Tunable plasmonic molecular rectennas to produce electricity from light

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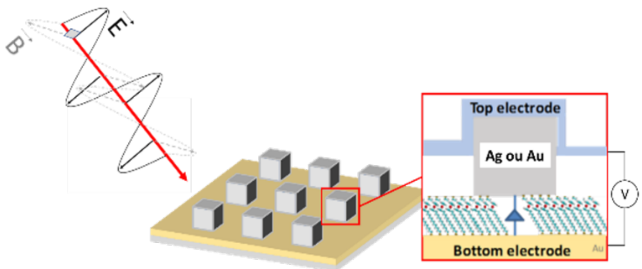
Current PV technologies do not allow to convert the whole solar spectrum into electricity, and most of light and flexible PV systems exhibit limited power conversion efficiency, typically around 20%. Indeed, PV devices exploit the particle nature of light and the working spectral range of a PV device is limited by its band gap, which is an intrinsic property of the semiconducting material. Therefore a system designed to have maximum efficiency under solar illumination, does not perform as well in indoor environments due to the different spectral range of artificial light. Hence, a PV module would have to be re-designed and optimized in its entirety (including the semiconductor material) for harvesting artificial light efficiently to supply electricity to low power autonomous systems (few hundreds of µW) such as detectors (temperature, pollution, toxic gas,…) and Internet Of Things (IOT) devices.

A promising way to solve this problem would rely on a technological breakthrough through the development of optical rectennas composed of plasmonic nano-antennas associated with rectifying diodes to directly convert light into electricity. The rectenna technology has two main advantages. The first one comes from the ability to convert electromagnetic waves into electricity from far infrared to the visible range of the solar spectrum with high-power conversion efficiency (PCE). The second advantage is related to the possibility of tuning this working spectral range within these limits to produce electricity from any light source.

Recently, a rectenna has been fabricated by e-beam lithography and an original bottom-up fabrication process has been patented at IM2NP [1]. Thanks to this design, we demonstrated a photo-electrical effect at a bias higher 0.3V resulting from rectification of light under an illumination at 1,55µm. These promising results allow IM2NP to be part of the few groups in word able to rectify optical frequencies. In the meantime, a new project on rectenna technology aims at investigating organic molecular high frequency diodes for rectenna applications. The last results obtained on these innovative light harvesting approach will be detailed.



Schematic representation of our rectenna proposed architecture

[1] D Duche, L Escoubas, U Palanchoke, JJ Simon, TS Balaban, patent EP 3 493 283 A1 (2017) / US Patent App. 16/762,126 (2020)