Photocatalytic reduction of CO_2 to C_1 fuels by (Ni/ZnO)@C nanoreactors

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Abstract

The (Ni/ZnO)@C core-shell nanoparticles were prepared by carbonization of Ni^{2+}- and Zn^{2+}-cyclodextrin complexes at 723 K for 2 h. ZnO and Ni encapsulated in carbon-shell were etched partially to form the (Ni/ZnO)@C yolk-shell nanoreactors for photocatalytic reduction of CO_2 to C_1 fuels. By XRD, it is clear that ZnO is the main zinc crystallite in the nanoreactors, and its nanoparticle size is between 10-20 nm. The TEM images of the nanoreactors indicate that Ni and ZnO having the nanosizes of 5-30 nm are capsulated in the porous carbon-shell that allows molecules to diffuse in and out for photocatalytic reduction of CO_2 to C_1 fuels. It is worth noting that ZnO in the (Ni/ZnO)@C yolk-shell nanoreactor plays the main photoactive role in photocatalytic degradation of methylene blue. However, excess Ni encapsulated in carbon-shell leads to a de-activity in photocatalytic degradation of MB and reduction of CO_2. By *in situ* FTIR spectroscopy, the disappearance of CO_2 is at the expense of formation of species containing CH and carbonyl groups, possibly related to yields of C_1 species such as HCOOH.

Keywords: *CO_2 reduction, photocatalysis, nanoreactors, yolk-shell, methanol.*

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