VIDEO ARTICLE

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Simple Strategies to Produce Efficient, Green & Sustainable Organic Photovoltaic Devices

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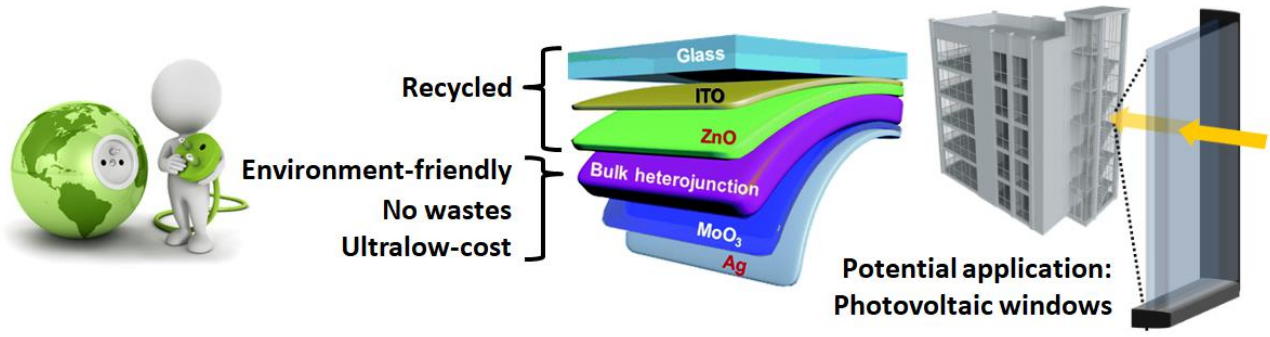
Graphical Abstract



Abstract

To achieve the global objectives for CO_2-emission reductions, it is essential to spread the use of green energies on a global scale. This can be achieved by developing new technologies such as low-cost solar cells that can harvest a highly abundant renewable energy source, namely, sunlight. Organic solar cells (OSCs) can be produced as semitransparent photovoltaic windows through low-cost solution processes such as spin-coating and are now regularly demonstrating power conversion efficiencies above 10% [**1**]. However, the following major issues need to be overcome to ensure that OSC can be manufactured in a safe, sustainable and economical manner in any country around the globe: (1) Ensure that the synthesis and processing of organic semiconductors (active materials) can be done without releasing hazardous products in the environment; (2) Reduce initial and running costs for OSC manufacturing; (3) Promote circular economy and reduce costly materials wastes. In this lecture, I will present our results related to several simple strategies to overcome the above-mentioned issues. To remove the necessity for advanced chemical synthesis, we propose to use natural photosynthetic dyes as active materials which can be easily extracted from carrot skins wasted by the food industry [**2**]. On the other hand, to avoid releasing chlorinated organic solvents into the environment, we introduce a modified miniemulsion technique to replace hazardous solvents with the eco-friendly water, [**3**] or an innovative active layer processing technique that considerably reduces the amount of used solvent [**4**]. In this innovative process called push-coating, minimal amounts of active layer solutions are spread through capillary forces which enable large-area coating without any active material waste. Despite being extremely low-cost, push-coated OSCs exhibit similar performances as OSCs fabricated through conventional active layer deposition. Although reducing the active layer cost is beneficial, to ensure that OSCs can be produced in developing countries, lowering the cost of the OSC electrodes is an essential step. This can be achieved by recycling transparent electrode substrates from OSCs or other organic electronic devices that have reached the end of their lifecycles [**5**]. Combining the various strategies proposed here should help further develop the OSC field and reach the requirements necessary for large-scale commercialization of this low-cost and easily integrated clean energy source.

Keywords: Organic semiconductors, renewable energy, photovoltaics, green & sustainable process, waste recycling.

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Biography of Presenting Author

Varun Vohra is a French researcher with Indian origins who has received his PhD in Materials Science from the University of Milan-Bicocca in Italy in 2009. He was a European Marie-Curie Early-Stage Fellow between 2006 and 2009, and was consecutively awarded two of the prestigious Japan Society for the Promotion of Science Fellowships in 2011 and 2012 for his studies on high efficiency organic solar cells (OSCs). Between 2014 and 2019, he was a Japan Science and Technology Agency Fellow Assistant Professor at the University of Electro-Communications in Tokyo and was promoted to Associate Professorship in March 2019. He is one of the pioneer researchers who successfully fabricated OSCs with power conversion efficiencies exceeding the milestone value of 10%. At the age of 36, he has published over 40 academic contributions including several papers as first author on journals such as *Nature Photonics*, *ACS Nano* and *Advanced Materials*. Although he continues to conduct fundamental research to elucidate the relationship between active layer nanomorphology and OSC performances, his current research projects focus more on innovative processes and materials for sustainable photovoltaic windows manufacturing which could be easily implemented in developing countries with minimal initial financial and energy investments. Additionally, his group has studied several approaches to reduce the negative impact of OSC fabrication on the environment.

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