Graphene-based light-sensitive interfaces for retinal prosthetics

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G conductive properties have been long exploited in the field of organic photovoltaics and optoelectronics by the scientific community worldwide as well as in the Graphene Flagship. We engineered a G-based device coupled with photosensitive polymers, and tested its ability to elicit light-triggered neural activity modulation *in vitro* on primary neurons and *ex vivo* on retina explants. We designed and fabricated such a multi-layered G-based device mimicking a simple three layers retinal prosthetic, previously reported to rescue light sensitivity and visual acuity in blind rodents, composed by: a flexible substrate, to allow for prime conformability and easy *in vivo* surgical procedure, the conductive polymeric layer PEDOT:PSS to enable charge separation, and the rr-P3HT light-transducer layer. The new prototype target a higher light sensitivity while preserving flexibility and biocompatibility: CVD-G substitution of the PEDOT:PSS conductive layer improves charge separation with a consequent enhancing of the photo-conversion efficiency. The new G-based device has been characterized from an electrochemical point of view and in contact with primary neurons and blind retina explants. Light-triggered responses have been recorded by Patch-Clamp or MEA techniques *in vitro* and *ex vivo*, showing a stronger light-transduction efficiency with CVD-G replacing PEDOT:PSS. The G-based device have shown functionality also after sub-retinal *in vivo* implantation in blind rodents, paving the way for potential biomedical applications of CVD-G in implantable stimulating devices, in the context of retinal implants.

Figures

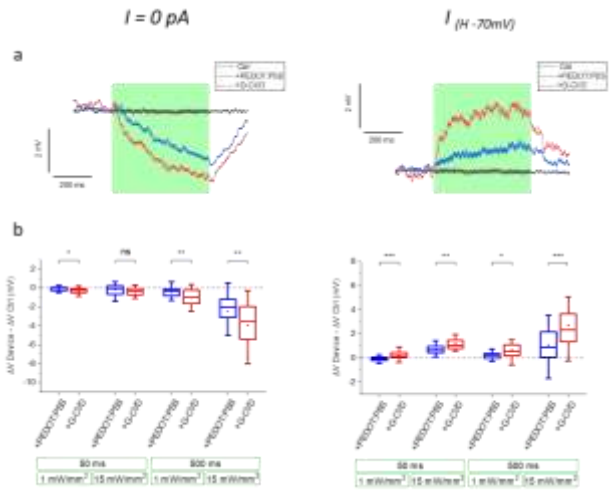

Figure 1: *in vitro* electrophysiology upon illumination. a) Representative current-clamp traces held at I=0 or at -70 mV on rat hippocampal neurons upon light stimulation layered on Control samples, and devices with PEDOT:PSS or CVD-G as conductive material. b) Statistical evaluation of the membrane voltage modulation triggered by light at different power densities and durations.

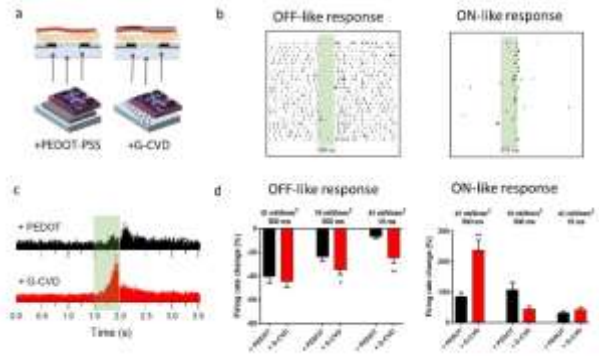

Figure 2: *ex vivo* electrophysiology upon illumination. a) Devices tested on MEAs in subretinal configuration. b) Representative raster plots of OFF- and ON-like light responses of RGCs. c) PSTH of the light triggered firing activity of RGCs. d) Firing activity inhibition and activation in blind retinal explants upon 540 nm light stimulation at different power densities and durations.