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Mimicking Natural Photosynthesis: Solar to Renewable H_2 from Water Splitting by Organic-Based Systems

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Visible light-driven H_2 production from water splitting using cheap and robust photocatalysts is one of the most exciting ways to produce clean and renewable energy for future generations. Cutting edge research within the field focuses on so called “Z-scheme” systems, which is inspired by the photosystem II / photosystem I (PSII/PSI) from natural photosynthesis. Organic/polymericsemiconductors have been identified as promising photocatalysts for H_2 production from water due to their comparative low cost and facile modification of the electronic structure. However, the majority only respond to a limited wavelength region (<460 nm) and exhibit fast charge recombination. Herein, we report an oxygen-doped polymeric carbon nitride structure with heptazine chains linked both by oxygen atoms and by nitrogen species, which results in a reduced band gap and efficient charge separation. A novel synthetic method has been developed to control both surface hydrophilicity and more importantly, the linker species in a polymer, which highly influences the band gap and charge separation. As such, the synthesized polymer can be excited from UV via visible to even near-IR (800 nm) wavelengths, resulting in a 25 times higher H_2 evolution rate (HER) than the previous benchmark polymeric g-C_3N_4 (λ>420 nm), with an apparent quantum yield (AQY) of 10.3% at 420 nm and 2.1% at 500 nm, measured under ambient conditions, which is closer to the real environment (instead of vacuum conditions). When the polymer is coupled with $BiVO_4$ as O_2 evolution photocatalyst, the system stably splits water into H_2 and O_2.This workpaves the way for more applications of solar energy conversion based on organic semiconductor photo catalysts and Z-scheme systems.

Biography:

Yiou Wang is currently on a doctorate programme in Dr. Junwang Tang’s Solar Energy Group at the Department of Chemical Engineering of UCL after receiving his BSc from Peking University, China in 2014.