Interfacing Nature’s Catalytic Machinery with Synthesis Materials for Semi-artificial Photosynthesis

Semi-artificial photosynthesis interfaces biological catalysts with synthetic materials and aims to overcome the limitations of natural and artificial photosynthesis.¹ It also provides an underexplored strategy to study the functionality of biological catalysts on synthetic scaffolds through a range of techniques. This presentation will summarise our progress in integrating biocatalysts in bespoke hierarchical 3D electrode scaffolds and photoelectrochemical circuits.² We will first discuss the fundamental insights gained into the function of the water oxidation Photosystem II, where (i) unnatural charge transfer pathways have been revealed at the enzyme-electrode interface, and (ii) O₂ reduction that short-circuit the water-oxidation process has been discovered.³⁴ The wiring of Photosystem II to a H₂ evolving hydrogenase or a CO₂ reducing formate dehydrogenase has subsequently enabled the in vitro re-engineering of natural photosynthetic pathways. We have assembled efficient H₂ evolution and CO₂ reduction systems that are driven by enzymatic water oxidation using semi-artificial Z-scheme architectures.⁵⁷ In contrast to natural photosynthesis, these photoelectrochemical cells allow panchromic light absorption by using complementary biotic and abiotic light absorbers. As opposed to low-yielding metabolic pathways, the electrochemical circuit provides effective electronic communication without losses to competing side-reactions. Progress in the integration of robust live cyanobacteria in 3D structured electrodes will also be discussed.⁸

References

(1) Kornienko et al., Nature Nanotech., 2018, 13, 890–899
(3) Zhang et al., Nature Chem. Biol., 2016, 12, 1046–1052
(4) Kornienko et al., J. Am. Chem. Soc., 2018, in print (DOI:10.1021/jacs.8b08784)
(8) Zhang et al., J. Am. Chem. Soc., 2018, 140, 6–9

Date: 25th February 2019 (Monday)
Time: 11.00am to 12.30pm
Venue: SPMS Lecture Theatre 4
Host: Assistant Professor Soo Han Sen

For more details, please visit:

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