Nanoporous Particles as Encapsulation and Delivery Devices for Enzymatic Decontaminants

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Enzymatic degradation is an efficient method to decontaminate chemical warfare agents. Organophosphorus hydrolase (OPH) is an enzyme capable of degrading a wide range of neurotoxic organophosphonate nerve agents. One challenge in using enzymes for this application is their tendency to denature as a result of changes in their chemical environment, such as changes in pH or temperature. Other researchers have shown that denaturation can be decreased or even prevented by immobilizing enzymes within a porous solid. Immobilization of enzymes also provides an easier means of handling and transportation, minimizes protein contamination, and allows for efficient recovery and reuse. It also offers longer stability under storage and reaction conditions that may otherwise denature the enzyme. Mesoporous silica particles have several advantages as an immobilization support. They have a large range of pore diameters (20-500 Å), large surface areas (300-1500 m^2g^{-1}), are chemically inert, stable at elevated temperatures, and have surfaces that can be easily functionalized. Our research has shown that OPH is more stable and more active when immobilized on acid-prepared mesoporous silica (APMS) compared to that of OPH in free solution, in the presence of paraoxon, an organophosphonate that is structurally similar to nerve agents. This has been confirmed through the use of UV-Visible spectroscopy and ^{31}P NMR to determine the Michaelis-Menton kinetic parameters k_{cat} and K_M. Remarkably, immobilized OPH remained active after being heated to temperatures as high as 65 ˚C, for times between 24 hours and 1 month. Current research is directed towards extending the shelf life of the immobilized enzyme by using an encapsulation technique to further prevent chemical environmental factors from denaturing the enzyme. This work focuses on the use of hydroxyethyl cellulose as the encapsulator, with an environmentally triggered release by the fungus *Aspergillus niger*.