

**Engineered Beads for Chem-Bio Defense (CBD) Personal Protective Equipment (PPE)
Research and Development (R&D) Project Summary**

Principal investigator's name: Stephen Hudson
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Firm name: Tetramer Technologies, LLC
Firm address: 657 S Mechanic St. Pendleton, SC 29630-1808
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SUMMARY OF RESULTS

A summation of Phase I results

During this Phase I, Tetramer demonstrated the ability to controllably produce and scale up polymer/MOF composite microbeads with an ultra-high (>80 wt%) loading of UiO-66-NH₂ MOF powders for Personnel Protective Equipment (PPE) applications (Figure 1). The MOF-beads produced by Tetramer during this Phase I effort were demonstrated to have exceptional decontamination capabilities when exposed to soman (GD) reagents at the U.S. Army Edgewood Chemical Biological Center. Under the test conditions used, Tetramer's beads were significantly more effective at decomposing GD into pinacolyl methylphosphonic acid than the MOF powder by itself.

The primary advantage of this technology is that the MOF-beads provide the added mechanism of chemical warfare agent decontamination to current chemical protective suits. Whereas current suit designs incorporate adsorbent materials to prevent breakthrough dermal exposure of military personnel to toxins, these beads could also decompose the dangerous contaminants into less harmful species. This would result in a higher safety factor and success rate for operations in contaminated environments. Additionally, these bead-infused suits could result in significantly more robust Hazardous Materials (HAZMAT) PPE products to protect environmental health and safety personnel against exposure to Toxic Industrial Chemicals (TICs).

During the Phase I, Tetramer was able to develop manufacturing processes to control the particle size and size distribution of the beads within the range of 100 – 300 µm. The beads were shown to have sufficient mechanical, thermal, and chemical properties for application to chemical protective fabrics. As illustrated in Figure 1, high density loadings of the microbeads were applied to relevant fabric samples from a global Hazmat suit manufacturer who is currently in discussions with Tetramer for the development of a new line of PPE suits incorporating these beads. Tetramer plans to continue development work with this manufacturer and leverage their experience and channels to market for commercialization of the beads. Concurrent discussions are underway with other manufacturers of PPE suites, including those with

contracts to produce the JSLIST suit for the military. Ceramic fillers were successfully incorporated into the beads and improved their thermal stability.

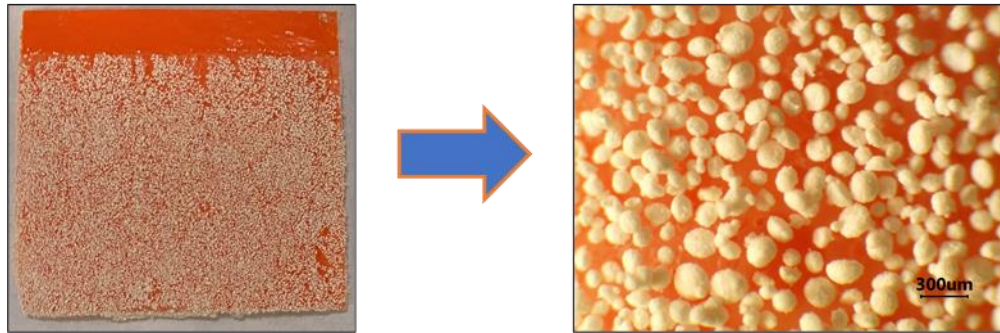


Figure 1. Chemical protective fabric coated with a monolayer of Tetramer's 106 μm diameter MOF-beads.