PROTECTION - SCIENCE AND TECHNOLOGY ADVANCES FOR CHEMICAL AND BIOLOGICAL PROTECTION

Integrated Soldier Protection System (isps): A Nanomanufactured Textile Composite Designed For In Situ Chemical And Biological Agent Neutralization

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The landscape of potential chemical and biological (CB) agents encompasses a wide variety of ever evolving, broad acting, highly pathogenic, and sometimes immediately lethal threats. The state-of-the-art (SOA) for individual personal protection equipment (PPE) against CB threat exposure is the use of multi-layered suits constructed from impermeable barrier materials, activated sorbents, full-face respirator masks, boots, and gloves. Protective gear postures differ depending on the known or assumed threat identity, and the likelihood of exposure. Regardless of posture, existing gear is bulky, uses static barrier materials (activated carbon and butyl rubber), is difficult to don, and severely restricts the operator's performance due to weight, bulk, poor moisture vapor transport and high thermal burden. Importantly, SOA sorbent-based and barrier technologies do not render threat contaminants inactive. This lack of active decontamination within existing CB ensembles inherently limits the lifetime of these garments and puts wearers at risk for transfer hazards and secondary exposure during doffing, complicating the logistics of CB operations. Despite advances in the CB defense over decades, current PPE solutions add logistical, mobility, and thermal challenges which place warfighter health and mission success at risk. The warfighter has an imperative need for an improved approach to PPE that enables greater maneuverability, more time on target, and most importantly increased safety.

Herein we describe a new type of silver and carbon-free, self-decontaminating textile capable of active neutralization of both chemical and biological threat agents on contact. The Integrated Soldier Protection System (ISPS) textile solution, developed as part of the Defense Advanced Research Projects Agency (DARPA) Personalized Protective Biosystems (PPB) program, combines broad spectrum chemistries for CB agent self-decontamination with filtration technology to generate functional composite garment textile materials for protection applications. The core layer of the ISPS textile is uniquely manufactured via a co-electrospin-electrospray (co-ESES) process to co-integrate CB mitigants directly and homogenously within a polymer fiber network, distributing agent-detoxifying mitigant ubiquitously and at a high mitigant-to-polymer load ratio throughout the nonwoven structure. This core technology is combined with low-weight, high strength casings to generate a composite textile that provides enhanced CB protection capability over the current SOA PPE. The ISPS textile provides equivalent chemical agent protection as compared to SOA in Aerosol Vapor Liquid Assessment Group (AVLAG), Low Volatility Agent Permeation (LVAP) and Franz Cell testing but is 30% lighter in weight and actively decontaminates >94% agent challenge over a 24-hour period, with most decontamination occurring within the first 3-hours. Finally, as a gain-of-function over SOA PPE, the ISPS textile also provides excellent protection against biological agent challenges including >4 log reduction in viable microbes, spores, and viruses via AATCC100 and ISP18184, as well as >99% particle filtration efficiency.

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Teledyne FLIR kindly acknowledges the following for their contributions to the project:

• The Joint Program Manager Protection (JPM-Protection) and Joint Program Executive Office for Chemical, Biological, Radiological and Nuclear Defense (JPEO-CBRND) for providing samples of PPE standard garments.

• Dr. Robert Stote, Dr. James Touchette and Dr. Natalie Pommerantz from the Combat Capabilities Development Command (CCDC) Soldier Center (SC), Drs. Keenan Carnes, Sean Kinahan, Gabriel Lucero, and Damiel Ackerman from the National Strategic Research Institute (NSRI), Drs. Eric Carnes and Shanna Ratnesar-Shumate from the University of Nebraska Medical Center and Drs. Stanley Hulet, Linnzi Wright, William Creasy, Susan Byers, Christopher Ruppert, Jennifer Smith, Jennifer Hughes, Matthew Powers, Michael Sheely, Kelly Nobles, Todd Sickler, Amber Purgh and Gregory Peterson from the Combat Capabilities Development Command (CCDC) Chemical & Biological Center (CBC) for their invaluable technical discussion and sample testing services.