Magnetically-Separable and Highly-Stable Nanoscale Enzyme Reactors in Magnetite-Coated Mesocellular Mesoporous Silica

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The substrate specificity of enzymes has great potentials to be employed in many applications such as chemical conversion, biosensor and bioremediation. However, the practical enzyme application requires demanding results in enzyme activation, stabilization, and recovery. To meet this demand, we have employed nanobiocatalysis approaches to achieve higher enzyme loading and activity, enzyme stabilization, and easy recovery. Magnetically-separable mesoporous materials have been developed by magnetite-coated mesocellular mesoporous silica, and used for the preparation of nanoscale enzyme reactors (NERs) based on a ship-in-a-bottle approach. NERs of two enzymes, α-chymotrypsin (CT) and lipase (LP), were prepared by crosslinking pre-adsorbed enzyme molecules, and proven to be highly active due to high enzyme loading, highly stable by effective prevention of enzyme leaching, and easily recyclable via a simple magnetic capture. For example, the activity of NER-CT was 34 times higher than that of simply-adsorbed CT, maintained the initial activity under shaking (250 rpm) for 30 days, and could be recycled uses for 35 times with negligible decrease of enzyme activity.