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Amyloid fibers for bioelectronics: HET-s(218-289) used for brain-machine interfaces

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Abstract:

Amyloid fibers were first known for their involvement in neurodegerative diseases (Ross and Poirier 2004). But overall, we learned, in the last decade, that they support predominantly functional mechanisms in a wide range of organisms (Levkovich, Gazit, and Laor Bar-Yosef 2020). Indeed, their properties make them a promising challenger to form a whole new kind of biomaterials. Easily synthetized and tunable, with high stability and mechanic resistance, amyloid fibers exhibit characteristics never gathered in one component.

Our study focused on HET-s prion domain (218-289), which is a fungus (*podospora anserina*) protein forming high aspect ratio (>2000) amyloid fibers (Doussineau et al. 2016). As a recombinant protein, we produced and purified it using biochemistry techniques and then studied its electrical properties. Only by its protonic conduction, relying on Grothuss mechanisms, we showed that it was able to transmit artificial pulses as short as 500ns with an amplitude of only 100mV with high reliability.

To go further, we performed *in vitro* neuronal activity recordings, using multielectrode array (MEA), on hippocampal primary neurons, grown on HET-s(218-289) hydrogel substrate. After 30 days, neurons have developed normally, showing every sign of good health, notably action potentials train spikes reaching few dozen microvolts. We also realized *in vivo* biocompatibility experiment in rats; no cytotoxicity appeared even after several months. Such results pave the way for new electrodes and/or new-generation electrode coating relying on materials from the same origin that the recorded objects. Added with the possibilities of functionalization (Altamura et al. 2017), one can imagine even more complex recording coatings for innovative brain-machine interfaces

References:

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