NIM Guest Lecture

"Cell Stimulation by Polymer Photoexcitation (CSPP): a new tool, many open issues"

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Abstract:
Current research in Bioelectronics deals with the coupling of the worlds of electronics and biology. This coupling can go both ways, allowing the realization of new biosensors and bioactuators. Tools generated in this arena, such as medical diagnostics and bioelectronics implants, will dominate the future of healthcare and help increase the span and quality of our lives.

Organic electronics seems to be ideally suited for the interface with biology: the "soft" nature of organic materials offers better mechanical compatibility with tissue than traditional electronic materials, while their natural compatibility with mechanically flexible substrates suits the non-planar form factors often required for biomedical implants. Interestingly, their ability to conduct ions in addition to electrons and holes opens up a new communication channel with biology.

In this scenario, we reported the successful interfacing of light-sensitive conjugated polymers with different model cells, tissues, live animals. In the latest years, we demonstrated that optical excitation of the organic semiconductor leads to selective and reliable modulation of the activity of the living counterpart, by different phototransduction mechanisms (photothermal, photoelectrical, photoelectrochemical, and/or their possible combinations). Modulation of cells by polymer photoexcitation may lead to a new generation of neuronal communication and photo-manipulation

techniques, representing a simpler and valuable alternative to existing optogenetic tools. However, the necessary key to all these innovative technologies is a fundamental understanding of the interface between electronic materials and living cells, which is by far much more complex than conventional organic solar cells. Indeed, we deal here with both electronic and ionic charge conduction; different electrical, optical and chemical processes occur in the polymer bulk and at the interface with the physiological medium; the solid/liquid interface is not a 'static' system but modifies itself on both short and long (seconds and more) timescales and it is deeply affected by the presence of the *living* system, with which it closely interacts. Current knowledge about the photo-activated processes occurring at the conjugated polymer/living cell interface will be here summarized and critically discussed.