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Organic electronics allows the photo-electric excitation of neuronal activity in primary neuronal cultures and acute retinal explants

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Interfacing organic electronics and biology offers new possibilities in biotechnology, due to the unique properties exhibited by organic conducting polymers (e.g. biological affinity, mechanical flexibility, ease of functionalization and cost effectiveness). Organic conducting polymers have been exploited as materials for cellular interfaces in several fashions as: (i) passive electrode coatings or culturing substrates, (ii) organic biosensors or (iii) actuators for neurotransmitter release and electrodes for controlled cell seeding, growth and activity detection. Very recently, an organic photovoltaic donor-acceptor blend has been exploited for neuron stimulation by a photo-electric process. With respect to previous examples with inorganic semiconductors, this system has several advantages including flexibility, no power requirement and biocompatibility. Here, we report the novel use of a single component semiconductor organic polymer for the direct control of neuronal activity. This interface, that is more efficient than the classical bulk hetero-junction interface, has the remarkable capability to evoke excitation of neuronal firing in response to illumination. We demonstrate that the polymer layer has the ability to induce action potential firing up to 20 Hz in cultured hippocampal neurons. Moreover, this interface has been exploited to restore visual response in retinal explants obtained from animal models of retinal degeneration (light-blinded albino SD rats). By recording local field potentials in the RGC layer, we demonstrated the ability of the organic conductive polymer to mimic the function of photoreceptors and induce retinal activation of retinal ganglion cells after light illumination. These results paved the way to the development of a new and disruptive technology for interfacing artificial devices with neuronal networks, with applications in neuroprosthesis and brain machine interface research.