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Research keywords: Artificial Photosynthesis, Tandem dye-sensitized solar cells, Supramolecular Photochemistry, Photocatalysis, Transient spectroscopy, Spectroelectrochemistry.

Efficient dye-sensitized photocathodes offer new opportunities for converting sunlight into storable energy cheaply and sustainably.[1] We are developing dye-sensitized NiO cathodes for the photo-reduction of carbon dioxide or water to high energy products (solar fuels) using the lessons we have learnt from solar cells.[2] The potential advantage of this strategy is it exploits the selectivity of a molecular catalyst in a robust device. Assembling two photoelectrodes in a tandem configuration (see figure) enables water oxidation at the photoanode to supply electrons to the photocathode to be consumed in the reduction of e.g. H^+ to H_2. Generating hydrogen on one electrode and oxygen on another enables the two gasses to be collected separately. Additionally, by separating the functions of light absorption, charge transport and catalysis between the colloidal semiconductor and molecular components, the activity of each can be optimised, rather than relying on one material to have all the necessary credentials. We are tackling the main limitations to photocurrent, by improving the quality of the NiO electrodes [3] and engineering new photocatalysts, to increase the quantum efficiency of the device. The electron-transfer dynamics are key to the performance and a major challenge is slowing down charge recombination between the photoreduced dye and the oxidised NiO so that chemistry can take place.[4] Highlights from recent work include examining charge-transfer at the interface between NiO and new supramolecular photocatalysts using transient absorption spectroscopy and time-resolved infrared spectroscopy.

References

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