NEW APPROACHES TOWARDS ORGANIC PHOTODETECTION AND BIO-INTEGRATION

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Organic semiconductors technology has only recently started to merge with biology and medicine, especially in the field of polymeric coatings as protective layers for artificial devices. Very few examples, however, report the use of semiconducting polymers as active materials in the bio-environment.

Here we demonstrate hybrid, solid-liquid photodiodes, in which a semiconducting polymer film (poly[2-methoxy-5-(2'-ethylhexyloxy)-p-phenylene vinylene], MEH-PPV) is deposited on an Indium-Tin Oxide anode and contacted to various liquid ionic cathodes (water, saline solutions, physiological buffers, cell-culturing media), instead of commonly used metallic cathodes. In the double-phase device, in contrast to conventional photodiodes, ionic transport inside the liquid medium plays a key-role. Remarkably, the conductance type changes from mainly electronic, in the polymer film, to ionic, at the semiconductor-electrolyte interface and in the liquid phase. Such unconventional devices display good behaviors in photovoltaic regime. We give a complete opto-electronic characterization of the devices, discuss the peculiar properties which stem from the hybrid solid-liquid nature and propose a physical-chemical explanation of the working principle. The main differences between hybrid and conventional photodiodes, related to interface phenomena between the polymer film and the cathode, are extensively investigated as well; to this goal, we study the effect of ionic liquid media onto the photophysics of conjugated polymers, comparing the behavior of polymer bulk and polymer-liquid interfaces by means of several time-domain optical probes.

Additionally, we demonstrate that this hybrid device can be an interface for communicating with a neuronal network grown on top of the organic layer. The organic semiconductor behaves as photo-window for an unconventional and unprecedented organic-bio communication protocol.

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