Optical Activation of Enzymatic Cascades with PNIPAM-coated Gold Nanorod Actuators

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Metabolic reactions within organisms rely on enzyme pathways, which catalyze fundamental biochemical reactions within cells. Recent publications conclude that interenzyme distance plays a significant role in enzyme activity, and that there is a spike in reaction rates when enzymes are within a certain range (~20nm) of each other. The goal of this research was to create a system to control interenzyme distance, so that enzyme activity could be regulated. Enzyme pair glucose oxidase (GOx) and horseradish peroxidase (HRP) were attached to an infrared-sensitive polymer-coated gold nanoparticle, so that IR exposure will cause the polymer to contract; the decreased surface area of the polymer after the contraction will theoretically increase the reaction rate of the enzymes significantly, as long as the contraction of the polymer brings the enzymes within less than or equal to ~20nm. After synthesizing the actuator, data was collected on the total ratio of the enzymes GOx and HRP on the polymers, as well as the number of each enzyme on each particle. With this information, the reaction rate can be effectively calculated by measuring the amount of substrate ABTS oxidized by HRP to ABTS+. The data of the reaction rates shows a significant increase in the production of ABTS+, and therefore an increase in enzyme activity, after the LCST temperature of the polymer has been reached.

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