NEXT-GENERATION BIOAEROSOL DETECTION & IDENTIFICATION

Stabilization Of Critical Reagents For Cold-chain-free Global Deployment

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Most diagnostic and detection reagents, patient/environmental samples, vaccines, and therapeutics that are crucial to effectively track and combat infectious disease require continuous refrigeration or freezing to maintain their desired activities; this 'cold-chain' requirement leads to unnecessarily high acquisition, storage, and transport costs, as well as nightmarishly complex logistics, when such biosurveillance equipment must be deployed nation-wide or globally. We have developed the technology to incorporate expensive, scarce, and sensitive biologics into food-grade dry powders that protect them against various transport/storage/environmental conditions – like extreme shifts in temperature/humidity and exposure to X-ray-based screening – that would normally inactivate them almost immediately. Notably, we have shown that biologics stabilized using our methods and materials retain their activity for 1 year regardless of how they are shipped and stored.

Using our Superior Nebraska Aerosol Process (SNAP) of combining novel nanomaterials with food-grade excipients and evaporative processes that occur at body temperature, we can create a coating of self-assembled nanomaterials that stabilizes sensitive biomolecules against extreme temperatures, freeze/thaw cycling, vacuum, and high voltages. These new techniques and materials allow us to reduce the high acquisition, storage, and transport costs/difficulties normally associated with cold-chain logistics, while also protecting sensitive reagents/samples from a variety of conditions they could encounter when deployed in the field. As an example, PCR reagents (a mix of enzymes and nucleic acids) are widely used in most common clinical tests needed for infectious disease/pandemic management, as well as in globally-deployed biosurveillance equipment. These reagents must currently, however, be shipped on dry ice and stored frozen until use, without being subject to any thawing and refreezing, stringent requirements that dramatically increase the complexity and cost of acquiring and deploying inherently expensive and scarce biomolecules. In contrast, our new scaleable, translatable process allows us to take complex mixtures of temperature-sensitive liquid reagents – like the PCR mix – and convert them into a stabilized dry powder that can be easily shipped and stored under environmental conditions with no added coolants or desiccants. Dry powder products are then simply dissolved in aqueous buffer immediately before use, with no requirement for specialized laboratory equipment or consumables. Furthermore, since we have developed a general process compatible with a wide variety of reagents, we can stabilize nearly any biological reagent used in the multitude of testing modalities, vaccines, and therapeutics that are critical for public health management and biodefense at home and abroad, including far-forward and austere environments. In addition to dry powder products, our technology allows us to encapsulate and stabilize biologicals in other nanomaterials, such as thin-film coatings or bulk hydrogels, which, for example, facilitates environmental sampling when biologicals are stabilized in-situ on swabs or eliminates the need for certain liquid reagents when transparent thin-films of stabilized biologicals are applied directly to detector/diagnostic substrates. This new technology is currently TRL 8 after a decade of continuous support from various DoD agencies. Furthermore, since this technology has the potential to stabilize biologicals used in diagnostics, therapeutics, vaccines, and sensors, it is applicable to all military Roles of Care.