Dr Mariano Campoy-Quiles

Tenured scientist at Institute of Material Science of Barcelona (ICMAB-CSIC)

From colour-on-demand organic solar cells to solar thermoelectrics

Earth receives from the Sun electromagnetic radiation with wavelengths ranging from the UV (< 250 nm) to the mid IR (> 2500 nm). Typical solar cells having a single photoactive layer can harvest a fraction of the energy above their band gap (around 1000 nm). How can this range be extended to capture more efficiently the solar energy? Making solar cell stacks with active layers exhibiting different band gaps, aka tandem solar cells, has been the most widely used approach. Despite the academic success of this approach, commercial implementation has thus far being limited to niche applications due to the extraordinary fabrication complexity of tandem cells.

In this talk, I will present a series of new opportunities that emerge when using molecular based technologies, which are characterized by a low carbon footprint and amenability for chemically tuning their optoelectronic properties. First, I will demonstrate that multicomponent systems are the most efficient strategy to obtain a colour-on-demand solar cell technology [1]. As an example, I will show a greenhouse design that simultaneously optimizes photovoltaic performance and crop growth [2]. Then, I will introduce a high throughput screening method that enables the fast experimental evaluation of the complex parameter space of multicomponent systems aimed at obtaining panchromatic absorption [3-4]. Finally, I will discuss two methods of extending the harvesting capabilities into the infrared by two very different approaches. In the first, we use photonic structures to strongly enhance the charge transfer absorption [5]. In the second, we apply the Seebeck effect to directly convert heat into electricity through solar organic thermoelectric generators [6, 7].