TETRAMER
MOLECULAR ARCHITECTS

April 12, 2024

Tetramer Technologies is seeking university collaborators interested in advancing and commercializing technologies from their labs through the Small Business Innovation Research (SBIR) and Small Technology Transfer Innovation Research (STTR) Department of Defense programs.

To receive updates via email when Tetramer is reviewing future SBIR / STTR opportunities, visit tetramer.com/universities or email info@tetramer.com directly with your information.

SBIR/STTR programs advance high risk, high reward technologies to commercialization by providing funding for entrepreneurship activity. During an SBIR/STTR, a university collaborator can use funds to provide research opportunities for undergraduates, graduates, and post docs. Successful commercialization can result in potential royalty streams for inventors and universities and new jobs for students.

For these programs, university researchers and Tetramer will partner to submit an SBIR or STTR proposal with Tetramer serving as the prime contractor and university collaborators acting as subcontractors and/or consultants. Tetramer has extensive background in contracting and executing these programs and in partnering with universities through the process. At this point, we are identifying university partners with good technical fit from a concept and capabilities perspective.

If you are interested in collaborating with Tetramer on any of the attached topics of interest, please follow the steps below:

- Reach out to the contact listed for the topic of interest no later than **May 1, 2024** to allow adequate time for review.
- Include a **non-proprietary** quad chart of your proposed idea using the template provided.
- Include research capabilities information (i.e. equipment, experience, etc.) and whether there is existing IP which can be licensed.

The Tetramer lead will review all requests and coordinate meetings with researchers. Please reach out with any questions to the individual listed with each topic.

TETRAMER TECHNOLOGIES, LLC
657 S. Mechanic St. | Pendleton, SC 29670 | (864) 646-6282 | Tetramer.com

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Army STTR – Tetramer's Topics of Interest

Reach out to the Tetramer PI listed under each summary **by May 5, 2024** for collaboration opportunities. Final proposals are due 6/12/2024.

More detailed descriptions are available on Army STTR 24.B Topics page

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A24B-T004 Metamaterials Based on Magnetic Shape Anisotropy for K-band Microwave Applications

Objective: Develop a metamaterial utilizing magnetic shape anisotropy of ferromagnetic nanoparticles for operation of ultracompact antenna in the K frequency band of the microwave spectrum.

Description: Metamaterials demonstrating resonant response to electromagnetic radiation in the microwave Ku (12 GHz to 18 GHz) and K (18 GHz to 26.5 GHz) bands are highly desirable for multiple applications, including ultracompact microwave antennae, radar detection and frequency-selective wireless heating. Availability of ferromagnetic materials with high saturation magnetization and low magnetic damping [1,2], combined with recent advances in nanolithography, enable the development of such metamaterials based on arrays of ferromagnetic nanoparticles, where the resonance frequency of the metamaterial is determined by the magnetic shape anisotropy of the nanoparticles [3]. The shape anisotropy enables fabrication of devices with a selection of operation frequencies via lithography. For example, arrays of ultracompact antennae covering a wide band of the microwave spectrum, where each antenna is tuned to its own resonance frequency via control of the fabricated nanoparticle shape, can be used for ultrafast monitoring of the electromagnetic environment. An important advantage of a magnetic metamaterial is independence of its resonance frequency on the antennae dimensions [4], which enables ultracompact antennae for communications with miniature devices. The metamaterial antenna gain can be further boosted via magneto-electric or magneto-resistive effects in nanoparticle-based heterostructures to reach record levels of sensitivity to microwave signals [5].

The goal of this proposal is development of magnetic metamaterials based on arrays of ferromagnetic nanoparticles that show resonant response to electromagnetic radiation tunable by the nanoparticle shape. The metamaterial must operate at room temperature without a bias magnetic field and must show tunability of its frequency via shape anisotropy in the 2 GHz – 26.5 GHz frequency range (covering S, C, X, Ku and K bands). The metamaterial must exhibit resonant response to the frequency of incident electromagnetic radiation with the quality factor exceeding 100. To enable commercial applications, the metamaterial must be fabricated from a polycrystalline or amorphous ferromagnetic film deposited at room temperature by a high-throughput technique such as sputtering or electrodeposition. Operation of a K-band ultra-compact microwave antenna based on the shape-anisotropy metamaterial must be demonstrated. The overall antenna dimensions must not exceed 5 millimeters.

Interested in A24B-T004 Metamaterials Based on Magnetic Shape Anisotropy for K-band Microwave Applications? Contact Dr. Bogdan Zdyrko (bogdan.zdyrko@tetramer.com)

A24B-T014 Phase Change Materials for Enhanced Warfighter Survivability

Objective: The Army seeks innovative solutions utilizing phase change materials tailored for thermal regulation within a Closed-Circuit Self-Contained Breathing Apparatus to reduce thermal burden, enhance operational longevity, and improve warfighter efficiency.

Description: This STTR topic addresses the need for an advanced material solution capable of thermally regulating the microclimate of a Closed-Circuit Self-Contained Breathing Apparatus (CC-SCBA) by acting as a heat exchanger within the system. The envisioned technology would utilize phase change materials (PCMs) that are lightweight, reusable, and regenerative, with a transition temperature tailored to the unique operational demands of tactical respiratory protection devices.

Current CC-SCBA systems place a significant thermal load on the operator, leading to increased fatigue and reduced mission duration and effectiveness. Additionally, the inherent heat generation compromises the CO2 scrubbing efficiency, curtailing system endurance. The integration of an optimized PCM matrix could surmount these limitations by regulating the temperature of inspired air, thereby enhancing warfighter lethality and survivability.

The material must demonstrate efficacy in a composite or blend format, ensuring compatibility with existing CC-SCBA configurations and surpassing the performance of conventional ice-based systems. The developed technology should demonstrate structural stability and efficient thermal exchange within the constrained form factor of CC-SCBA units. Overall, success is defined by a phase change material that extends the operating lifetime of a CC-SCBA in terms of the thermal limitations set forth by the current NIOSH standard for CC-SCBAs (42 CFR 84.103). The ideal solution is a phase change material that can maintain an inspired air temperature below 35 °C under operational flow conditions for a duration of 4 or more hours.

The development process will include the optimization of encapsulation methods to prevent leakage and enhance material integration within the CC-SCBA framework. Additionally, these materials should exhibit long-term chemical stability and resistance to thermal degradation over repeated use cycles, ensuring reliability and safety in field operations. It should also be noted that the PCM will be required to operate in nearly 100% humidity in most normal conditions.

Interested in A24B-T014 Phase Change Materials for Enhanced Warfighter Survivability? Contact Dr. Bogdan Zdyrko (bogdan.zdyrko@tetramer.com)

A24B-T015 Distributed Multithreat Microsensor

Objective: Demonstrate a mission-configurable miniature, deployable sensing capability.

Description: Maneuver elements require early warning and situational understanding of the battlespace to include adversary actions and the threat of area denial tactics through the employment of hazardous persistent chemical agents. Soldiers are at risk of encountering dangerous circumstances as a consequence of having limited remote sensing capabilities for these situations. The joint forces require a small, lightweight technology that integrates with their equipment in a small form factor while affording prompt detection and reporting of the presence of multiple possible hazards or adversary troops and equipment in order to effect risk-based maneuver decisions and avoid hazards.

Emerging technology in miniature sensor science has increasingly demonstrated functionality and performance in the detection of hazardous chemicals and adversary movements and actions. Functionalized materials including metal oxide frameworks, carbon nanotubes, graphene, and conductive polymers have been reported with increasing sensitivity, selectivity, and reliability as environmental sensing modalities. Colorimetric technologies supply an inexpensive option for prompt and effective threat agent detection, and lend themselves to automation through the incorporation of color imagery or diode transduction.

Interested in A24B-T015 Distributed Multithreat Microsensor? Contact Heather Lange (heather.lange@tetramer.com)

A24B-T018 Biosynthetic PFAS Alternatives to Provide Omniphobicity

Objective: Develop and scale production of biosynthetic materials for environmentally friendly, omniphobic technologies for Department of Defense clothing and equipment without use of fluorine or perfluorinated compounds (PFAS).

Description: The Department of Defense (DoD) uses finishes with perfluorinated compounds (PFAS) to provide essential properties for Warfighter protection and survival, including water, chemical, oil, and stain repellency for clothing and equipment items. PFAS, which are associated with cancer, reproductive health issues, and developmental delays, are being banned from use and manufacture worldwide. There are over 9,000 different PFAS compounds, used since 1940 in clothing, food packing, personal care products, water/stain resistant products, and non-stick cookware (1,2). Since PFAS have worked so well in providing water, liquid, oil, and omniphobicity, they have been the default chemicals used in the textile industry to provide the durable treatments needed to meet DoD clothing and equipment requirements.

The DoD is seeking new, biosynthetic and environmentally friendly non-PFAS technologies for clothing and equipment to impart omniphobicity. No PFAS-free alternative has been developed thus far which can provide the needed level of oil repellency, and while water repellency can be obtained, non-PFAS finishes struggle to meet military durability requirements over the expected life cycle of an item. Truly novel non-PFAS formulations/technologies are needed that can provide durable omniphobicity equivalent to those obtained using PFAS.

Biosynthetic materials are key to sustainable domestic production and offer new opportunities to discover and synthesize novel compounds (3,4). The goal of this topic is to solicit new biosynthetic material technologies that can replace PFAS compounds in DoD clothing and equipment, providing the needed level of oil repellency and durability. The developed non-PFAS bioinspired solution should target at least one of the following areas: textile-based systems clothing and equipment items (uniforms, shelters, sleeping bags, hydration systems), food packaging and/or protective clothing items (barrier materials) and be developed into a formfactor that can be integrated into an end item. The biosynthetic solution may be provided as an alternative coating or finish for an existing DoD item, or as an entirely new material or substrate with inherent repellency to replace and/or be integrated into existing materials within the DoD system. Integration into DoD end items must consider other requirements for the final product, such as retaining water repellency, flame resistant properties, or others.

Specific care must be taken to avoid "regrettable substitutions" such as siloxanes, which are under similar scrutiny as PFAS compounds from health and safety standpoints. Due to health, safety, and regulatory concerns, solutions should not contain any carbon-fluorine bonds, including partially fluorinated fluoropolymers, even those not defined as "PFAS" by the EPA. Thoroughly review state-of-the-art for non-PFAS substitutions and be familiar with environmental concerns for manufacture (such as the use of isocyanates or solvents) as well as feasibility of producing omniphobicity with the proposed system using environmentally friendly materials and processes (5). (Suggested Reference: https://www.ri.se/en/popfree/pfas-substitution-guide-for-textile-supply-chains)

Interested in A24B-T018 Biosynthetic PFAS Alternatives to Provide Omniphobicity? Contact Dr. Monika Mujkic (monika.mujkic@tetramer.com)

A24B-T019 Additive Manufacturing for Protective Eyewear

Objective: Develop materials and an approach to manufacturing ballistic protection eyewear lenses with integrated prescription correction that is also suitable for point-of-need additive manufacturing.

Description: Combat eye protection is a ubiquitous need for all deployed Soldiers. The eyewear provides the wearer protection against ballistic-fragmentation and environmental concerns, like blowing sand, while remaining transparent to retain situational awareness. Protective eyewear lenses are currently made via injection molding and are not easily customized to provide vision correction. Any needed prescription vision correction is currently achieved with the Universal Prescription Lens Carrier (UPLC).[1] The UPLC sits behind the primary protective lens and contains a separate set of corrective lenses specific to the User's vision correction needs mounted into the UPLC frame. This creates integration issues for equipment worn on the face and eyes and limited field-of-view through the prescription lenses in addition to adding substantial logistical burden. The Army product manager for Soldier Protective Equipment (PdM SPE) has an ongoing initiative to identify technologies that would allow the elimination of a separate vision corrective lens (I.e. an integrated vision correction / ballistic protection lens). These lenses are expected to have a life cycle of less than six months since ballistic eye protection lenses are often rapidly degraded in combat environments due to scratching and abrasion.[2] Therefore, it is also desirable to have rapid turnaround on individually customized corrective lenses and to limit the logistics burden by providing manufacturing capability that is close to the point-of-need as well as being customizable to an individual wearer. An additive manufacturing

(AM) method is most likely to meet these requirements. As AM technology has progressed, printing resolution and material development have improved to the point where optically clear samples are now achievable.[3] The cost of this technology has also decreased to being a commercially viable approach to manufacturing custom lenses. Companies in this space are continuously developing new materials for their 3D printers to impart performance that has only previously been attainable with conventional manufacturing methods. Significantly, the expanded use of augmented reality (AR) in both military and civilian sectors has spurred advances in optically clear and durable eyewear manufactured with AM.

The goal of this topic is to develop materials and processes to rapidly manufacture a customized (“one off”) optical lens that meets all requirements of MIL-PRF-32432A for ballistic protection lenses as well as providing excellent optical quality, dimensional tolerances, and stability in all environments sufficient to provide vision correction.

Interested in A24B-T019 Additive Manufacturing for Protective Eyewear? Contact Adam Haldeman (adam.haldeman@tetramer.com)

More detailed descriptions are available on Army STTR 24.B Topics page:

https://www.armysttr.com/24b-topics-1-1?ss_source=sscampaigns&ss_campaign_id=660d3a93003d7a765df3d2ae&ss_email_id=660da6b939d10d79ceeb27fc&ss_campaign_name=24.B+Topic+Announcement+%26+Other+Army+STTR+Updates&ss_campaign_sent_date=2024-04-03T18%3A58%3A31Z