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A Feasibility Study of Integrating CO_2 Capture and Light-Driven CO_2 Conversion to a Fuel.

Dr. Junwang Tang Chemical Engineering
Prof. Zhengxiao Guo Chemistry
Kimfung Li (PhD) Chemical Engineering

Photocatalytic conversion of CO_2

Photocatalytic conversion of CO_2 to a more stable energy carrier like methanol using sunlight energy offers a sustainable solution to address unnatural rise in CO_2 level. We have previously demonstrate facile synthesis of nanostructured films that are sensitive to UV light irradiation. However, only less than 7% of sun radiation that reaches earth is in the UV range (Fig. 1), and the way forward to our project is therefore to develop visible light sensitive material with suitable bandgap to convert CO_2 to fuel.

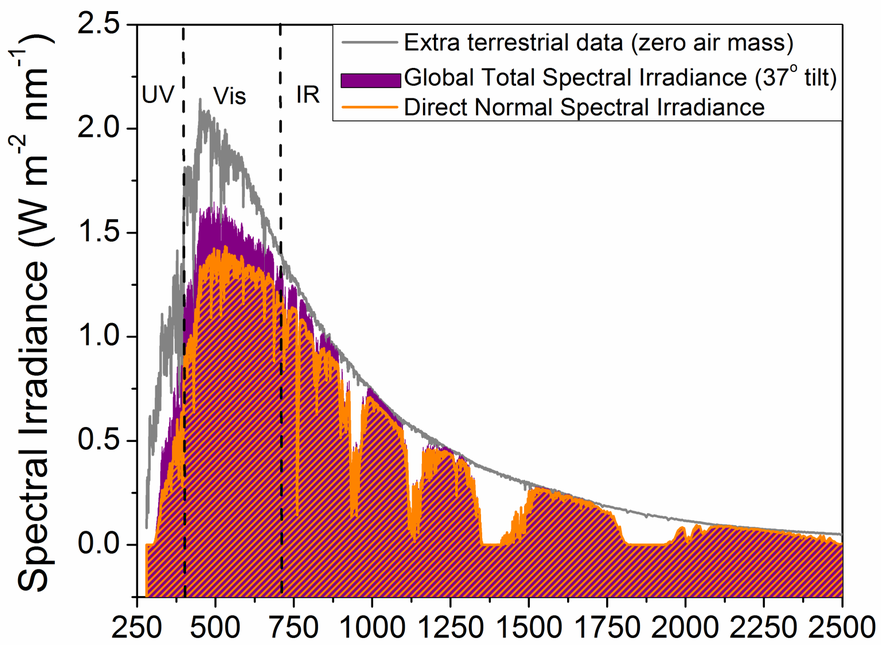

Figure 1: Spectra of Sunlight radiation. Plot based on ASTM G173 data modelled using the SMARTS2 (vesion 2.9.2) from Ref. 1 and 2.

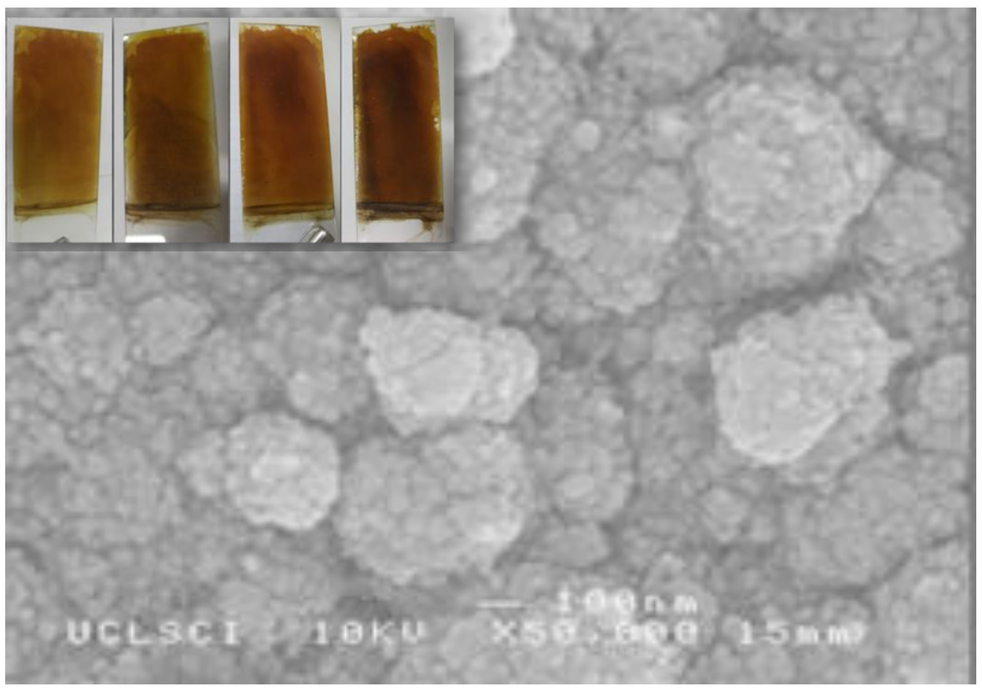

Figure 2: Solution grown Cu_2O film's morphology and its sensitivity towards visible light

Copper based photocatalyst

Copper and copper based nanostructures have been reported to be active for H_2 production with chemical scavenger under visible light irradiation[3], but no report on CO_2 reduction to fuel. Opportunities have been spotted on Cu_2O because of its appropriate bandgap for visible light excitation (around 2eV). Apart from the previous UV-driven materials, we have successfully grown Cu_2O film on glass substrate using a facile solution growth method (Fig. 2) that shows significant sensitivity towards visible light radiation.

CO_2 reduction

We have observed CO_2 photoreduction to fuel over Ta-containing photocatalyst previously developed by means of detecting evaporated methanol and CO after light exposure (Fig. 3). Currently, the amount of detected methanol and CO is still very low, possibly due to un-optimized photocatalyst and difficulties to quantify soluble products in water. Continuous investigation is underway to conduct quantitative analysis of CO_2 reduction activity in UV and visible light by means of photoelectrochemical measurements and optimization of the photocatalyst.

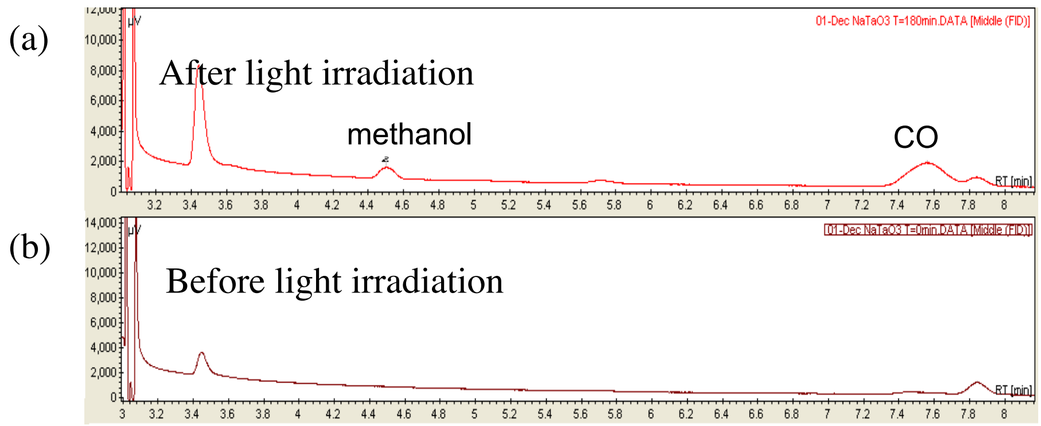

Figure 3: (a) GC results show methanol and CO yield when the synthesized Ta-based photocatalyst is exposed to light, (b) baseline of sample before exposure of light.

1. Gueymard, C., Solar Energy, Volume 71, Issue 5, November 2001, Pages 325-346.
2. Gueymard, C., Solar Energy, Volume 76, Issue 4, April 2004, Pages 423-45
3. Gao, F. et. al., Chem. Commun., 2009, 3571–3573