Announcement

NJIT Technology Innovation Translation and Acceleration (TITA) Program

TITA-2024 Seed Grant Awards

The NJIT Technology Innovation Translation and Acceleration (TITA) Seed Grant program will enable faculty and students to successfully accelerate the translation of their innovation to enterprise development and business incubation. The TITA seed grant program will foster entrepreneurial pathways from research and innovation to business and value creation with the acquisition of intellectual property, market validation, and engagement of stakeholders towards commercialization.

The TITA Seed Grants will increase awareness of the potential commercial benefits at earlier stages of the translation and market validation process and allow researchers and stakeholders to collaborate for entrepreneurial success. It will also help faculty to submit competitive translational research proposals to external grant funding opportunities.

We are pleased to award five TITA-2024 seed grants funded for $75,000 each in this cycle. The TITA seed grant program was initiated last year with four TITA-2023 seed grants with technology innovation translational research projects which are now transitioning to Phase-3 of the program for market validation towards entrepreneurial pathways. Thus, there are currently 9 innovative technologies funded for $75,000 each under the TITA program for translational research and market validation for potential tech transfer and commercialization activities. The TITA program that was initiated in Fall 2022 with the NJ State and institutional funding is now supported by the Accelerating Translational Research (ART) grant funded by the NSF Technology and Innovation Partnership (TIP) directorate for further enhancement and expansion through the NJIT Center for Translational Research which will be formally established in early Spring 2024.

Congratulations to All TITA Seed Grant Awardees!

TITA Seed Grant Awards

NJIT Technology Innovation Translation and Acceleration (TITA) seed grants are funded in three phases of $25,000 each with a total potential funding of up to $75,000 as following:

<u>Phase-1 (Up to $25,000): Technology Innovation Translation Research and Proof of Validation</u>: The Phase-1 proposal must incorporate collaborative research and partnership with at least one external stakeholder from industry, academia, community or local government organizations, federal labs, or professional user groups (such as physicians in hospital or private practice for medical devices). The objectives of the Phase-1 proposal must include market research for unmet need(s), developing prototype devices/technology, translational research for application validation, and assessment of all risks associated with bringing the application to market, especially with respect to competition and future growth.

<u>Phase-2 (Up to $25,000): Technology Innovation Acceleration to Entrepreneurship</u>: The Phase-2 funding will focus on the development of pre-commercial prototypes of devices or technology, scalable validation, and business plans and technology transfer to an existing company or forming a new start-up company establishing market channels. This phase, often called the early incubation stage, will include advanced market validation studies (such as early clinical trials for validation of potential medical devices). The Phase-2 goals must also include development of collaborative partnership-based business models and strategies to attract interest from external entrepreneurs, investors or a commercial entity for licensing and commercialization.

<u>Phase-3 (Up to $25,000): Advanced Technology Innovation Acceleration to Commercialization</u>: The collaborative partnership-based Phase-3 proposal will focus on developing commercialization plans with advanced commercialization-ready technology or product(s) and additional regulatory, business, marketing, and risk management. This phase will also include larger scalable technology validation, market trials (such as early clinical trials for medical devices) and user-acceptance studies towards submission of investment proposal and grants to secure future funding for commercialization from the NJIT Investment Fund, an angel investment fund, NSF TIP or similar grant program.

NJIT Technology Innovation Translation and Acceleration (TITA) Program

TITA-2024 Seed Grants

Title of the Technology: *n*-Fast - A Nanotechnology Approach to Developing Fast Dissolving Active Pharmaceutical Ingredients (APIs)

Proposers and Affiliations:

Somenath Mitra, PhD, Distinguished Professor, Chemistry and Environmental Sciences, NJIT

Ms. Rachel Theka, Thive Consulting, Middlesex, NJ

Executive Summary:

A significant challenge currently faced by the pharmaceutical industry and drug development is the substantial proportion (40 to 70%) of active pharmaceutical ingredients (API) and new chemical entities (NCE) that exhibit low water solubility. This leads to poor bioavailability and often results in therapeutic ineffectiveness. These hydrophobic molecules fall within the Biopharmaceutics Classification System (BCS) categories II and IV drugs, with a potential global market ranging from $600 billion to $1 trillion. Alongside the development of new drug molecules, the drug delivery market is experiencing a Compound Annual Growth Rate (CAGR) of 6.5%, with projections to exceed $375 billion by 2027. Additionally, the rapid drug release market is expected to reach over $32 billion by 2027. Faster release is particularly critical for BCS Class II and Class IV drugs, and this acceleration can further propel the growth of the overall pharmaceutical market.

Current technologies for enhancing drug solubility, including milling, spray drying, salt formation, supercritical fluid processing, nanosuspension, homogenization, lipid formulation, and cocrystal formation, have limitations as they often lead to alterations in crystal structure, polymorph, or require the use of additional chemicals. What the market currently needs are API crystals that dissolve rapidly while preserving the original crystal structure and polymorph.

Dr. Mitra's group at the New Jersey Institute of Technology (NJIT) is developing a nanotechnology approach to enhance the solubility, bioavailability, and effectiveness of API crystals by improving their water solubility without altering the crystal structure. Essentially, this involves creating a fast-dissolving version of the drug. The technology aims to reformulate various insoluble APIs falling under BCS Class II and IV with bioabsorbable, functionalized nanoparticles to enhance solubility and ultimately efficacy. These fast-dissolving APIs will be applicable in oral, transdermal, inhalation, and injectable formulations, lowering the required dosage and thereby reducing side effects and toxicity.

Title of the Technology: SonoNanoArgon – Destruction of Emerging Contaminants using Ultrasound and Argon Nanobubbles

Proposers and Affiliations:

Jay N. Meegoda, PhD, PE, FASCE, Distinguished Professor, Civil and Environmental Engineering, NJIT

Marc Ottolini, Strategy and funding advisor, Portfolio of AIRLABS, RENSAIR, SUSURRO, NANOVISION, London, UK

Executive Summary:

Destruction of emerging contaminants such as PFAS, microplastics, pharmaceuticals, and pathogens demands robust and energy-intensive methods. Specifically for PFAS cleanup DoD is expected to spend over $32B. This does not include much higher amount that is expected to be

spent by water and wastewater treatment facilities and landfills. Currently, ultrasound technology is s a promising solution to address this challenge.

Ultrasound waves induce the formation of nano-sized cavities. These nanobubbles, under the continuous application of ultrasound energy, undergo compression and relaxation, resulting in energy accumulation inside nanobubbles. Eventually, these nanobubbles reach a state of instability, causing them to implode rapidly at bubble locations, generating temperatures of up to 5000°C. These extreme temperatures pyrolyze emerging contaminants and pathogens into individual atoms making emerging contaminants harmless products. Nanobubbles made of Argon gas enhance the destruction of emerging contaminants and pathogens with the application of ultrasound. The combination of argon nanobubble with ultrasound is bolstering the destruction capabilities of ultrasound while simultaneously reducing energy consumption. The presence of Argon gas nanobubbles results in the supersaturation of Argon gas in the solution containing emerging contaminants, which, in turn, creates additional cavitation sites for ultrasound-induced reactions. Additionally, the hydrophobic nature of the gases contained within nanobubbles, coupled with their negative zeta potential, enhances the adsorption of emerging contaminants and pathogens onto argon nanobubble surfaces. As ultrasound energy continues to drive the implosion of nanobubbles, it paralyzes these harmful substances absorbed onto Argon nanobubbles, presenting a more efficient, cost-effective, and environmentally friendly method for eliminating emerging contaminants and pathogens when compared to only ultrasound. This approach requires significantly less energy and fewer resources, making it an ideal solution for addressing the contemporary environmental challenges of destroying emerging contaminants.

Dr. Jay Meegoda of the New Jersey Institute of Technology (NJIT) is developing a system for a continuous supply of Argon nanobubbles in ultrasound reactors to enhance destruction of emerging contaminants and pathogens. With the commercialization of the technology, we are attempting eliminate the PFAS in the USA to significantly improve the heath of humanity.

Title of the Technology: Rapid, Robust, Cost-effective, Field-based, AI-integrated point-of-use Electrochemical Platform Technology for *in-situ* detection and quantification of PFAS in source water.

Proposers and Affiliations:

Sagnik Basuray, Associate Professor, Chemical and Materials Engineering, NJIT
Joshua Young, Assistant Professor, Chemical and Materials Engineering, NJIT
Charmi Chande, co-founder and C.T.O., ESSENCE DIAGNOSTICS LLC., NJ

Executive Summary:

Recent market analysis reports show that the United States PFAS (per- and polyfluoroalkyl substances) Analytical Instrumentation Market exceeded USD 75 million in 2021. It is projected to experience substantial growth at a compound annual growth rate (CAGR) of more than 20%

from 2021 to 2028. By 2028, the market is anticipated to achieve revenues exceeding USD 350 million. Several factors are primarily driving the demand for PFAS analytical instrumentation, like increased awareness of the widespread prevalence of PFAS contamination, the approval of the PFAS Action Act of 2021 by the US House of Representatives, $10.0 billion in funding through President Biden's Bipartisan Infrastructure Law. The market is anticipated to experience an initial surge in growth, primarily fueled by commercial testing laboratories, utilities, and regulatory bodies. Commercial testing laboratories have emerged as the largest end-user segment in 2021, followed closely by wastewater treatment utilities. Manufacturers of products containing PFAS are also showing a growing interest in PFAS testing to understand the presence of PFAS and adhere to contamination guidelines, which could help them avoid fines and litigation. Long-term market growth is expected to be sustained by industries, academia, and regulatory bodies. Some of the key factors influencing the future sales of PFAS testing devices will include ease of use, data reproducibility and reliability, low cost of ownership, and on-site rapid testing.

The existing PFAS analytical instrumentation market is constrained by its reliance on laboratory-based methods, resulting in a lengthy 15-day wait time for results and a substantial cost ranging from $300 to $400 per sample analysis. Hence, a highly sensitive, selective, low-cost, maintenance-free, and user-friendly portable sensor capable of detecting per- and poly-fluoroalkyl substances (PFAS) at current federal limits in various environmental matrices is urgently required. We propose to address this challenge by developing an integrated electrochemical sensor platform (ESSENCE) for rapid, in-situ detection and quantifying PFASs in treated water. It will be extended to detection in field samples in the future. The sensor platform's key benefits that lead to high sensitivity and selectivity are due to shear force enhancement from the chip architecture to eliminate matrix interferences and high sensitivity from an automated and operator-independent electrochemical platform. Further data analysis integrated with Deep Learning (DL)/machine learning (ML) using the electrochemical data generated by the capture of PFASs by PFAS-specific capture probes immobilized on the platform will lead to significantly enhanced selectivity. Thus, the platform will act as a point-of-use device to measure PFAS concentration directly. In this proposal, the sensor will be used to measure the three most important PFAS identified by EPA. They are perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), and perfluorobutane sulfonic acid (PFBS).

The efforts for translating the device include the development of a new version of our current chip and integration with the ESSENCE platform for high chip-to-chip reliability, high sensitivity, and selectivity that meets the latest federal limits. PFOS, PFOA, and PFBS calibration curves will be generated. Data analysis with artificial intelligence/machine learning will allow for selective quantification of PFOS, PFOA, and PFBS in a mixed sample. The final aim is continuous in-situ monitoring and fast prescreening of all major PFAS compounds. Based on a NSF-Icorps customer discovery conducted by the PIs through interviewing 100 potential customers, the first line of potential customers would be water treatment plants like municipal corporations like the Jersey City Municipal Utilities Authority (JCMUA), as the water matrix is cleaner and more straightforward with significantly less interference. This would allow us to develop a more robust chip architecture (significantly more R&D) for future detection of PFAS in the field.

Title of the Technology: “CidaGel: Injectable Gel for Dental Pulp Regeneration”

Proposers and Affiliations:

Vivek, Kumar, PhD, Associate Professor, Department of Biomedical Engineering, NJIT
Corey Heffernan, PhD & Laura Osorno, PhD, NJIT
Emi Shimizu, DDS, PhD, Rutgers School of Dental Medicine
Carla Cugini, PhD, Rutgers School of Dental Medicine

Executive Summary:

Every year, over 15 million patients in the U.S. undergo root canal procedures, leaving devitalized teeth susceptible to severe pain, reinfection, and breakage. The lack of regenerative support for dental pulp post-root canal is a critical issue in dentistry, necessitating an innovative solution. The global oral care market, expected to reach $60 billion by 2028, demonstrates a growing demand. With over 15 million annual root canal procedures in the U.S. and 75 million worldwide, the need to restore soft tissue in the pulpal cavity is evident, addressing a critical gap in dental care for both adults and children.

The global oral care market's projected growth to $60 billion by 2028, driven by factors like increasing dental caries incidence and new product development, presents a significant opportunity. CidaGel addresses a substantial portion of the market by catering to the unmet needs of root canal patients, aligning with the broader trends in oral care.

The KumarLab at NJIT has developed CidaGel, an injectable peptide-based material that uniquely promotes localized tissue regeneration while effectively preventing microbial colonization. CidaGel fills the challenging geometric canal space, surpassing existing solutions. With a patented guided tissue regeneration (GTR) strategy, the technology demonstrates selective regeneration of soft tissue in rodent and canine models, marking a significant breakthrough in dental regenerative medicine. CidaGel aims to improve dental soft tissue ingrowth and prevent severe infections, addressing a vital unmet need. With over 10% of root canal procedures resulting in long-term failures, the potential impact extends beyond dental health to systemic well-being. As a medical device, it seeks to preserve the structure and function of natural teeth, contributing to enhanced overall oral care. The technology will undergo rigorous evaluation in preclinical studies for FDA 510k submission. A phased approach will include non-GLP and GLP testing, pilot GMP manufacturing, and a strategic interaction with the FDA. The ultimate goal is to develop a commercialization-ready product, securing future funding for large-scale validation and commercialization.

CidaGel was developed at the KumarLab at NJIT by Prof Vivek Kumar, and is being translated with his team - Corey Heffernan, PhD and Laura Osorno, PhD. Complimentarily, the efforts will be synergized with New Mexico Tech's Vice President for Research & Economic Development Mike Doyle to help accelerate Cidagel's innovative approach to dental pulp regeneration and infection prevention. CidaGel presents a unique solution to a pressing problem in oral care, and a platform for a host of other infectious diseases. The technology's potential

impact, combined with a well-defined translational research and development plan, positions it as a promising venture with substantial commercialization opportunities in the growing global oral care market.

Title of the Technology: Climate-Smart Electrocatalytic Membrane Technology Transforms Nitrate Pollution into Enhanced Ammonium Salt Fertilizer

Proposers and Affiliations:

Wen Zhang, Ph.D., P.E., BCEE, Professor, Department of Civil and Environmental Engineering, New Jersey Institute of Technology
Jianan Gao, Ph.D. candidate, Department of Civil and Environmental Engineering, New Jersey Institute of Technology
Ed Weinberg, P.E. President ESSRE Consulting, Inc.

Executive Summary:

Exposure to excessive nitrate (NO_3^-) could lead to negative health impacts such as methemoglobinemia and other diseases. To minimize the adverse health impacts of nitrate, the World Health Organization has set a recommended maximum contaminant level (MCL) of 45 mg L^{-1} NO_3^- (10 mg·L^{-1} as nitrate nitrogen) in drinking water. Currently, over 40 million people in the US still do not have access to municipally-treated water, instead relying mostly on private groundwater wells. Even in public water systems, nitrate is among the most commonly reported water quality violations in the US. Thus, there is a need for efficient nitrate removal suitable to protect public health.

The global wastewater treatment market, currently valued at USD 295 billion, is expected to reach USD 572 billion by 2032, growing at a CAGR of 6.9%. This growth highlights the increasing demand for effective nitrate removal, particularly in municipal and agricultural sectors. The agricultural wastewater treatment market alone is projected to grow from USD 2.18 billion in 2021 to USD 3.13 billion by 2030. Besides, huge potential markets exist for treatment of diverse wastewater such as ion exchange brine (global discharge: >50 billion ton per year), landfill leachate (U.S. discharge: >60 million ton per year), mining wastewater (U.S. discharge: >200 million ton per year). Technology development for nitrate removal and ammonia recovery will have both positive environmental and financial impacts. Particularly, electrocatalytic membrane technology, with its unique value propositions (e.g., potentially driven by renewable energy and minimum use of hazardous chemicals), stands poised to capture a significant portion of this market and offer both environmental benefits and lucrative business opportunities.

Dr. Wen Zhang's group at NJIT plans to develop novel flow-through electrocatalytic membrane systems to recover nutrients such as nitrate or ammonia (NH_3). This cutting-edge electrocatalytic membrane technology has proven effective for NO_3^- conversion into NH_3 with concurrent NH_3 recovery as valuable products such as ammonia salt fertilizers. This innovative electrocatalytic membrane and cell system will use a reactive gas-permeable cathodic membrane

to efficiently convert NO_3^- in the influent flow through feed stream to NH_3, and subsequently trap the NH_3 via an acid solution generated by the anode, which results in the generation of ammonium salt solution fertilizer. Compared to conventional methods like ion exchange, air stripping and biological nitrification/denitrification, electrocatalytic membrane technology provides nitrogen removal from water or wastewater and nitrogen upcycling via nitrogen nutrient recovery and reuse. This system is electrochemically driven, which eliminates secondary pollution or the addition of external carbon or chemicals. This electrocatalytic membrane design selects a copper-based material, which is not on the DOE's Critical Mineral list, unlike other similar technologies that may employ Critical Minerals content (e.g., platinum and palladium) for the catalytic component. Broader impacts, beyond these environmental and sustainability benefits, exhibited by our bench-top results indicate a lower carbon intensity than industrial NH_3 gas synthesis via the Haber-Bosch process, which may provide a transformative pathway to "green" ammonia and industrial decarbonization.
