Semiconductor Photocatalysis of Bicarbonate to Solar Fuels: Formate Production from Copper (I) Oxide

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Abstract

Copper oxide-based photocatalysts, micron- and nano-sized, and silver nanoparticle-copper oxide nanocomposites (Ag/Cu_2O) were synthesized, characterized, and evaluated for the first time in the application of bicarbonate conversion to formate. The Ag/Cu_2O nanocomposite yielded considerable production improvement over pure copper oxides due to the role of silver as a plasmonic sensitizer. We attribute these marked production improvements to direct electron transfer (DET) from metal to semiconductor, and plasmon-induced resonant energy transfer (PIRET). These photocatalysts were studied in two different hole scavenger solvents (2-propanol and glycerol) using a solar simulator with air mass coefficient 1.5 and 0 (AM 1.5, AM 0) filters. Formate production increased significantly with AM 0 solar irradiation due to inclusion of the ultraviolet portion of the solar spectrum, and nano-particulate Cu_2O showed improved photocatalysis relative to micron Cu_2O. Green chemistry solvent, glycerol, proved to be a far superior hole scavenger in comparison to 2-propanol.