A Bio-photoelectrolytic Organic Semiconductor Platform For Measurement And Control Of Proliferation And Behaviour Of Living Cells Using Light Pulses

Latest advancement in bioelectronics are focusing on the possibility to selectively control bioelectrical activity of living cells and tissues, *in vitro* as well as *in vivo*, for therapeutic and diagnostic (theragnostic) applications. In recent years, organic semiconductors have been shown to be promising for interfacing with biological systems because they are biocompatible, printable and their optical properties can be tailored.

A multidisciplinary international team from seven research institutes has published the results of their research work in an article in *Advanced NanoBioMed Research*, the open access journal from Wiley, which highlights the progress made in opto-electrical stimulation of living cells.

The team members are from University of Rome Tor Vergata (Department of Electronic Engineering and Department of Biomedicine and Prevention), Free University of Bozen-Bolzano (Faculty of Science and Technology), Istituto di Struttura della Materia CNR (CNR-ISM, Rome, Italy), Cicci Research srl. (Grosseto, Italy), Eurac Research (Institute for Biomedicine, Bolzano, Italy), and Pennsylvania State University (Department of Materials Science and Engineering, Pennsylvania, USA).

They designed a bio-photoelectrolytic platform based on semiconducting polymer thin films, onto which cell lines in a biological medium were cultured, that can be used in two different architectures: 1) the **open-top** for light stimulation of cells during culture (Figure 1, left); and 2) the **sandwich-closed** layout for bioelectrical signal measurements (Figure 1, right). The team demonstrated it is possible to inhibit cell proliferation (proliferative activity of cells is reduced by 50% respect to cells maintained in standard culture conditions) in a cancer cell line (neuroblastoma cells) by subjecting the platform to a series of light pulses over time (Figure 2). Light stimulation was found to increase the concentration of calcium ions inside the cells by three times, a phenomenon linked to the opening of cell membrane voltage-gated Ca^{2+} channels.

The closed-top architecture enabled recording of bioelectrical signals which support such a polarization behaviour of the cells and, after comparing with patch clamp measurements, was shown to be able to provide a tool for the initial recording of photovoltages that can complement analysis with more sophisticated electrophysiological tools (Figure 3).

The bio–photoelectrolytic platform and the effective use of light stimulation may open new avenues for *in vitro* light control/manipulation of cell behaviour, for the development of future novel *non-invasive* tools for application in bio-sensing, regenerative medicine and cell-based therapy, and for cancer progression control and therapy.

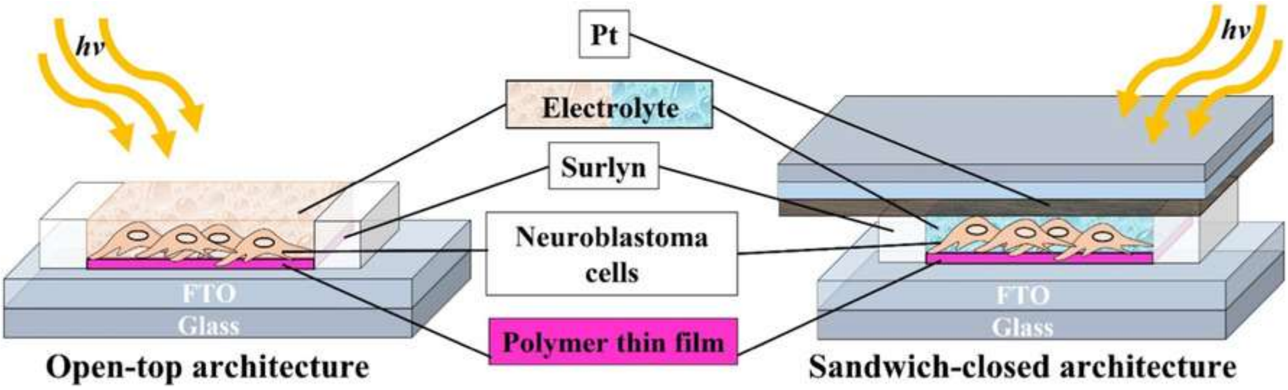

Figure 1: Conjugated polymer bio–photoelectrolytic platform. Schematic of the open-top (left) and sandwich-closed (right) architecture.

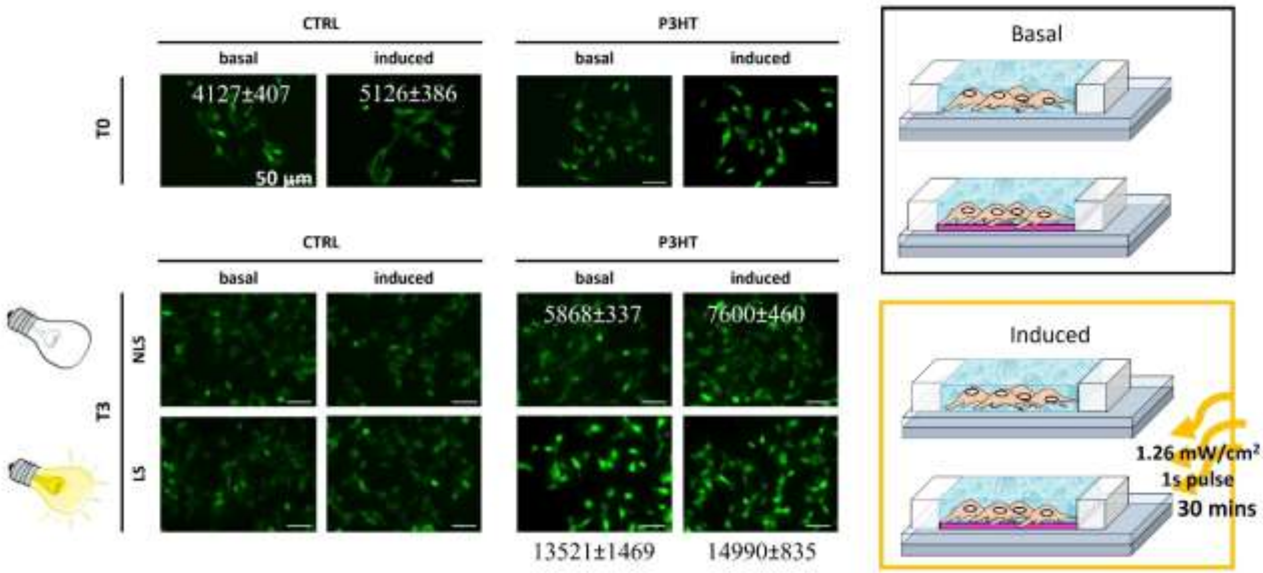

Figure 2: Cell calcium dynamics analysis. Images are acquired before (basal) and after (induced) 30 min of photostimulation. Green fluorescence is linked to the intracellular calcium levels, and indicated as correlated total cell fluorescence (CTCF) ± SEM. Scale bar 50 µm

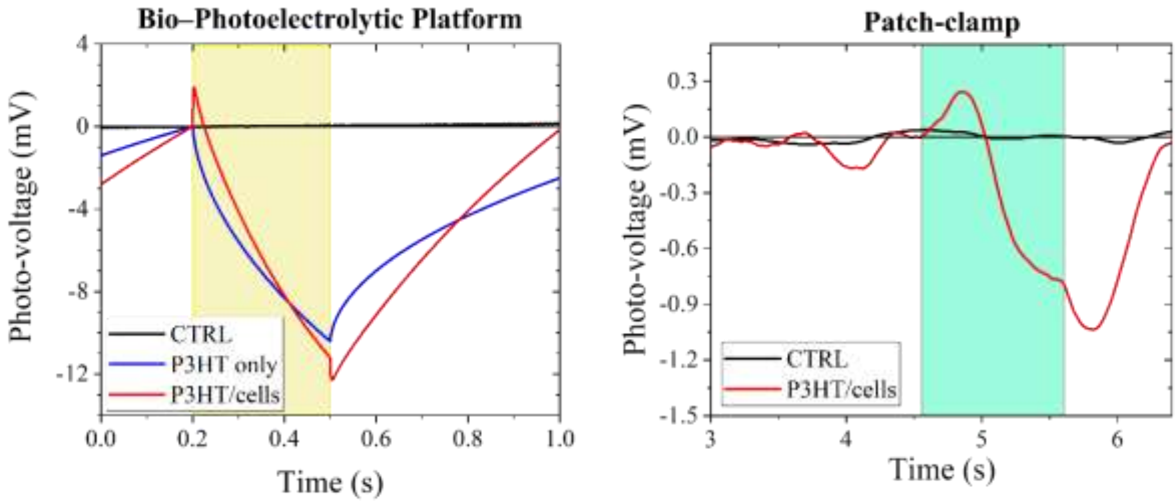

Figure 3: Bioelectrical signals recorded by employing the sandwich-closed bio-photoelectrolytic platform (left) and patch-clamp (right) from cells cultured on the semiconducting polymer thin film.

The results are published in Advanced NanoBioMed Research (open access):

"A Polymer Bio–Photoelectrolytic Platform for Electrical Signal Measurement and for Light Modulation of Ion Fluxes and Proliferation in a Neuroblastoma Cell Line" Manuela Ciocca, Serena Marcozzi, Paolo Mariani, Valentina Lacconi, Aldo Di Carlo, Lucio Cinà, Marcelo D. Rosato-Siri, Alessandra Zanon, Giada Cattelan, Enrico Avancini, Paolo Lugli, Shashank Priya, Antonella Camaioni,* and Thomas M. Brown*

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