The Potential of Hierarchically Ordered Nanoporous Materials for the Biomimetic Nanocatalysts

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This work describes chemically functionalized nanoporous silica as a novel catalyst for the rapid hydrolysis of a phenyl ester. Work demonstrates a very simple and flexible approach to control surface reactivity on the nanometer scale using a self-assembled organic monolayer consisting of polar, (dihydroxyl, carboxyl, ethylene-diamine, and dihydroimidazole), and non-polar (isobutyl) groups. All five functional groups are an essential requirement in preparing an enzyme-like catalyst because of the synergistic effect and hydrophobic partitioning, which has been verified by a 13C CP-MAS solid-state NMR technique. Catalytic activities were obtained from the catalytic efficiency constant and specificity constant using Michaelis-Menten kinetics. Catalytic activities were close to those of a natural enzyme when 12% of the surface was covered by hydrophobic isobutyl silane. The rate of enzyme catalyzed activity was dependent on the energy of the transition state as defined in terms of an energy barrier derived from the relationship between transfer free energy and specificity constant.