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Multifunctional Electrospun Membranes On Nylon-cotton Fabrics For Warfighter Chemical Protection

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Functionalized fabrics, with breathability and moisture permeability, for chemical protection are important for warfighter uniforms and, potentially, as air filtration membranes. Multi-nozzle electrospinning onto 50% nylon/cotton (NYCO) substrates has been investigated using spin dopes prepared from TPU dissolved with ethyl acetate in dimethylformamide (DMF) and blended with UIO66-NH2, a zirconium-based metal organic framework (MOF). Fire retardancy has been imparted to the coated NYCO by pre-treating it with tannic acid (TA) prior to electrospinning and by mixing TA into the electrospinning solution. The coated NYCO has been characterized by field emission scanning electron microscopy (FE-SEM) and X-ray photoelectron spectroscopy (XPS), and the electrospinning conditions have been optimized to give air-permeable membranes on NYCO. FE-SEM shows a highly porous membrane with excellent fiber alignment and MOF distribution. The thermal insulating properties of the fabrics have been measured, along with their flame retardancy using the vertical flame test, and the chemical protection ability of the coated NYCO has been assessed using a custom-built photoionization detector-based system to measure permeation time of a chemical agent through the fabric. The coated NYCO fabrics are shown to be fire retardant and active with respect to sorption of the nerve agent simulant dimethyl methylphosphonate (DMMP). The permeation time of DMMP through MOF-containing NYCO coatings are proportional to the MOF concentration within the coatings and significantly higher than control TPU-coated samples that do not contain MOF. The multi-nozzle electrospinning technique used is scalable, amenable to manufacturing, and has the potential to revolutionize chemical protection for the warfighter uniform.

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