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Title
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High-pressure CO₂ photoreduction, FSP and Z-scheme: a promising synergy

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The first successful attempts use light to catalyze a process were dated around the 1970s. Since then, photocatalysis was deepened and in the last years CO₂ photoreduction has gained attention as a possible way to valorize carbon dioxide. The main problem of this process is the low conversion and direct Z-scheme heterojunction seems to be a way to increase the catalyst efficiency¹. The latter are created joining two semiconductors together, with the effect to reduce the electron-hole recombination rate by quenching the photogenerated holes. High purity, thermally stable mixed metal oxides semiconductors can be obtained through Flame Spray Pyrolysis (FSP) synthesis. The FSP apparatus is reported in **Figure 1**. Both pure semiconductors, namely WO₃ and TiO₂, and Z-scheme composed of WO₃/TiO₂ in a 40/60 mass ratio have been synthesized through FSP synthesis. Ammonium metatungstate hydrate (AMT) and titanium tetra-isopropoxide (TTIP) were used as precursors. Dimetilformamide (DMF) was used as solvent. Catalysts have been tested in a three-phase high pressure photoreactor². 18 bar have been used as operating pressure in presence of Na₂SO₃ as hole scavenger. The performances of the two bare oxides were comparable, although they showed a slightly lower productivity (ca. 14 mol/kg_{cat} h) compared to the P25 benchmark result (ca. 16,8 mol/kg_{cat} h). The Z-scheme WO₃/TiO₂ 40/60 showed an astonishing 2.5-times increase compared to FSP titania and about 2-times increase with respect to the benchmark P25 catalyst under the same conditions. XRD, BET, DRS, SEM/TEM analysis have been conducted to show the physical difference and to explain the improvement due to this promising synergy.

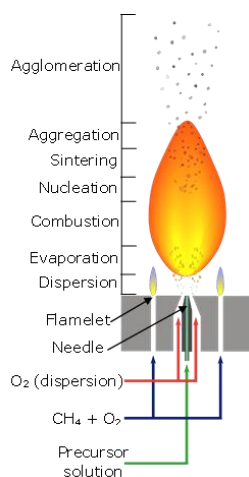


Figure 1: Flame-Spray Pyrolysis scheme.

Keywords: Carbon dioxide, Photoreduction, Z-scheme, FSP

References

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2. F. Galli, M. Compagnoni, et al., *Appl. Catal. B Environ.*, 200 (2017), 386–391, 10.1016/j.apcatb.2016.07.038