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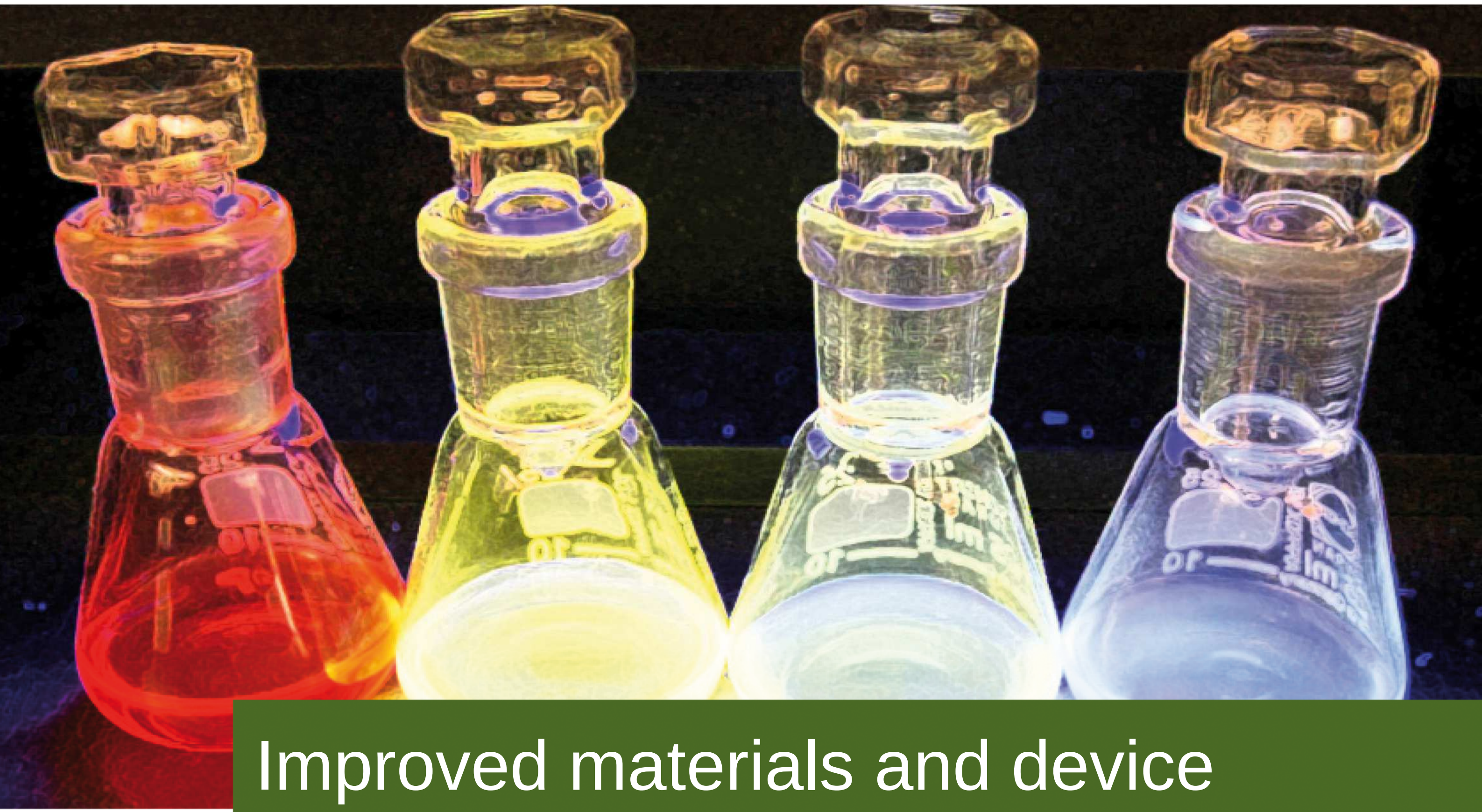

Improved materials and device architectures for polymers solar cells

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One of the prime challenges for further advancing the power-conversion efficiency (PCE) of polymer-fullerene organic solar cells lies in developing new materials for photoactive layers and optimizing the device architecture by including suitable interlayers and second absorber layers. For a range of diketopyrrolopyrrole-based small band gap polymers we demonstrate how the molecular weight of semiconducting polymers is a crucial parameter in obtaining high power conversion efficiencies in the range of 6-8% for single junctions, with band gaps down to 1.3 eV. By extending the spectral response to the near infrared region, i.e. to photon energies below 1.5 eV it is possible to convert a larger fraction of the solar emission spectrum. By using interlayers and advanced anti-reflection layers it is possible to enhance the incoupling of light and photocurrent. When the new semiconductor materials are combined with a wide band gap material it is possible to make very efficient tandem and multi-junction devices. As an example we will present a newly designed, high molecular weight, small band gap semiconducting polymer that provides high photon-to-electron quantum efficiencies down to 1.3 eV and reaches PCE = 7.0% in single junction cells with a fullerene acceptor and PCE = 8.9% in tandem cells, when combined with a wide band gap polymer-fullerene cell. The high efficiency of the tandem cell is achieved by an almost perfect complementarity of the absorption spectra of the two absorber layers that reduces thermalization losses.