Abstract #85 | Oral

Piezoelectric materials for biomedical applications: From tissue engineering to cancer nanomedicine

G. Ciofani[1]

[1] *Istituto Italiano di Tecnologia, Smart Bio-Interfaces, Pontedera, Italy*

Electrical stimulation of cells and tissues is an important approach of interaction with living matter, which has been traditionally exploited in the clinical practice for a wide range of pathological conditions; standard methods of stimulation are, however, often invasive, being based on electrodes and wired connections. The possibility to achieve an indirect electrical stimulation, by means of piezoelectric materials, is therefore of outstanding interest for all the biomedical research, and it emerged in the latest decade as a most promising tool in many bioapplications [1].

The generation of small electric charges upon the application of mechanical stimuli to piezoelectric nanomaterials is a unique phenomenon in the context of remote stimulation of cells and tissues. Electrical cues are known to foster specific biological responses, and piezoelectric nanomaterials own the ability to act as real “nanotransducers”, thus allowing obtaining “wireless” and remote electric stimulation thanks to non-invasive excitation through mechanical sources (usually ultrasound or vibrations).

Piezoelectric nanomaterials are usually ceramic or polymeric, with piezoelectric nanoceramics typically showing higher piezoelectric features than polymers. Concerning piezoelectric polymers, poly(vinylidene difluoride) (PVDF) and its copolymers show the best piezoelectric features, and have been widely investigated to promote cell stimulation: some works of our group, as example, reported on PVDF-based nanocomposites for stimulation of neuronal [2] and bone [3] cells.

Finally, it is worth to mention the potentialities of piezoelectric stimulation of cancer cells. It is in fact well-known as low-intensity electric stimulation represents an alternative treatment able to affect cancer cells without the use of any drugs/chemicals, and to significantly enhance the effects of chemotherapy by reducing multidrug resistance. Recently, our group provided the first evidences of the efficacy of this antitumor approach mediated by piezoelectric barium titanate nanoparticles and ultrasound, respectively on breast cancer [4] and on glioblastoma multiforme [5] cells. Efforts are now focused on replacing inorganic and non-biodegradable ceramic materials with piezoelectric polymers (such as the aforementioned PVDF) exploitable in the clinical practice.

Affix

References

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