P1.25

Organic electronics allows the photo-electric excitation and inhibition 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 and ease of functionalization). OCP have been exploited as materials for cellular interfaces in several fashions as: (i) culturing substrates, (ii) organic biosensors or (iii) actuators for neurotransmitter release and electrodes for controlled cell seeding, growth and activity detection. An organic photovoltaic donor-acceptor blend has been exploited for neuron stimulation. 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 has the remarkable capability to evoke both excitation and inhibition of neuronal firing in response to illumination. We show that both photo-stimulation and photo-inhibition can be obtained through the same general method, by simply adding or removing the conductive electrode (ITO) underlying the organic layer. 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 LFP 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 retinal prosthesis.