Scientists Captured the Image of Charge Transfer in Photocatalyst Particles

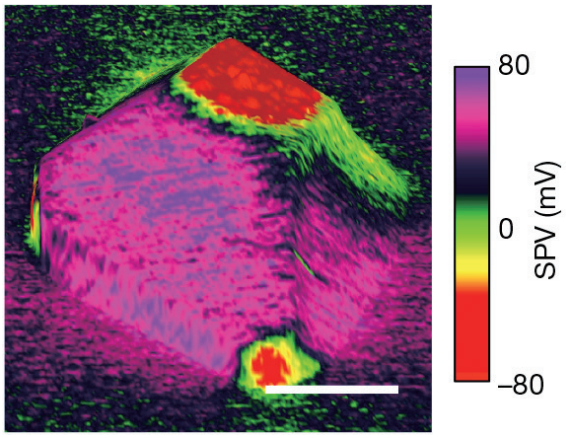
By YAN Fusheng (Staff Reporter)

A team of CAS scientists has made progress in understanding photocatalytic processes by monitoring excited charge carriers on single photocatalyst particles, which could lead to the development of new photocatalytic materials and a better understanding of how to tune photocatalyst particles for solar-to-fuel conversion.

Renewable energy has been at the forefront of research as scientists work to reduce our dependence on fossil fuels. One promising technology in this area is photocatalysts, which convert solar energy into chemical energy stored in the bonds of fuel molecules. However, to make significant progress in this field, a better understanding of how electric charges are generated and transferred within photocatalyst particles is necessary.

Recently, a team of scientists led by FAN Fengtao and LI Can from the Dalian Institute of Chemical Physics (DICP) of the Chinese Academy of Sciences has made an impressive leap forward in understanding photocatalytic processes. In the October 12 issue of *Nature*, the team reported on the monitoring of excited charge carriers on single photocatalyst particles. The findings have the potential to provide much-needed detail on photocatalytic processes.

The conversion of solar energy into chemical energy is particularly appealing for its application in long-distance vehicles. Photocatalysts can absorb sunlight, which excites the electrons of the material, causing them to transfer from the semiconductor to a molecule adsorbed on the photocatalyst's surface. One such reaction that is attracting attention is water splitting, which converts water into hydrogen and oxygen. The team studied particles of cuprous oxide (Cu_2O), which can promote water splitting when used with a suitable co-catalyst.



Scientists used facet and defect engineering to redistribute charge on the photocatalytic particles (indicated by SPV, mV) that facilitates the water-splitting reaction. (Image by DICP)

The scientists discovered that by altering the ratio of surface areas of two different facets in the Cu_2O crystals, they were able to produce particles that preferentially accumulated negatively charged electrons on one facet and positively charged holes on another.

Furthermore, they observed that the electrons migrated to the negatively charged facet within less than one picosecond (1 ps is 10^{-12} seconds) after light irradiation.

The team used time-resolved measurements to track changes in the electron population on individual facets with high temporal resolution. They observed that electron transfer occurred rapidly and that the rate at which hydrogen is generated can be directly related to the dynamics of electron and hole transfer in the photocatalysts.

The ability to track electron populations with high resolution in both space and time on a single particle will extend our understanding of the microscopic mechanisms underlying photocatalytic processes. These findings could lead to the development of new photocatalytic materials and a better understanding of how to tune photocatalyst particles for solar-to-fuel conversion.

Reference

Chen, R., Ren, Z., Liang, Y., *et al*. (2022). Spatiotemporal imaging of charge transfer in photocatalyst particles. *Nature, 610*(7931), 296–301. doi:10.1038/s41586-022-05183-1