PROTECTION - SCIENCE AND TECHNOLOGY ADVANCES FOR CHEMICAL AND BIOLOGICAL PROTECTION

Encapsulated Polymeric Structured Metal Organic Framework Beads For Adsorption And Reaction Of Toxic Agents

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With potential use by military and terrorist organizations, a wide range of chemical warfare agents (CWAs) such as sarin and mustard gas as well as a number of toxic industrial chemicals (TICs) continue to represent a significant threat because of their high availability and toxicity. Current military chemical–biological (CB) suits and masks rely on the use activated carbon as the primary protective barrier layer. This carbon layer, although often a good adsorbent and effective against CWAs, does not act as a reactive layer and is thus not an efficient CWA detoxifier. To improve the overall performance of the protective equipment and ultimately operator safety, there is a desire to integrate a reactive component into the personal protective equipment (PPE). The integration of a reactive component mitigates the hazard and actively decomposes, or detoxifies, the wide range of CWAs and TICs that can be experienced by the soldier. A range of metal-organic framework (MOF) materials have shown great promise both as an effective adsorbent and, more importantly, as a rapid and efficient means of catalyzing the detoxification or destruction of the harmful chemical agents. However, incorporation of the MOFs into PPE is limited and represents a significant challenge primarily because of their inherently small, generally submicron size and their tendency to be deactivated as they are fabricated into large active particles or beads.

Mainstream Engineering demonstrated a process to produce MOF-polymer beads which we have scaled to the multikilogram per day level to reproducibly produce high porosity polymer encapsulated MOF beads with no loss of MOF activity or available surface area. These beads high porosity allows excellent access of the MOFs active sites with an extremely low pressure drop. Our platform approach integrates thermally and chemically stable polymers and can be applied to a wide range of MOF materials providing protection from a wide range of CWA/TICs. We will discuss the ability to control the formation of mechanically robust beads from 0.1 mm to 2 mm with a MOF loading as high as 90% demonstrating the retention of the high level of MOF activity with no loss of active surface area, high mechanical stability, and no dusting of the beads for both integration in clothing and chemical filters. We will discuss the process to make beads with a range of MOFs and the capture and destruction of a range of chemical simulants, CWAs, and TICs such as sarin and mustard. We will discuss the application of the beads to clothing, filters cartridges and general adsorption that can be applied to a wide range of PPE.

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