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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 transformation technologies have been highlighted as an alternative, because they have shown a high selectivity and conversion yield under ambient operatic conditions. However, in a biological reaction process using a gas substrate, the overall reaction rate is limited by the low ga 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. e addition of methyl-MSNs increased the solubilized CO_2 concentration by 31.1% and the volumetric mass transfer coe cient was 78.3% higher than that in a control experiment without nanoparticles. e 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 nish the batch enzyme reaction from 1.5 h to 1.0 h. is 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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