# MOF Vaccines—Decreasing the Dependency on Refrigerated Transport

Infectious diseases continue to pose a major threat to worldwide human health and lead to significant morbidity, mortality and healthcare costs. On the frontline of prophylactic care is vaccination, which is one of the most important preventative measures taken to reduce the threat of dangerous illness. Unlike small molecule therapeutics, vaccines are typically heat or freeze sensitive biomolecules that require constant refrigeration from the manufacturer to the clinic. The series of hand offs from manufacturer to shipper to distributer *etc.* is colloquially known as the *cold chain* and is one of the largest impediments for getting these life-preserving drugs to people living in remote or impoverished areas. *Furthermore, this cold chain in the biomedical field requires a tremendous amount of power, resources, and produces enormous amount of unrecyclable waste.* Domestically, a 2009 study by the US Department of HHS found of 45 vaccine providers monitored, none were meeting established cold chain protocols and 76% were exposing the vaccines to inappropriate temperatures before finally being administered to a patient. A second study found that this can result in a loss of up to 36% of their effective shelf life. The end result is that lot-to-lot variation in the strength of a vaccine means physicians can only assume the vaccine they are offering is an effective dose. This can be particularly worrisome if the patient is left to assume they are inoculated and then engage in high risk behaviors, substantially increasing the likelihood of pathogen transmission.

Our approach to addressing this critical problem is to encapsulate protein-based therapies in a biocompatible metal-organic coordination polymer framework that can be rapidly and completely disassembled by exposing it to the low pH environment of the skin. Upon encapsulation of the protein, the framework effectively “freezes” the protein preventing denaturation from heat or organic solvent. These properties are perfectly aligned for transdermal vaccine delivery by dissolvable microneedles. We plan to make microneedles using the same material dissolvable suiters are made from to allow for the slow release of vaccines into the skin. In the skin, the low pH will dissolve the framework into biocompatible imidazole and zinc salts. The unique property of the framework will allow us to process a vaccine *inside* the polymer matrix, keeping it safe for ultra-long-term storage and easy, sanitary, and quick dosing at any clinic in the world.

Jeremiah Gassensmith
gassensmith@utdallas.edu
The University of Texas @ Dallas