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Enhancement of biocatalytic conversion of carbon dioxide using methyl-functionalized silica nanoparticles

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As chemical methods to reduce carbon dioxide (CO_2), catalysis, electrocatalysis, and photocatalysis methods have been studied to obtain valuable products such as methanol, formic acid, and formaldehyde from CO_2. However, chemical catalytic reaction methods require high-temperature and high-pressure operating conditions and electric/photodynamic energy, with the drawbacks of a low selectivity and overall conversion yield. Biological CO_2 transformation technologies have been highlighted as an alternative, because they have shown a high selectivity and conversion yield under ambient operation conditions. However, in a biological reaction process using a gas substrate, the overall reaction rate is limited by the low gas solubility and slow gas–liquid mass transfer rate. In this study, methyl-functionalized magnetic silica nanoparticles (methyl-MSNs) were synthesized and applied to a CO_2–water system to evaluate gas–liquid mass transfer. The addition of methyl-MSNs increased the solubilized CO_2 concentration by 31.1% and the volumetric mass transfer coefficient was 78.3% higher than that in a control experiment without nanoparticles. The addition of methyl-MSNs in the formate dehydrogenase reaction resulted in a 12.0% increase in formic acid production and could decrease the reaction time required to finish the batch enzyme reaction from 1.5 h to 1.0 h. This result showed that the addition of methyl-MSNs could be useful for biological processes, including enzyme reactions, when using a gas substrate to improve productivity.

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Biography

Byung-Keun Oh received his Ph.D. degree in Chemical and Biomolecular Engineering at Sogang University for his work on protein chip for detection of pathogens existing in contaminated environment in 2003. He worked then as a postdoctoral fellow in Northwestern University from 2004 to 2006. In 2006, he joined the faculty as a professor in Department of Chemical and Biomolecular Engineering at Sogang University. His research interests mainly lie in the interdisciplinary area which can be termed as "biotechnology and bioenergy", especially the development of nanoparticle-based biodetection schemes and the enhancement of biological conversion efficiency in gas based fermentation.

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