Electricity and Fuels from the Sun: Understanding and controlling electron and energy transfer reactions in solar energy conversion materials

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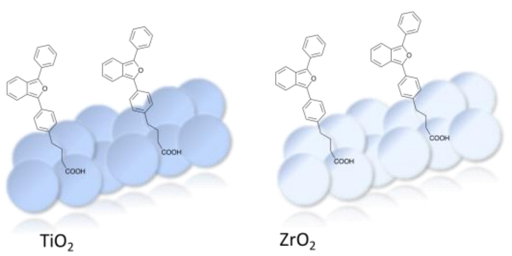
Ca 160 years ago, the first scientific article that showed that CO_2 is a greenhouse gas was published. And about 125 years ago, Swedish chemist Svante Arrhenius predicted that an increased amount of CO_2 in the atmosphere would lead to increased temperatures. Jump ahead to 1912 and the Italian photochemist Giacomo Ciamician stated that we should not use coal, but the sun, for our energy supply.

Solar energy has tremendous potential to be a central part of the transition to a more sustainable society. If we can increase the efficiency of direct conversion of solar energy into useful energy forms for us by just 1%, it corresponds to more than the entire combined potential of all other types of renewable energy (nuclear power not included).

In my research group we are concerned with conversion of solar energy into fuels and electricity and especially with the (multi)-electron and energy transfer processes that govern the energy conversion reactions. One of the avenues we are exploring concerns how we can manipulate the incoming solar radiation so that we can increase the efficiency of solar cells. This means we look into the process of singlet fission to better utilize sunlight with *higher-than-necessary* energies and photon upconversion to use the red part of the solar spectrum. Another avenue of our research concerns how we can store solar energy – in chemical bonds. Simply a way to make fuel from sunlight. One can think of several different end products, it could be hydrogen, or methanol or methane. These processes require moving a lot of charges. Issues with stability, and unwanted reactions occurring are common.

In the talk, I will give examples of how the environment and choice of material affects the electron and energy transfer rates and yields. For example, we have shown that by changing the polarity of the surrounding solvent, we can control the singlet fission dynamics. In order to further understand the environmental effects, we have also studied well-known singlet fission chromophores in gels, aiming at an understanding on how self-assembly in the solid state can be used to achieve efficient singlet fission.



References

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