Functional Polythiophene Deposition and Biocompatibility with SH-SY5Y Neuroblastoma

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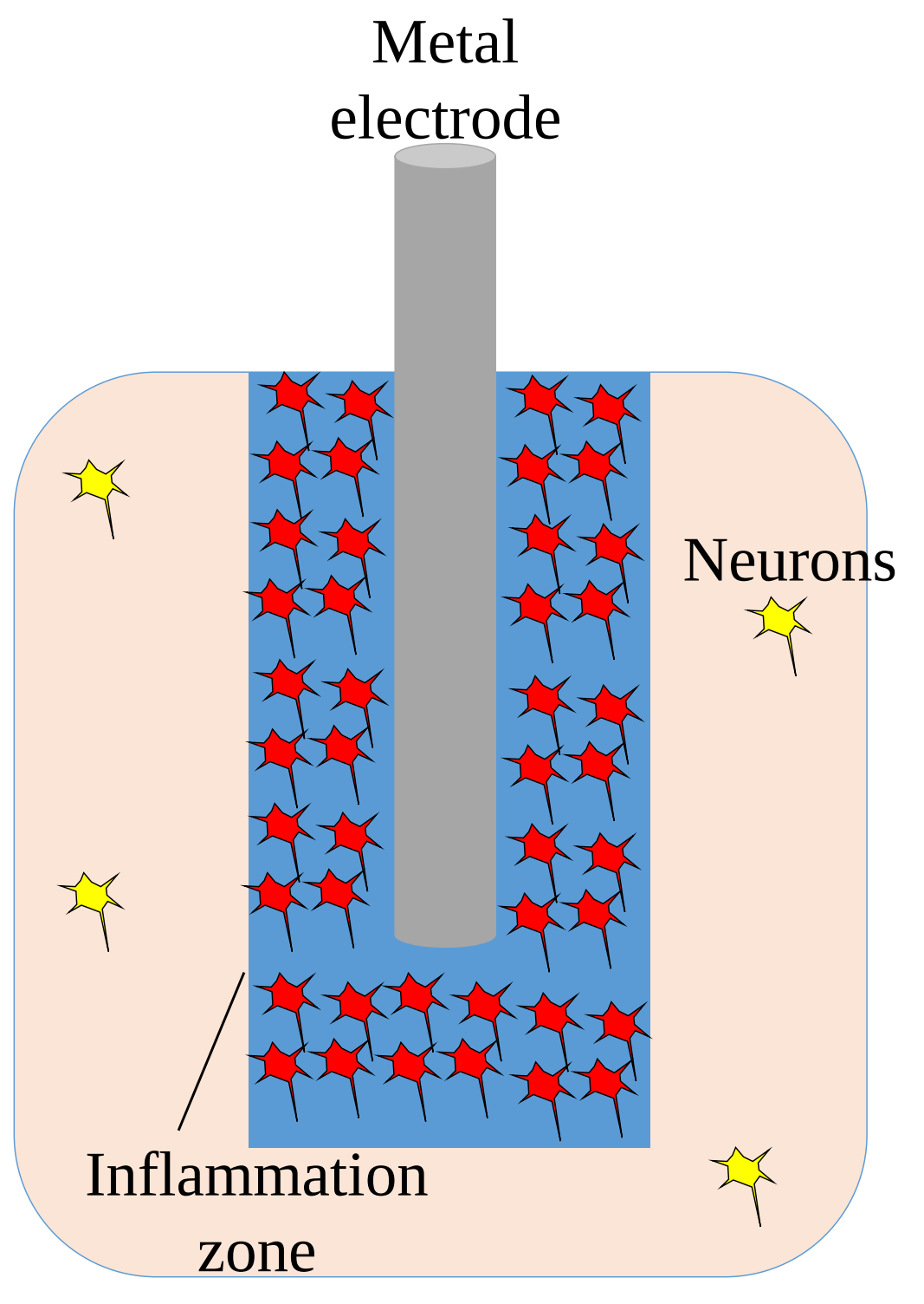
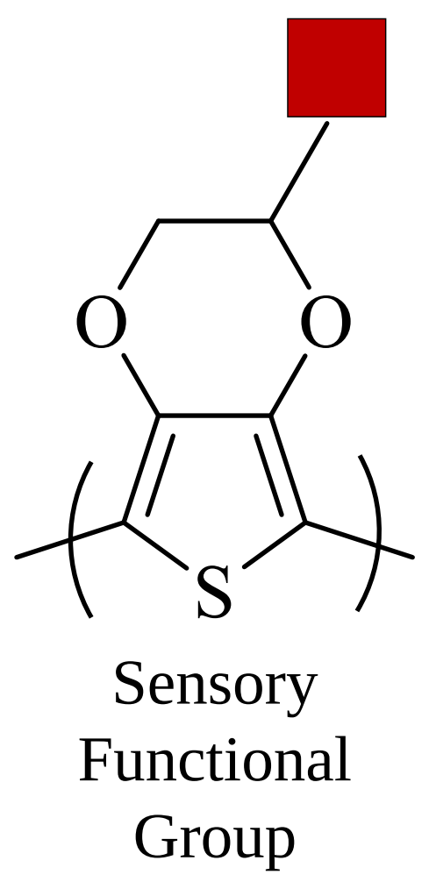
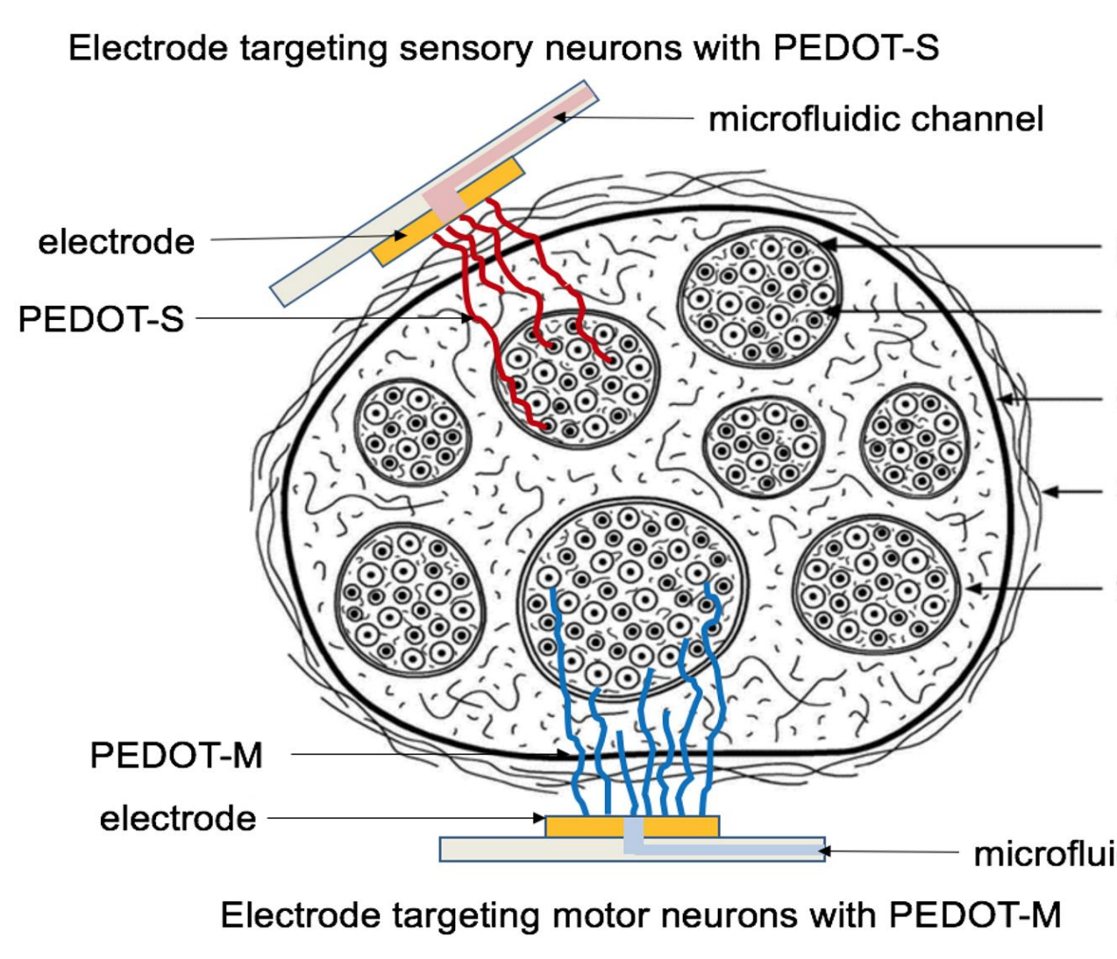
Abstract

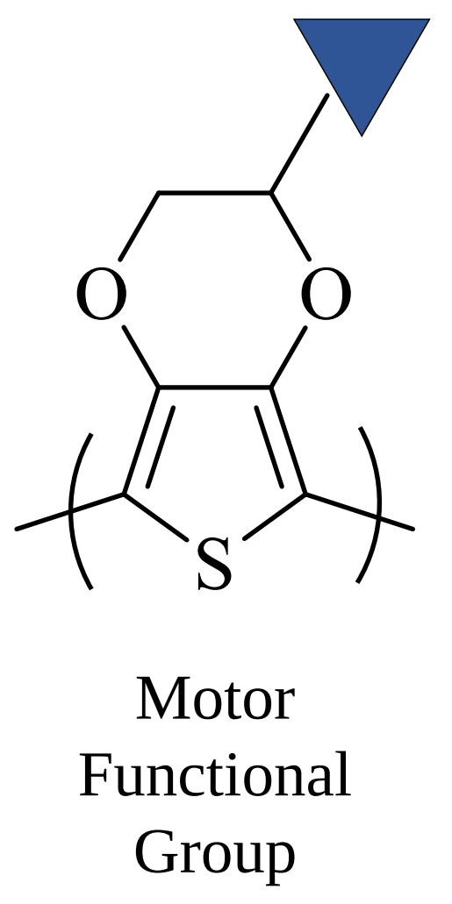
We have been investigating the electrochemical deposition of functionalized polythiophenes around neural cells with the goal of creating stable, directly biointegrated electronic devices. Our previous efforts have primarily focused on the well-studied 3,4-ethylenedioxythiophene monomer (EDOT). While the corresponding polymer (PEDOT) has shown considerable potential, its highly hydrophobic character leads to issues when depositing it around living cells. Here, we discuss recent efforts to examine the potential of an EDOT monomer with a pendant carboxylic acid moiety (EDOT-acid). We have examined the cell viability of EDOT-acid relative to EDOT and have found that EDOT-acid solutions are much more cytocompatible. We have also seen variations in the growth mechanisms when P(EDOT-acid) is deposited around living cells. P(EDOT-acid) grows in a manner that is more attached directly to the cell surfaces, rather than to the electrodes as seen with PEDOT. Most recently, we have been examining the deposition of a bifunctional monomer that combines EDOT with dopamine, creating what we call EDOT-dopamide. P(EDOT-dopamide) polymers can also be grown electrochemically and show low impedances over a broad frequency range. The morphological, physical and chemical characterization of these materials with optical and electron microscopy, spectroscopy, and other techniques will be discussed and compared with PEDOT.

Research Plan

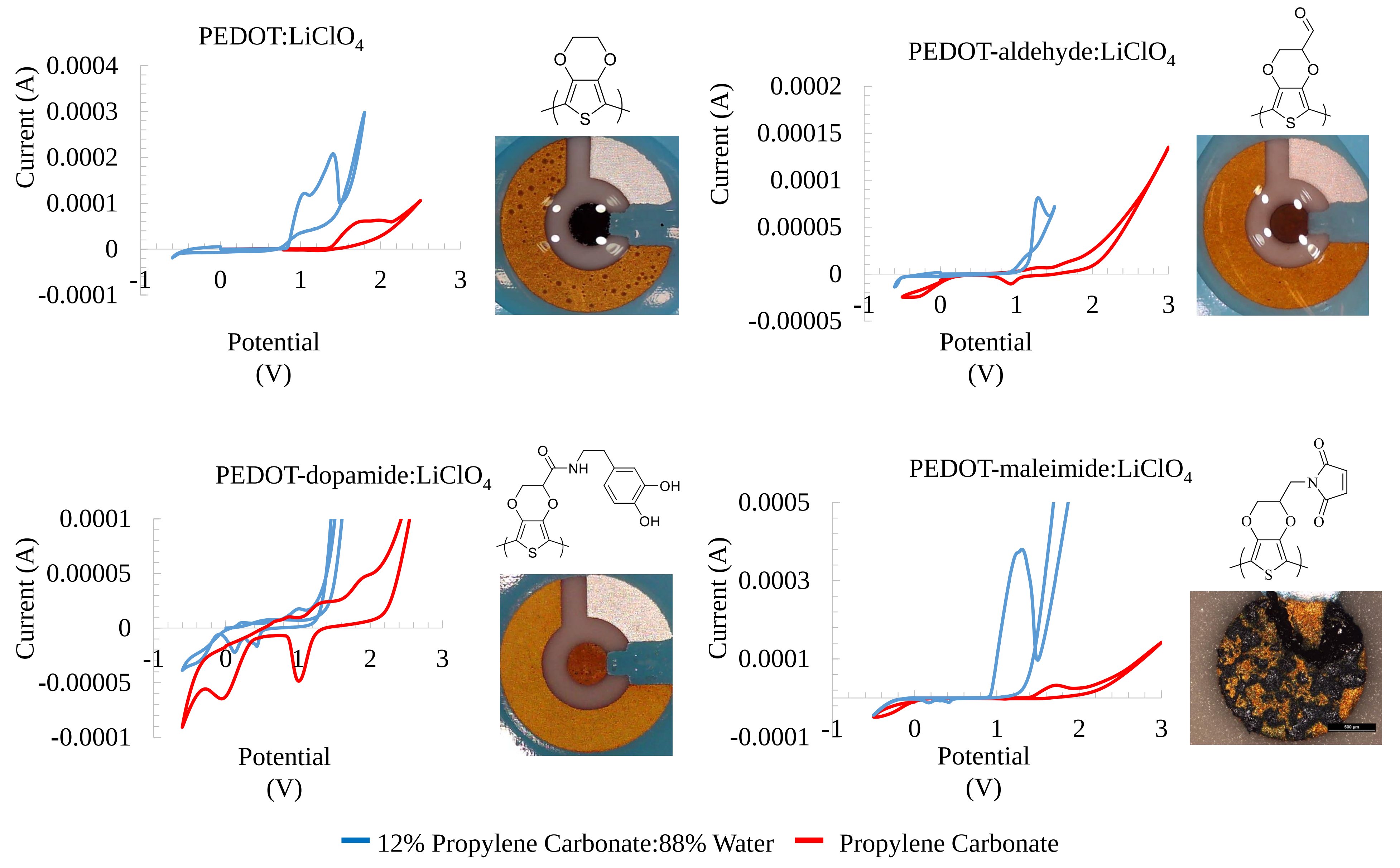




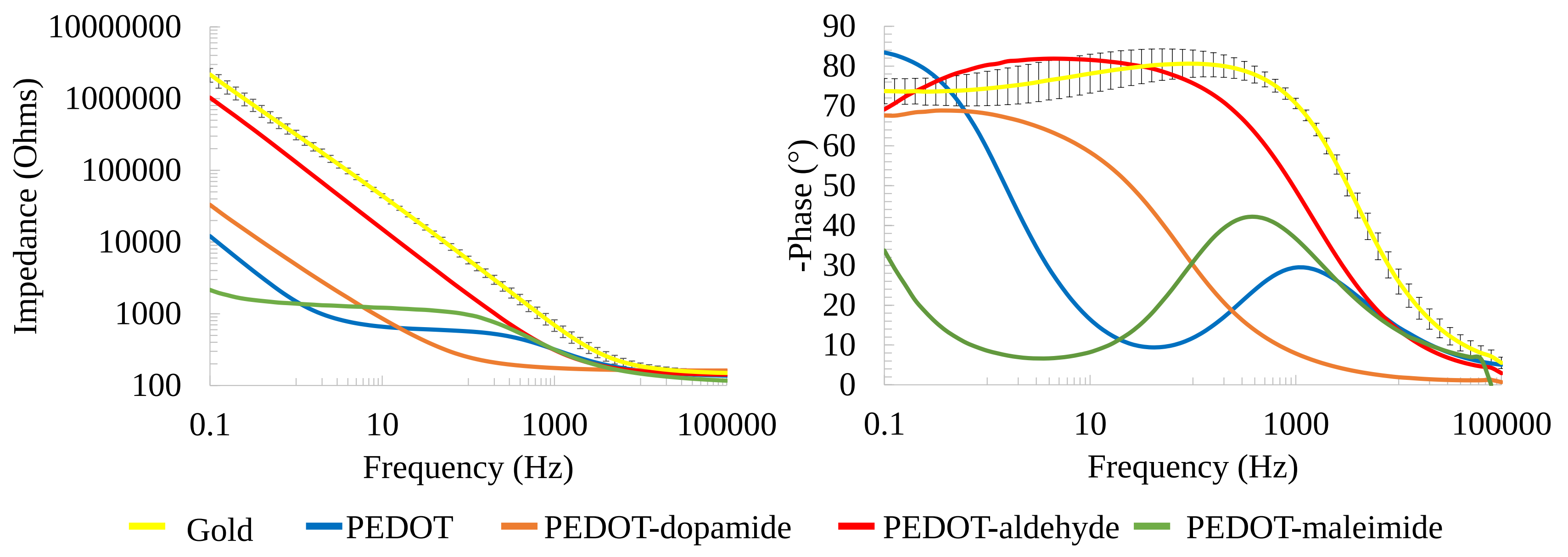


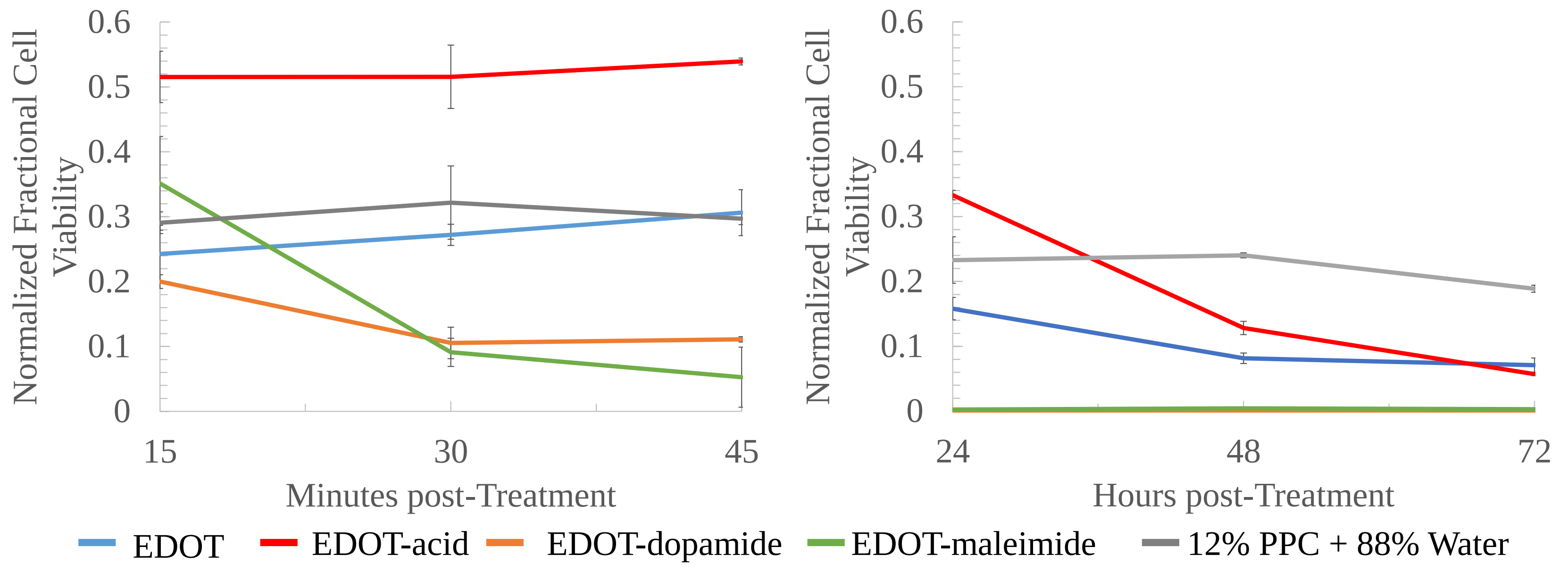


Biofunctional EDOT Characterization

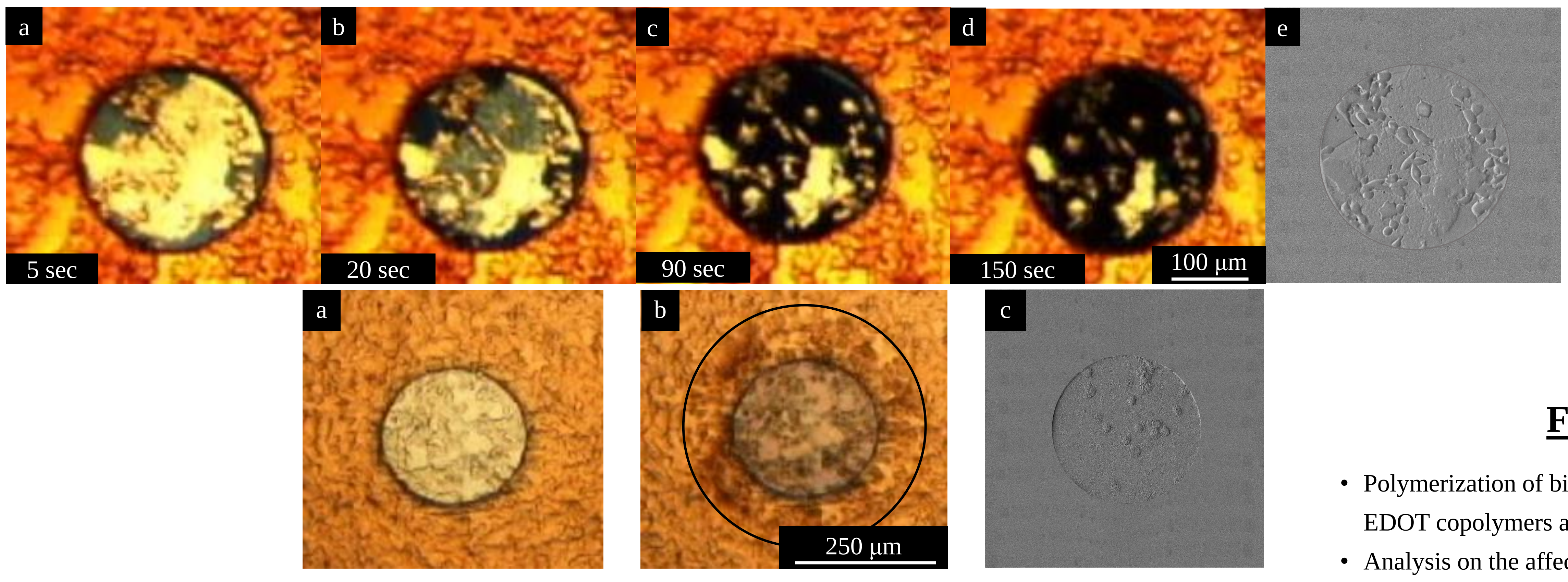


	EDOT	EDOT-aldehyde	EDOT-dopamide	EDOT-maleimide
Propylene Carbonate	1.75 V	1.7 V	1.9 V	1.7 V
12% Propylene Carbonate:88% Water	1.1-1.4 V	1.3 V	1.0 V	1.25 V





Polymerization Around Cells

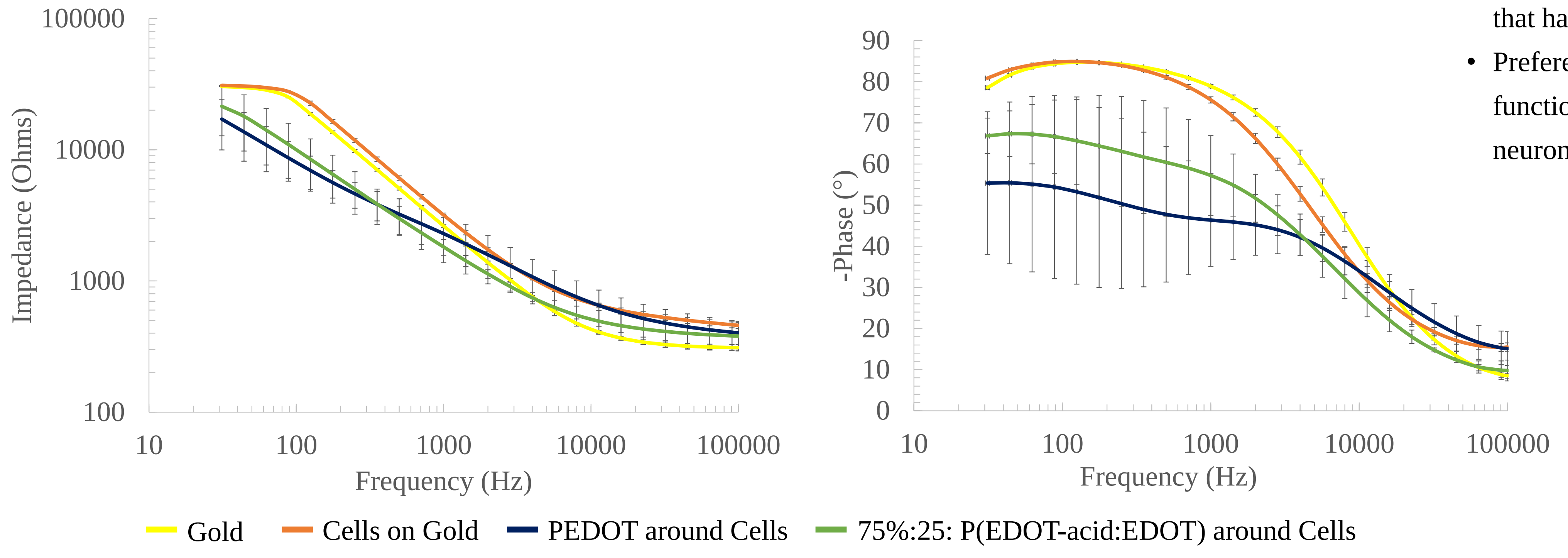


PEDOT:PSS (Top)

- PEDOT:PSS Deposition around SH-SY5Y neuroblastoma
- Deposits starting from the gold substrate
- Surrounds cells
- Current Density 5.1 µA/mm² 2.5 min

Functional PEDOT:PSS Copolymer (Bottom)

- 75%:25% P(EDOT-acid:EDOT):PSS copolymer deposition around neuroblastoma
- Direct growth onto cells over growth on gold electrode
- Ring of PEDOT copolymer grew 85 µm away from electrode edge
- Current density 20 µA/mm² 2.5 min



Future Work

- Polymerization of biofunctional EDOT and biofunctional EDOT copolymers around cells
- Analysis on the affect of varying biofunctional PEDOT's that have been grown on cells
- Preferential growth of PEDOT based on specific functional to select groups of differentiated primary neurons

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