MITIGATION - SCIENCE AND TECHNOLOGY ADVANCES FOR CHEMICAL AND BIOLOGICAL HAZARD MITIGATION

Encapsulation Of Cell-free Bio-reactions: Delivering Dna-programmable Functions To Materials

Marilyn Lee U.S. Army DEVCOM Chemical Biological Center **Jennifer Lee** DTRA matrixed to DEVCOM CBC **Susan Kozawa** ORISE supporting DEVCOM CBC **Steven Blum** U.S. Army DEVCOM Chemical Biological Center **John Biondo** Excet supporting DEVCOM CBC **Kristian Van de Voorde** U.S. Army DEVCOM Chemical Biological Center **Matthew Lux** U.S. Army DEVCOM Chemical Biological Center

Encapsulation is a way to protect and co-localize molecules by packaging them into particles. Biological molecules and systems often benefit from stabilizing encapsulation treatments in examples ranging from therapeutics to foods. In this work, we seek to apply these benefits to cell-free protein synthesis reactions. Cell-free systems use crude cell extracts or purified enzymes to enact a variety of biological functions outside of living cells, with wide-ranging applications to benefit the warfighter, including enzymatic decontamination, on-demand biosynthesis of therapeutics, or eye-readable biosensors. Functions can be dictated by simply adding DNA instructions. Cell-free systems may be freeze-dried for shelf-stability and already display remarkable tolerance to integration with materials like plastic polymers or porous materials like paper, but encapsulation may push this stability even further.
Here we describe ongoing work to load cell-free reactions into particles of various types, including hydrogel resins, diblock copolymer vesicles, and microfluidic droplets. We show advantages and disadvantages of each format and propose methods to produce core-shell designs. We hypothesize these strategies will improve control over humidity exposure, re-hydration rate, and expand tolerance to material processing steps. This technology has the potential to enable integration of DNA-programmable functionality into the materials that make up warfighter equipment to introduce new capabilities like self-decontamination or reduce burden through built-in contaminant sensing.

Funding was provided 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.