Nanotechnology applied to solar energy devices

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Solar devices allow the use of solar radiation by converting renewable but scattered energy into more concentrated and directly useful energy such as electricity or green hydrogen.

The most developed solar conversion technology is photovoltaics, especially silicon. It can be considered mature and is entering a second major phase as a power source for electrolysers to produce green hydrogen. Increasing the efficiency of solar cells is therefore essential. However, the last laboratory efficiency record for c-Si cells was six years ago, with a value of 26.1% in 2018,4 very close to the theoretical value of 31%[1] . Since then, there has been no evidence of significant improvements in the electronic design of the cell. As a result, alternative and disruptive strategies for performance improvement have been under development.
The use of spectral converters is one of the most promising approaches. These are compounds derived from rare earth elements. They can absorb solar radiation outside the spectral response of the solar cell and re-emit it in a wavelength range useful to the solar device. They are called down-converters (DC) or up-converters (UC), depending on whether ultraviolet or infrared radiation is used. They can increase the efficiency of c-Si devices to ~ 37% - 40% [2,3]. It is also easy to implement in other photovoltaic technologies.
Another promising solar application is the photoelectrolysis of water (PEC) (Figure 2). This system enables the direct conversion of solar energy into green hydrogen. This simplifies green energy generation and interconnection systems. The photoelectrochemical splitting of water is a process in which sunlight is used to drive the electrochemical splitting of water into hydrogen and oxygen. The key to this is the development of suitable semiconductors that are able to absorb solar radiation and generate electron-hole pairs with sufficient free energy to facilitate the corresponding evolution reaction (OER or HER)[4].

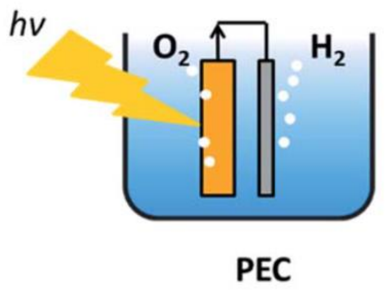

Figure 2. Photoelectrochemical (PEC) system diagram showing photoelectrodes immersed in electrolyte.

The introduction of new nanoscale and nanostructured materials will be particularly important in all these systems.

References

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Figures

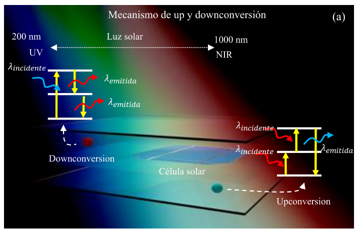
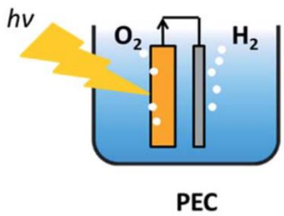


Figure 1. Arrangement of spectrum modifying particles in a photovoltaic (PV) device



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