Solar energy conversion with transparent photovoltaic and photoelectrocatalysis with semiconductors coated with molecules

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The increasing global energy consumption demands a greater variety of clean and sustainable power sources. In this context, transparent photovoltaic (TPV) is a disruptive and emerging technology in which the solar cells selectively transmit the visible light to human eyes but harvest UV and/or NIR photons or both. TPV can enter the market of building integrated photovoltaic (BIPV) with power-generating solar facades and can also equip greenhouses, car windows, sunglasses, providing thus an immense potential to generate solar electricity outside the conventional house roofs and solar farms.[1] In this regard, dye sensitized solar cells (DSSCs) are particularly attractive as they present the unique features such as transparency for both sides, which allows intrinsically see-through devices, color tunability with the choice of the dye providing high aesthetic property and finally they are relatively stable devices as proved by ageing tests. In the first part of this presentation, we will report the potential of pyrrolopyrrole cyanine dyes that selectively harvest NIR photons with unprecedented efficiency (4%) as regards to their transparency (AVT =76%).[2]

In the second part of the presentation, we will focus on projects related on artificial photosynthesis, which is the second appealing option to develop carbon neutral energy resource and to produce added-values chemical commodities to replace the current petrochemical feedstock to close the carbon cycle. Towards this goal, we have designed dye sensitized photoelectrosynthesis cells (DSPECs) for alcohol oxidation using TEMPO derivatives[3] for upgrading biomass derivatives into added-values commodities. Moreover, it will be presented photoelectrochemical devices for solar driven CO_2 reduction with catalysts made of abundant elements (Co and Fe complexes) grafted on a classical semiconductor used in photovoltaic such as $Cu(In,Ga)Se_2$ (CIGS).[4] Scope and limitations of such approaches will be also discussed.

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