Conference on CO_2-based Fuels and Chemicals (Cologne, 23-24 March, 2022)

Topic: Advanced Technologies / Artificial Photosynthesis

Microreactors combined with innovative metal-organic aerogels for an efficient CO_2 photoreduction with visible light

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The continuous photoconversion of CO_2 into value-added products such as alcohols represents a promising approach to tackle the climate change challenge. Process performance, however, is up-to-date limited by the low photocatalytic activity and selectivity of the available semiconductor materials (particularly under visible light), as well as by the need of more efficient photoreactor configurations.

In this work, we propose the use of a planar optofluidic microreactor with enhanced surface-area-to-volume ratio, uniform light distribution, larger photon receiving area, flow control, and improved mass transfer, for the continuous photoreduction of CO_2 with visible light over a prepared photoactive surface containing Ti-based metal-organic aerogels. The materials are synthesized by cross-linking Ti(IV) oxide/hydroxide clusters with benzene-1,4-dicarboxylate (BDC) and/or aminobenzene-1,4-dicarboxylate (NH_2BDC) ligands into a colloidal gel, which supercritical drying results in meso/macroporous aerogels with surface areas ranging from 300 to 500 m^2/g. The novel photocatalysts are characterized by several techniques such as SEM/TEM, Raman, UV/Vis reflectance, or PL analyses, and their optical and physico-chemical properties are related to the production of alcohols in the illuminated microreactor in terms of production rate, apparent quantum yield, reaction selectivity, and solar-to-fuel efficiency. The effect of both microreactor configuration and operating variables is also assessed to optimize process performance. This study may therefore provide novel insights into the development of innovative systems for the transformation of CO_2 to alcohols with visible light.