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Multifunctional, organic transistor-based platforms for the *in vitro* interfacing of 2D and 3D cellular cultures

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The rapid rise of organic bioelectronics has deeply affected the development of the field of *in vitro* cellular interfacing during the past 10 years. In fact, the last decade has been characterized by the introduction in the *in vitro* experimental practice of several different organic-based sensing structures (such as the organic electrochemical transistor, the organic charge field effect transistor, and several solution-gated organic FETs) that have been able to conveniently address (and sometimes brilliantly solve) common issues and shortcomings of pre-existing, standard technologies [1]. The *in vitro* electrophysiological field, with its constant need of increasingly accurate and accessible brain models, has particularly benefitted from this abundance of technological solutions, with important repercussions in biomedical domains such as the study of neurodegenerative diseases and personalized medicine. Moreover, the possibility of adopting innovative sensing devices and more and more convenient organic materials deeply broadened the plethora of possible solutions for the development of innovative multisensing tools for cellular applications, for example for the monitoring of important parameters such as the electrical and the metabolic activity [2,3], thus opening up interesting scenarios and new ways to approach such complex systems. On top of that, nowadays, cellular in vitro interfaces are undergoing a deep change of paradigm, thanks to the rapid evolution of increasingly refined tridimensional cellular structures (such as for example human induced pluripotent stem cells-derived neural and cardiac spheroids). This represents a very important step forward in a field that is still dominated by standard planar cultures, which has been limited for a long time by the lack of the physiological third dimension. In order to address all of this issues and present our outlook on the future of this exciting field, we here present a possible approach based on a flexible, multifunctional, and reference-less organic transistor-based system to *in vitro* cellular interfacing. This organic transistor-based platform can represent a very convenient solution for both standard *in vitro* electrophysiology and organoids applications, due to its intrinsic versatility and the possibility of obtaining flexible (and possibly conformable) devices with tridimensional recording sites to better exploit the great potential of these increasingly complex cellular aggregates. The proposed approach adds a higher level of versatility to the already impressive features commonly offered by organic bioelectronics materials and fabrication techniques, and will allow to obtain highly performing, multisensing, and ultraconformable organic cellular interfaces that will help to blur the borders between the *in vitro* and the *in vivo* domains.

References

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