

Neuromorphic biomaterials for cell interfacing

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Melbourne Centre for Nanofabrication

151 Wellington Road, Clayton, 3168

Zoom link: [click here](#)

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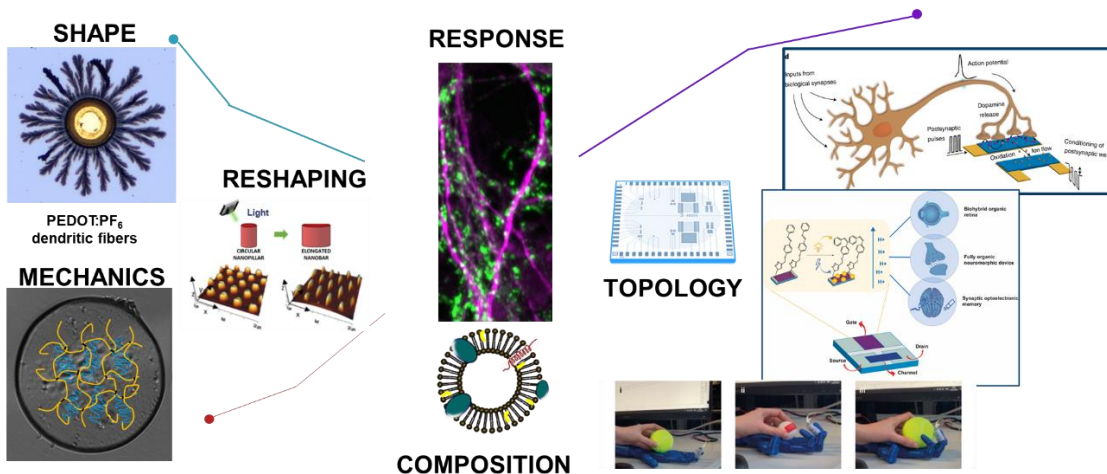
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In the field of organic neuroelectronics, the use of organic polymers shows promising results for the application in biological interfaces, because of their biocompatibility and mixed ionic and electrical conduction. These devices were shown to have neuromorphic properties emulating the synaptic plasticity of biological neuronal networks. Furthermore, they exhibit the ability to be integrated with cells and show response to neurotransmitters. However, they do not exhibit the 2.5D/3D features, characteristic of neuronal cells.

We identified different geometries for the structures that resembles dendritic spines and whole neuronal morphology made of soft and rigid composition. These have been produced via two photon polymerization and electrodeposition of PEDOT-based blends. In particular, thin shapes spines that can initiate contacts with presynaptic terminals, crucial in the early stages of spinogenesis; mushroom shapes that result from the plastic and dynamic reshaping of neuronal circuits during synaptic development; and stubby forms.

Our results show that microelectrodes and in general surface topography can impact directionality and influence neural network remodeling on bioelectronic devices, particularly affecting the growth cone phase, causing a shift from pausing to a resting state. Importantly, we have demonstrated that the growth cone rate changes in response to different pitch configurations. Our research has revealed that biomimetic topographical cues can quickly affect membrane adhesion proteins and enhance efficiency, as shown through the 3D reconstruction integrated into an electrical equivalent model. Looking toward future applications in controlling signal dissipation, this work has the potential to improve the recording of electrogenic cells towards seamless recognition and integration of artificial neuronal electrodes into biological neuronal networks in vitro and in vivo.





Francesca Santoro

- Italian, Naples 26.02.1986
- Bachelor's (2008) and Master's (2010) degrees in Biomedical Engineering at the 'Federico II' University of Naples (Italy) with specialization in biomaterials.
- PhD (2014) in Electrical Engineering and Information Technology in a joint partnership between the RWTH Aachen and the Forschungszentrum Juelich (Germany).
- Postdoctoral researcher (2014-2017) Stanford University (USA)
- Principal Investigator (2017-current) at Istituto Italiano di Tecnologia and founder of the 'Tissue Electronics' lab.
- Professor and head of Neuroelectronic Interfaces Lab (2022-current), RWTH Aachen and Forschungszentrum Juelich (IBI-3 Bioelectronics)
- AWARDS: (2018) MIT Technology Review Under 35 Innovator ITALIA and EUROPE. (2020) ERC Starting Grant. (2021) Inspiring Fifty Italy and Europe, Unstoppable Women Italy(201-2024) and winner of the Falling Walls Science Breakthrough of the Year in Engineering and Technology. (2022) PI in the Interstellar Initiative by the New York Academy of Science and recipient of the Early Career Award by the German National Academy of Science Leopoldina. (2023, 2024) Selected a speaker at the World Laureate Forum for Young Scientist.
- (2018) Rising Stars in *Journal of Materials Chemistry*, (2020) Rising Stars in *Advanced Materials*, (2023) Distinguished Invited Speaker in *Materials Research Society Fall Meeting*, (2024) Rising Stars in *Neuromorphic Computing and Engineering*, Emerging Investigator in *Materials Horizons*.