INNOVATING CROSS-DOMAIN SOLUTIONS TO DETECT EMERGING BIOLOGICAL THREATS

Solution Blow Spinning Of Cell-free Functionalized Polymer Fibers For The Detection Of Emerging Biological Threats

Jennifer Lee Defense Threat Reduction Agency **Susan Kozawa** Oak Ridge Institute for Science and Education **Stephen Blum** U.S. Army Combat Capabilities Development Command Chemical Biological Center **John Biondo** Excet Inc. **Kris Van de Voorde** U.S. Army Combat Capabilities Development Command Chemical Biological Center **Matthew Lux** U.S. Army Combat Capabilities Development Command Chemical Biological Center **Marilyn Lee** U.S. Army Combat Capabilities Development Command Chemical Biological Center

Cell-free protein synthesis is a synthetic biology platform that can be readily programmed to perform a variety of functions to benefit the warfighter simply by changing the DNA input into the system. For example, plasmids encoding for antimicrobial peptides can be used for decontamination while genetic circuits including RNA toehold switches can be used to detect emerging biological threats. Increasing the utility of cell-free systems is the ability to be lyophilized for shelf storage and rehydrated in situ for on-demand use in the field. These lyophilized cell-free systems are most often implemented in tubes or on matrices like paper and can be sensitive to certain environmental conditions such as humidity, thus their operation in the field is limited to more controlled environments. Embedding cell-free systems into polymers has the potential to expand their utility into more practical form factors that can be integrated into warfighter equipment to protect the cell-free systems from the elements as well as provide versatile detection capabilities.

Previously, our group has shown cell-free systems are tolerant to certain solvents and can maintain their function after being embedded in solvent-cast polymer films. This work demonstrates the feasibility of embedding cell-free systems into polymer fibers where envisioned end products could include functionalized textiles, wipes, and filters to alert the user to the presence of a threat. Solution blow spinning (SBS) is a scalable technique in which compressed air pulls fibers from polymer solutions. Here, SBS is used to create non-woven fiber mats from polycaprolactone, polyvinylidene fluoride-co-HFP, and polyethylene oxide solutions containing lyophilized cell-free reactions. Fiber properties are characterized (scanning electron microscopy, energy dispersive x-ray analysis, nuclear magnetic resonance spectroscopy) and cell-free activity assessed using colorimetric and fluorescent assays (microscopy, video analysis). Biothreat detection in fibers is demonstrated using an RNA toehold switch sensor to detect genetic material and fibers are spun onto commercial off the shelf masks to illustrate the potential application of cell-free/polymer fiber materials.

This research is funded by the U.S. Army via the Chemical Biological Advanced Materials and Manufacturing Science Program (PE 0601102A Project VR9) at the Combat Capabilities Development Command (DEVCOM) Chemical Biological Center.