bridging the gaps

Sustainable Urban Spaces

MSc Competition 2009

UCL

CO_2 Capture and Photocatalytic conversion to a renewable fuel: Nanostructured photocatalysts

Dr. Junwang Tang Chemical Engineering

Prof. Zhengxiao Guo Chemistry

Afsoon Jamali (Msc) Chemical Engineering

CO_2 and global warming

While the existence of greenhouse gases (water vapor, CO_2, methane, NO_x, O_3 and CFCs) in the atmosphere is vital, unnatural rise in atmospheric concentration of greenhouse gases can raise global average temperatures to alarming levels. Of all the greenhouse gases, CO_2 is particularly harmful because it can linger in the atmosphere for tens of thousands of years[1]. Efforts to decrease atmospheric CO_2 levels have seen many research and investments activities towards the renewable sources like solar, wind, tidal and geothermal energies.

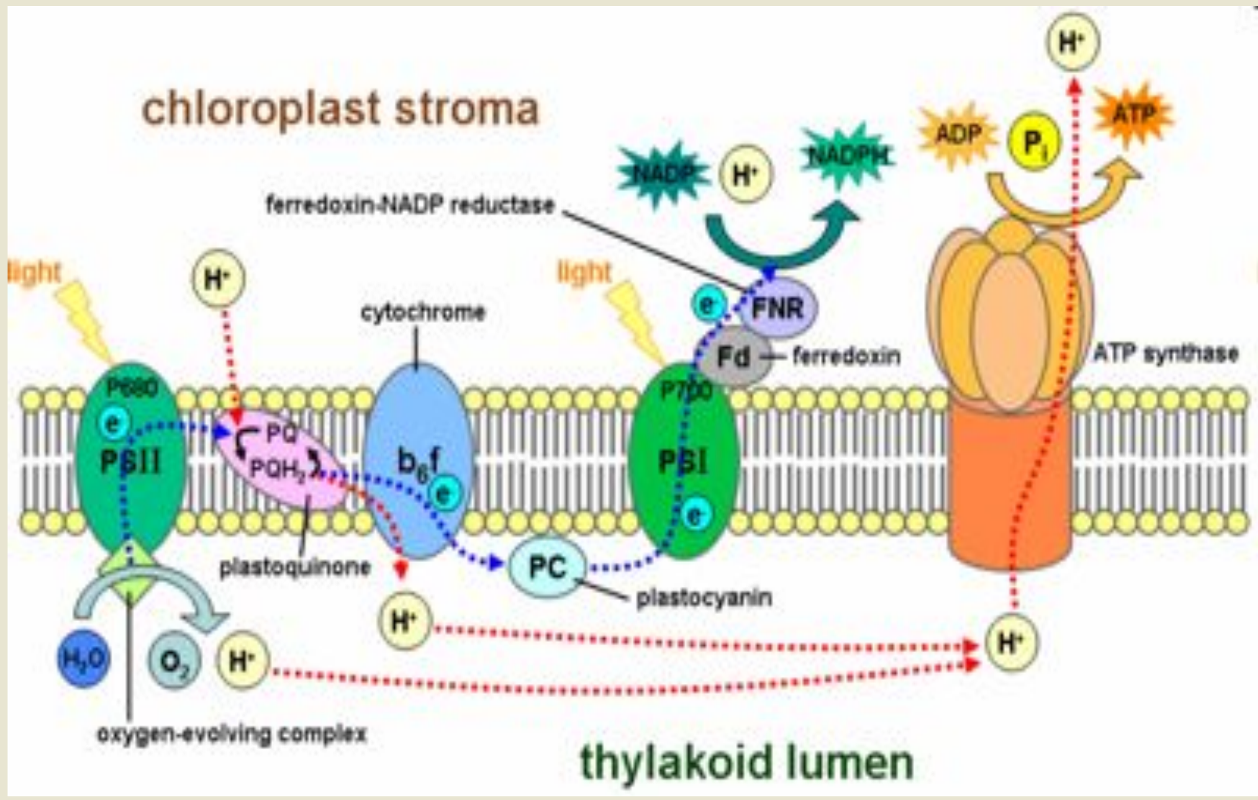

Fig. 1: Principles of photocatalysis.

Photocatalytic conversion of CO_2 to fuel

Currently large funding has been invested to the technology towards "instant" solutions to reduce CO_2 atmospheric level by means of CO_2 capture and sequestration in deep sea or earth mantle[3]. There is concerns on CCS because it is not sustainable, to some extent encourages higher consumption of the cheap fossil fuel and carries immense risk of leakage[4]. Photocatalytic conversion of CO_2 to a more stable energy carrier like methanol on the other hand uses renewable sunlight energy and offers a sustainable, closed-loop energy recycling, mimicking natural photosynthesis (Fig. 1 and equation 1).

$$2CO_2 + 6H^+ + H_2O \xrightarrow[\text{photocatalyst}]{\text{light}} 2CH_3OH + 1.5O_2 \quad (1)$$

Nanostructured photocatalst film

The main barrier in photocatalytic reduction of CO_2 is the rapid recombination of photogenerated electron-hole, even in nanoparticles[5]. Nanostructured photocatalyst films at least offer three significant benefits: lower both the electron-hole recombination; oxidation and reduction reactions occur at separated sites to mediate back reactions; do not need facility to separate oxidative and reductive products. We have successfully grown nanostructured TiO_2 (Fig. 2) , ZnO and Ta-based oxide films using a facile wet colloidal technique that are active in the UV light range for photocatalysis. Continued funding will enable us to step forward and compare the CO_2 reduction activity over diverse materials.

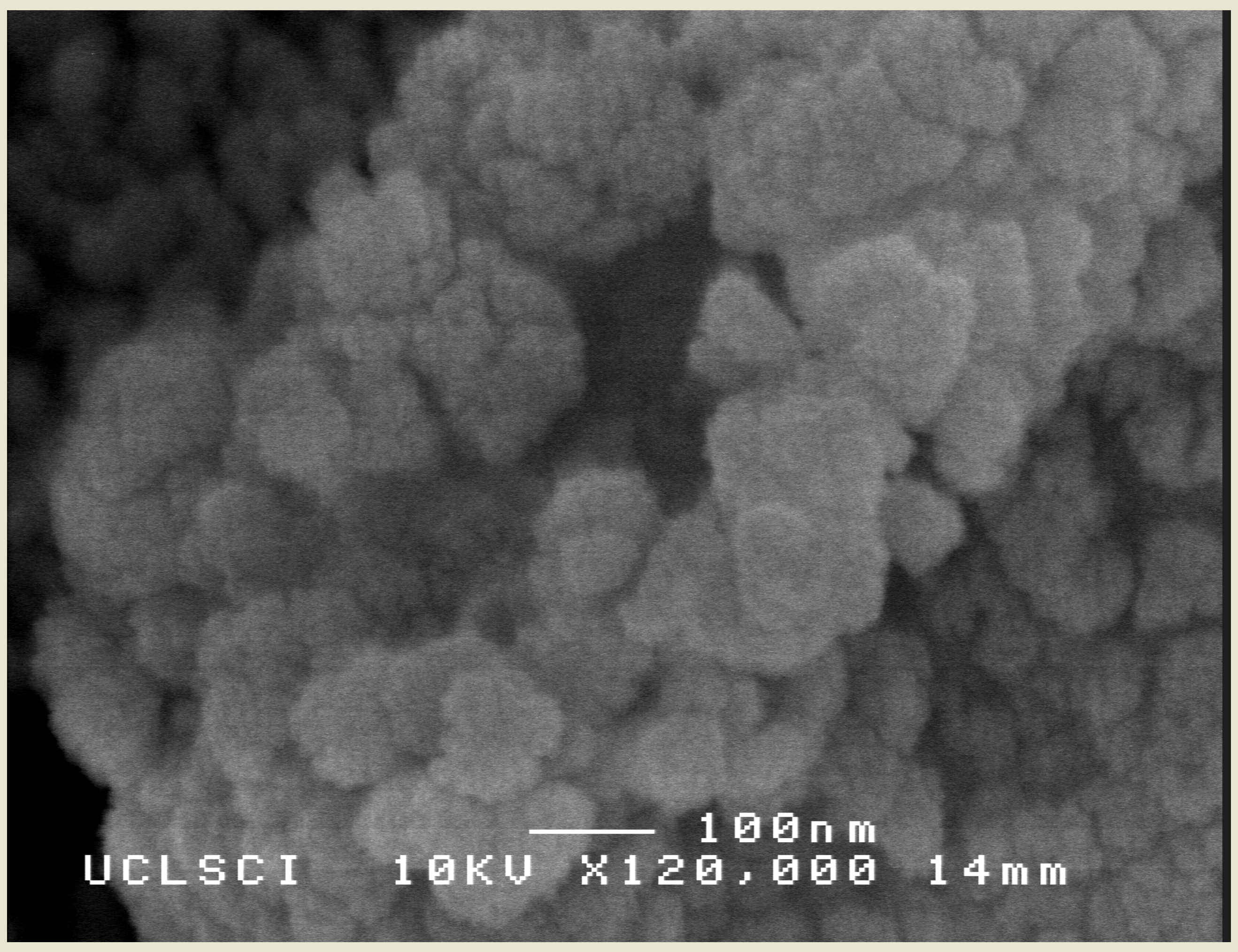

Fig 2: Nanostructured TiO_2 photocatalyst grown by simple wet-colloidal method.

1. Archer, D., J. Geophys. Res., 110, C09S05 (2005)
2. Somnath C. Roy, Oomman K. Varghese, Maggie Paulose, Craig A. Grimes ACS Nano 2010 4 (3), 1259-1278
3. Charles, D., Science, 2009. 323(5918): p. 1158.
4. Bockris, J. O' M., International Journal of Hydrogen Energy, 35, 5165-5172 (2010)
5. Junwang. T, J.R. Durrant, D.R. Klug, Journal of the American Chemical Society, 130, 13885-13891 (2008)