fluorescence quenching of the composite and phenols and chlorophenols had good responses between their concentrations and fluorescence quenching. In

addition, the composite also had good response to phenol in gas phase. In addition, dichlorophenol, trichlorophenol, tetrachlorophenol, pentachlorophenol, 4-aminophenol, and 4-nitrophenol also had good response for fluorescence quenching of the composite in the concentration ranges of 0.05 to 50 mM and fluorescence quenching increased with increase contaminant concentrations. However, the reproducibility is low and linear calibration is poor, mainly due to the segregation of the dye/clay composite from the AMC during the fabrication of test paper, due their differences in particle sizes and settling velocities. Thus, the composite test papers are not uniform in dye contents and further techniques to homogenize them during fabrication of test papers are needed.

4. Enzyme-Free Glucose Sensors based on Polymer/Cobalt Composite,
(PI: Yijun Tang, UW-Oshkosh)

This project aimed to fabricate a polymer/Cobalt sensor for detection of glucose, evaluate the performance of this polymer/Cobalt sensor, and improve the sensor according to the evaluation. The innovation of the project results from the use of cobalt, a metal expected to accelerate the reaction of glucose. A selected polymer functions as a support to fix cobalt particles on the surface of a sensor. This project aimed to evaluate the performance of such a newly designed glucose sensor.

In the detection of glucose using a polymer/metal sensor, the metal is the most critical component because it accelerates the reaction of glucose. The polymer also plays a role in the performance because it provides a support for the metal particles. In addition, the sensor material may also affect the performance of the sensor to some degree. As a result of research conducted under this project, it was determined that gold instead of platinum Au instead of Pt was to be used for the sensor material because no significant difference between these two materials was found. In addition, PVF polymer was selected over PANI polymer due to the fact that PVF provided cleaner response signals. The polymer/cobalt sensor was fabricated and its ability to detect glucose was tested and evaluated. Results have indicated that this polymer/cobalt sensor had potential utility as a glucose sensor but with a possible limitation: the large amplitude of absorption signal might interfere with glucose signals under some circumstances. As a result, two further metals (Iridium and Palladium) were tested. Iridium, a metal in the same group as Cobalt, exhibited excellent results in detecting glucose with much less absorption interference. Further studies are under way as part of a UW System Regent Scholar award.

5. Production of Organosolv Lignin for 3D Printing Filament,
(PI: Joseph Wu, UW-Platteville)

The goal of this project was to use a proprietary organosolv method to obtain lignin, which has been an undervalued byproduct of the bio-ethanol production process. The project focused on developing applications for the use of such organosolv lignin for production of commercial biodegradable 3D printing filament that is cost competitive in the current market.

Over the course of the project, various extractions conditions to obtain soluble lignin solution were tested. Various temperatures (100, 110, 150 and 175 oC), acid concentration (1 v/v%, 8.3 v/v% and 10 v/v%) and the liquid- to-solid ratio (5, 10, 12, and 15) were evaluated for lignin extraction. The best conditions for extraction were found to be 175 oC, 8.3 v/v% acid, and 15 liquid-to-solid ratio in 50 v/v% ethanol solution for a higher yield of extracted lignin. The project also aimed to develop analytical methods to evaluate the lignin yield. Towards this, UV analysis was performed to determine the concentration of lignin as it has a light absorption at 279.6 nm. Gravimetric analysis was also

performed as another quantification method. FTIR analysis was used to confirm the functional groups of lignin.

The project also proposed to develop a procedure to recover lignin from solution and towards this goal, the most effective means of isolating the lignin was found to be by precipitating it at pH 2 and separating it from the solution by filtration. Lastly, the project aimed to extrude lignin with PLA to generate a filament. Lignin based filament with 10 w/w% lignin in PLA was produced and such filament was used to print a tensile test specimen and test their tensile strengths. The mechanical properties of specimens were determined: Tensile strength = 16.8 MPa; Stiffness = 1.5 GPa; and %Elongation = 3.1.

6. The Prototype Development of a Comprehensive Microgrid Energy Management System, (PI: Fang Yang, UW-Platteville)

This project proposed to develop a novel microgrid energy management technology and to test such a system in a simulated environment. Specifically, the project aimed to further advance the technology under a real-world microgrid environment. To achieve this objective, a physical microgrid and its monitoring framework were implemented in the Engineering building located at the UW-Fox Valley campus, based on which the real-world microgrid operation data are collected and applied to test the microgrid technology.

The project resulted in the implementation of a building-based, small-scale microgrid testbed with a monitoring and communication framework. The microgrid was built upon an existing building electric power system with the utility grid power supply, rooftop solar panels for green energy supply, and various building electric loads. In addition, the project installed a capacitor bank for reactive power supply, a metering system for microgrid operation monitoring, and a central microgrid management computer to store, analyze, and apply these data to test the new microgrid technology.

The team was able to implement the application test with the real-world microgrid operation data. The microgrid operation data was collected and stored. Based on these data, typical microgrid operation scenarios were selected as test cases regarding various weather types, load profiles, and disturbances. The operation data for test cases were applied as input to execute the microgrid technology in the central computer to provide microgrid management solutions. A post analysis was done using the solutions to examine the rationale behind the response of the microgrid technology to realistic scenarios, identify and correct hidden defects of the technology, and improve the microgrid management system for robustness and reliability.

Appendix A

Industrial & Economic Development Research Program/SEED (IEDR/SEED) Grants

2017-2018

Investigator	Department	Amount	Researcher Company	Title
William Murphy	Biomedical Engineering	$163,506	Stem Pharm, Madison, WI	*A novel, scaffold-free approach for therapeutic cell delivery*
Mikko Lipasti	Electrical and Computer Engineering	$149,640	Thalchemy Corp., Madison, WI	*Investigating Spiking Neural Networks with Deep Learning*
Martin Zanni	Chemistry	$100,000	PhaseTech Spectroscopy, Madison, WI	*2D optical AFM: A new microscope technology to help grow a Wisconsin startup company*
Brian Johnson	Biomedical Engineering	$149,552	Onexio Biosystems, Madison, WI	*Improving efficacy and toxicity testing through high-throughput multi-culture in the MICRO-MT*

Appendix B

Industrial & Economic Development Research Program/SEED (IEDR/ SEED) Grants

2018-2019

Investigator	Department	Amount	Researcher Company	Title
Jess Reed	Animal Science	$133,174	Synesis Nutrition, Inc, Madison, WI	*TEER Bioscreening: Accelerating the Commercialization of Phytality™ an Enteral Nutrition Formulation for Improved Gut Barrier Function*
Amish Raval	Medicine	$106,985	Cellular Logistics Inc, Sun Prairie, WI	*Bioengineered Injectable Matrix to Improve Stem Cell Retention for Heart Repair*
Phillip Barak	Soil Science	$127,980	Nutrient Recovery and Upcycling, LLC (NRU), Madison, WI	*Recycling Municipal Wastewater Nitrogen into Fertilizer Nitrogen by Electrodialysis*
Bryan Bednarz	Medical Physics	$150,041	Voximetry Inc ("Vox"), Madison, WI	*RAPID: An Extremely Fast Monte Carlo Dose Computing Software for Nuclear Medicine*
Scott Reeder	Radiology	$81,820	Calimetrix Madison, WI	*Quantitative Fat Phantom for CT and MRI*

Appendix C

IEDR Research Projects, University of Wisconsin-Madison

2017-2018

1. A novel, scaffold-free approach for therapeutic cell delivery (PI: William Murphy, Biomedical Engineering Department), Industrial Partner: Stem Pharm, Madison, Wisconsin.
2. Investigating Spiking Neural Networks with Deep Learning (PI: Mikko Lipasti, Electrical and Computer Engineering Department), Industrial Partner: Thalchemy Corp, Madison, Wisconsin.
3. 2D optical AFM: A new microscope technology to help grow a Wisconsin startup company. (PI: Martin Zanni, Chemistry Department), Industrial Partner: PhaseTech Spectroscopy, Madison, Wisconsin.
4. Improving efficacy and toxicity testing through high-throughput multi-culture in the MICRO-MT (PI: Brian Johnson, Biomedical Engineering Department), Industrial Partner: Onexio Biosystems, Madison, Wisconsin.

Appendix D

SEED Research Projects, University of Wisconsin-Madison

2018-2019

1. TEER Bioscreening: Accelerating the Commercialization of Phytality™ an Enteral Nutrition Formulation for Improved Gut Barrier Function (PI: Jess Reed, Animal Science Department). Industrial Partner: Synesis Nutrition, Inc, Madison, Wisconsin.
2. Bioengineered Injectable Matrix to Improve Stem Cell Retention for Heart Repair (PI: Amish Raval, Department of Medicine). Industrial Partner: Cellular Logistics Inc, Sun Prairie, Wisconsin.
3. Recycling Municipal Wastewater Nitrogen into Fertilizer Nitrogen by Electrodialysis (PI: Phillip Barak, Soil Science Department). Industrial Partner: Nutrient Recovery and Upcycling, LLC (NRU), Madison, Wisconsin.
4. RAPID: An Extremely Fast Monte Carlo Dose Computing Software for Nuclear Medicine (PI: Bryan Bednarz, Medical Physics Department). Industrial Partner: Voximetry Inc ("Vox"), Madison, Wisconsin.
5. Quantitative Fat Phantom for CT and MRI (PI: Scott Reeder, Radiology Department). Calimetrix Madison, Wisconsin.

Note: Some publication titles were not available at the time of reporting

Appendix E

Applied Research Program Awards

2018-19

Applied Research Grant (ARG)			
Investigator	**Institution**	**Amount**	**Title**
Heather Clarke	UW-Green Bay	$26,316	*Moderators of the Effects of Social Isolation, Loneliness and Work-Family Conflict on Long Haul Driver Well-Being and Turnover*
Xiaohua Peng	UW-Milwaukee	$49,000	*ROS-Activated Prodrugs that Target Cancer Cells*
Heidi Wagner	UW-Madison	$37,900	*Developing Assessment Measures for Women's Building Construction Trade Pre-Apprenticeship Andragogy*
Weizhong Wang	UW-Milwaukee	$50,000	*Development of Secure Secret/Private Key Management Method for the Edge Nodes of the Internet of Things (IoT) Networks*
Applied Research-WiSys Technology Advancement Grant (AR-WiTAG)			
Investigator	**Institution**	**Amount**	**Title**
Sergei Bezroukov	UW-Superior	$10,217	*Wireless Devices for School Security*
James Boulter	UW-Eau Claire	$49,991	*Continuous Monitoring of Airborne Silica for Worker Safety and OSHA Compliance*
Elizabeth Glogowski	UW-Eau Claire	$50,000	*Stimuli-Responsive Polymer Dispersants for Architectural Coating Applications*
Md Maruf Hossain	UW-Green Bay	$49,236	*Mechanically Integrated Wind Power Generation Systems*
Hanwan Jiang	UW-Platteville	$50,000	*Development of a Non-Destructive Technique for Interior Cracking Detection and Stress Evaluation for Concrete Structures Based on Diffuse Ultrasound Coda-wave Interferometry and Three-Dimensional Imaging*
Francis Mann	UW-Parkside	$40,612	*Microbe-Facilitated Anthocyanin Extraction of Fruit Waste*

John Obielodan	UW-Platteville	$50,000	*Development of Thermoplastic Biocomposite for 3D Printing*
Prototype Development Fund (PDF)			
Investigator	**Institution**	**Amount**	**Title**
Gokul Gopalakrishnan	UW-Platteville	$14,800	*Shape Sensitive Molecular Sieving using Customized Nanoporous Silicon Membranes*
Gokul Gopalakrishnan	UW-Platteville	$6,385	*1Swipe Prototype v2.0*
Seth King	UW-La Crosse	$17,850	*Fabrication and Characterization of Zno/Graphene Nanocomposite Thin-Films*
David Lewis	UW-Eau Claire	$13,461	*Enantiodivergent Synthesis of Benzybornyl Derivatives*
Wei Li	UW-Platteville	$15,000	*Continued Development of the Prototype for a Semiconductor Quantum Dot Computer Aided Engineering (CAE) Simulator*
Wei Li	UW-Platteville	$15,000	*Development of the Prototype for a Semiconductor Quantum Dot Computer Aided Engineering (CAE) Simulator*
GRAND TOTAL		**$ 545,768**	

Appendix F

Applied Research Program Awards

2017-18

Applied Research Grant (ARG)			
Investigator	**Institution**	**Amount**	**Title**
Paul Block	UW-Madison	$38,177	*Building Precipitation & Groundwater Forecast Tools for Wisconsin's Central Sands*
Samantha Foley	UW-La Crosse	$38,806	*OnRamp: A Parallel and Distributed Computing Learning Environment*
Ionel Popa	UW-Milwaukee	$40,071	*Development of Protein Hydrogels-based Antibody Purification Columns*
Paul Van Auken	UW-Oshkosh	$39,749	*Finding Their Place: A Comparative Study of Refugee Resettlement in Local Communities and Economies*
Muthu Venkateshwaran	UW-Platteville	$49,952	*Development of Materials Capable of Controlled Delivery of Volatile Organic Compounds (VOCs) to Plans for Defense against Pathogens*
Jae-Hyuk Yu	UW-Madison	$41,205	*Development and Application of Natural Food Preservatives*
Applied Research-WiSys Technology Advancement Grant (AR-WiTAG)			
Investigator	**Institution**	**Amount**	**Title**
Harold Evensen	UW-Platteville	$38,904	*Nanoscale Vacuum-channel Field Effect Transistors from Aligned Carbon Nanotubes*
Dmitry Kadnikov	UW-Stout	$48,643	*Modular Chemical Probes for Detection of Citrulline Amino Acid*
Daehee Kim	UW-Stevens Point	$37,800	*Efficient Big Data Transfer Service (BigDTS) through Networks*
Seth King	UW-La Crosse	$31,584	*Low-Cost Zinc Oxide/Graphene Nanocomposite Thin Films for use as Transparent Conductors*
Wei Li	UW-Platteville	$39,000	*Computer Aided Engineering of Semiconductor Quantum Dots: Design and Non-Destructive Characterization*

Daryl Sauer	UW-Parkside	$47,600	*Identification and Isolation of Novel and Safe Disinfectants from Sustainable Wisconsin Based Sources*
Prototype Development Fund (PDF)			
Investigator	**Institution**	**Amount**	**Title**
Cheng-chen Huang	UW-River Falls	$14,957	*Novel Chemotherapeutic Compounds that Reduce Melanoma Cancer Stem Cells*
David Lewis	UW-Eau Claire	$13,234	*3-endo-(Arylmethyl)isoborneols as Chiral Organocatalysts*
Zhaohui Li	UW-Parkside	$11,000	*Development of a Mineral-Dye Composite with Improved Fluorescent Properties for Phenol Detection*
Yijun Tang	UW-Oshkosh	$9,963	*Enzyme-Free Glucose Sensors based on Polymer/Cobalt Composite*
Joseph Wu	UW-Platteville	$11,953	*Production of WiSys Organosolv Lignin (WOSL) for 3D Printing Filament*
Fang Yang	UW-Platteville	$15,000	*The Prototype Development of a Comprehensive Microgrid Energy Management System*
GRAND TOTAL		**$567,598**	