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Photocatalytic conversion of CO_2 to hydrocarbons over metal doped TiO_2: Artificial Photosynthesis

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Background

The increase of atmospheric CO_2 to values considered menacing to human life, urged mankind to address the problem. The most sustainable solution is the conversion of CO_2 to CO or hydrocarbons, such as methanol:

$$CO_2 + 2H_2O \rightarrow CH_3OH + 1.5O_2 \qquad \text{(Eq. 1)}$$

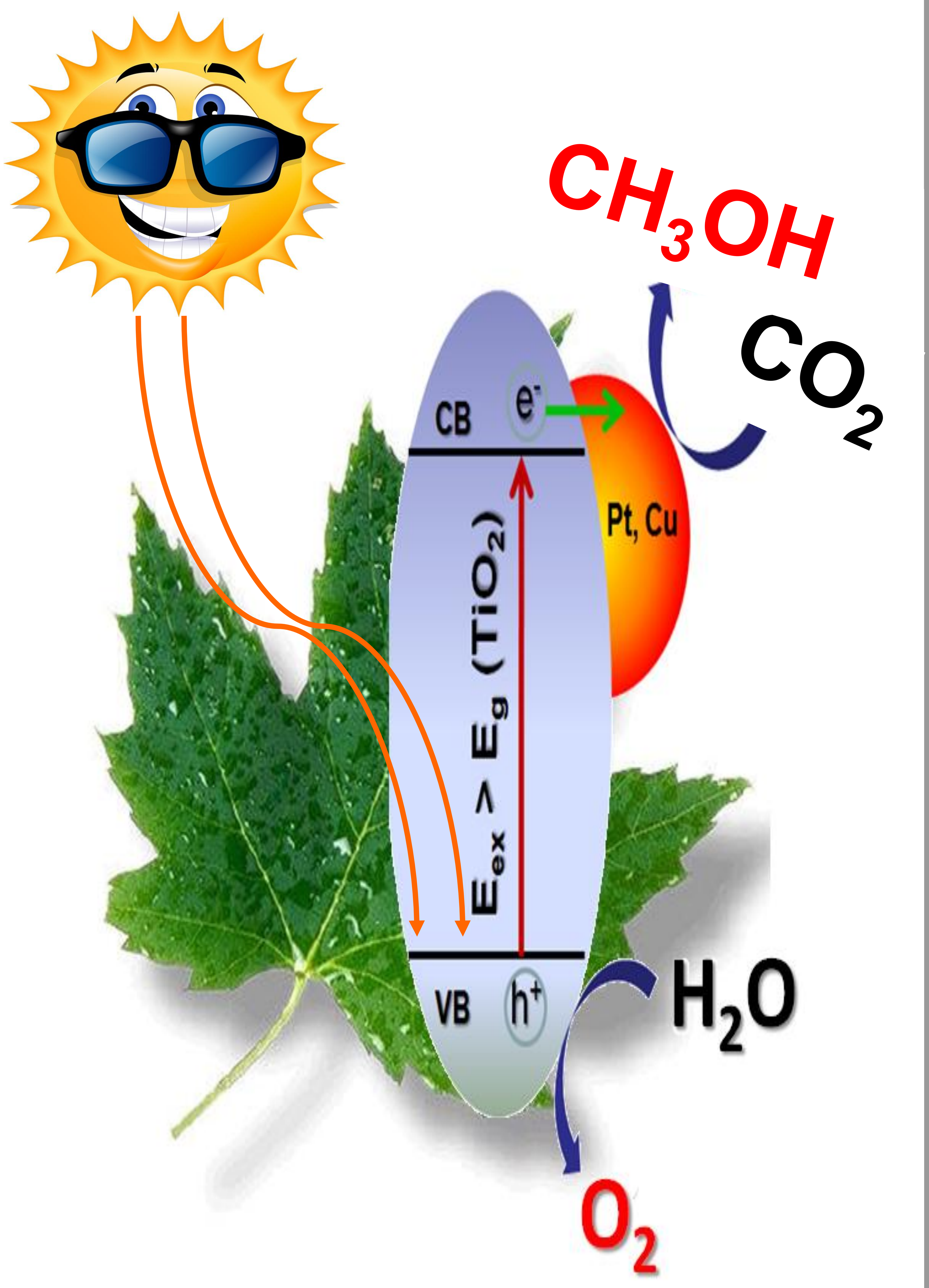
Such conversion is endothermic, meaning that energy needs to be added for it to take place. The most suitable source of energy is the sun because it is free, clean and abundant. In nature, plants and some bacteria convert CO_2 and H_2O effectively into sugars and O_2, a process known as photosynthesis. Scientists have for a long time been infatuated with the prospect of performing photosynthesis artificially by means of photocatalysis. Metal-doped TiO_2 is able to split water [i] and photoreduce CO_2 to CO and hydrocarbons [ii] under UV irradiation ($E_{exitation} \geq$ Eg TiO_2 (anatase) = 3.2 eV).

Objectives of this study

- **Determination of electron dynamics**
- **Determination quantum efficiency of the photocatalytic process**

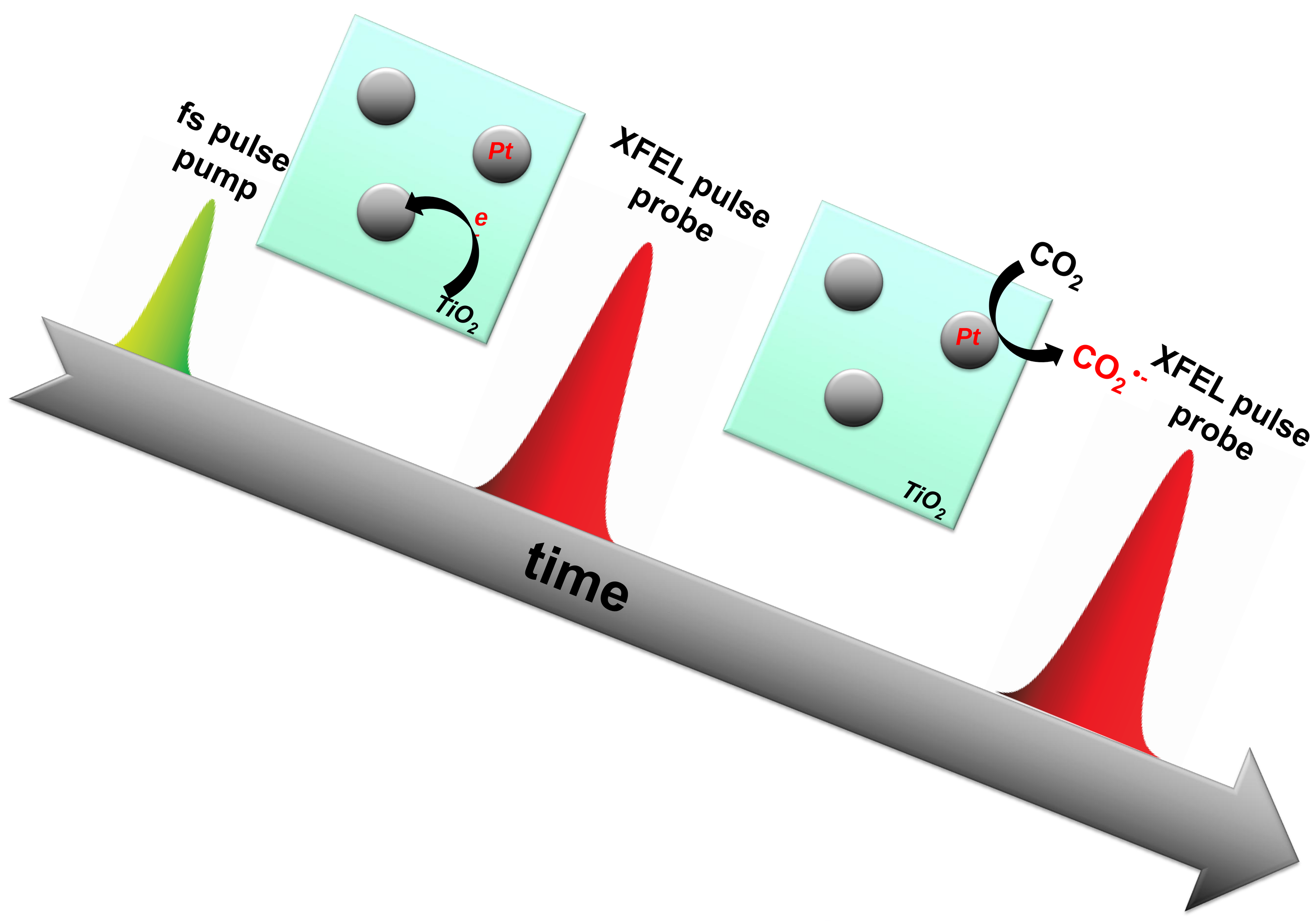
[i] A. Fujishima, K. Honda, Nature 238 (1972) 37.
[ii] S. C. Roy, O. K. Varghese, M. Paulose, C. A. Grimes, ACSNano 4 (2010) 1259.

Schematic representation of the process:

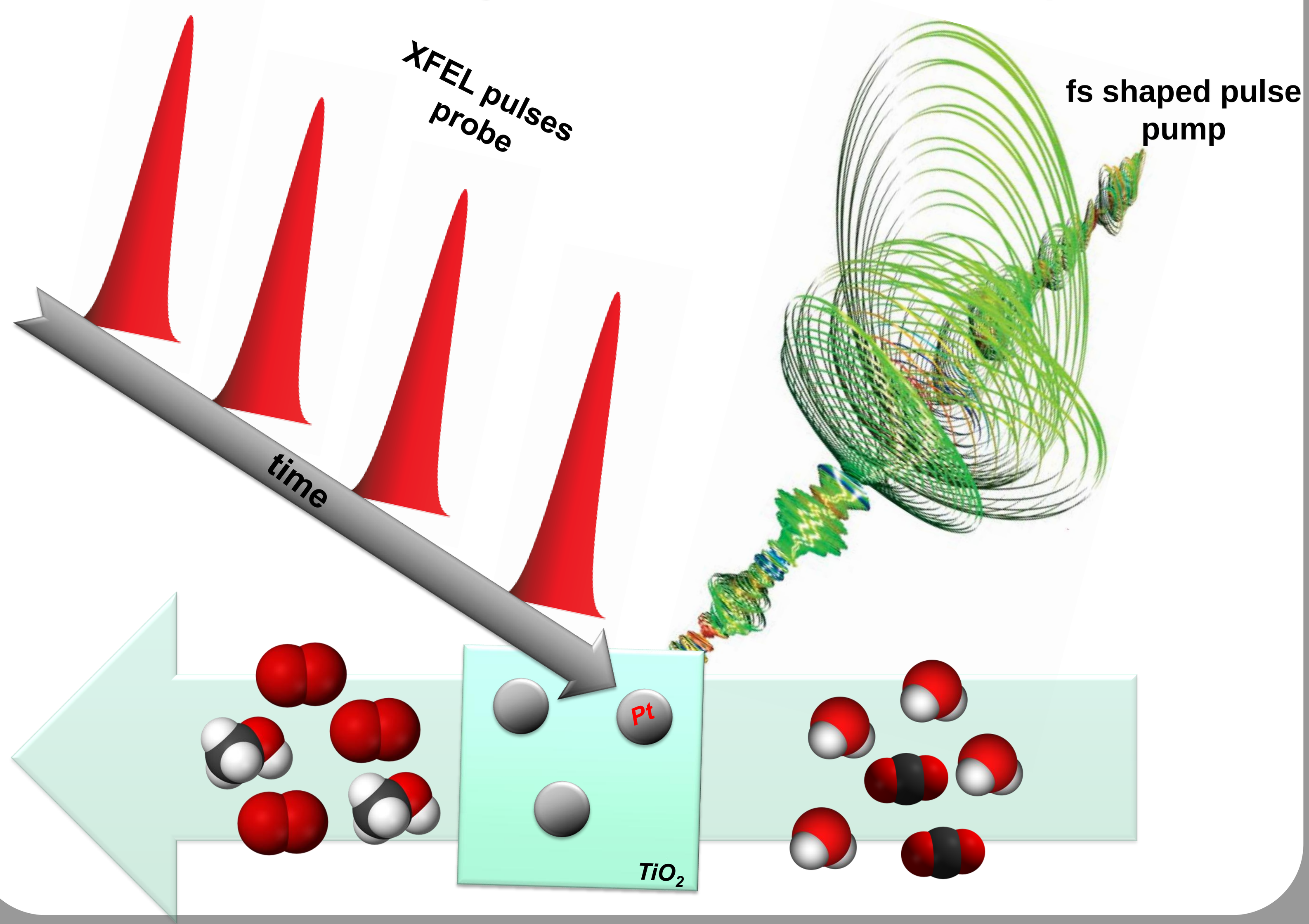


Proposed experiments:

Pump-probe for determination of electron transfer yield and time taken for each step



Quantum control: determination of catalyst state at different surface potentials



Remarks

We hope to achieve a fundamental understanding of the photoatalytic process, and thus the development of new materials with better properties, notable enhanced yield. The knowledge can be transfered to other catalytic process in which semicondutors doped with metal are used, since the reactivity is proportional to the net charge transfer [iii].

[iii](a) X. Ji, A. Zuppero, J. M. Gidwani, G. A. Somorjai, Nano Lett. 5 (2005) 753; (b) J. Y. Park, H. Lee, J. R. Renzas, Y. Zhang, G. A. Somorjai, Nano Lett. 8 (2008) 2388.