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Functional performance and biocompatibility of PEDOT:GABA neurotransmitter-loaded coatings

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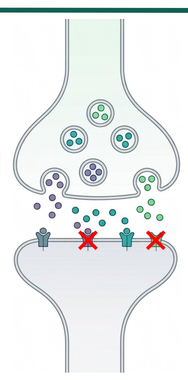
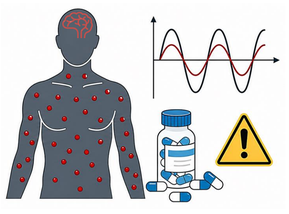
INTRODUCTION & AIM

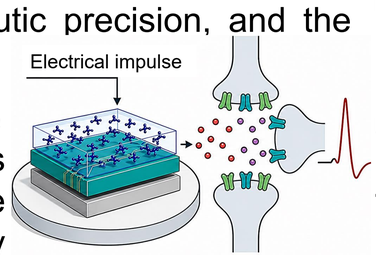
Neurological disorders are among the leading causes of disability and premature mortality, and are often associated with **disrupted neurotransmission** involving glutamate, GABA, dopamine and acetylcholine.



1 in 3 people will develop a neurological disorder in their lifetime



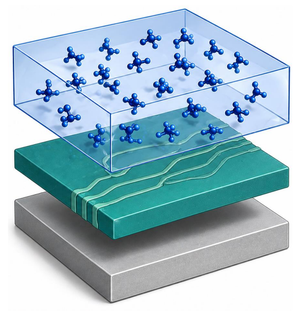
Current treatments often result in non-specific biodistribution, fluctuating drug levels, limited therapeutic precision, and the development of side effects.



Neurotransmitter-loaded microelectrode coatings (MECs) based on conducting polymer matrices with hierarchical structures offer a strategy to overcome these limitations by enabling electrically triggered, spatially controlled release of neurotransmitters (1).

The aim of this research was to assess the biocompatibility and neuromodulative capabilities of **poly(3,4-ethylenedioxythiophene):polystyrenesulfonate (PEDOT:PSS)** coatings with **GABA.**

METHOD

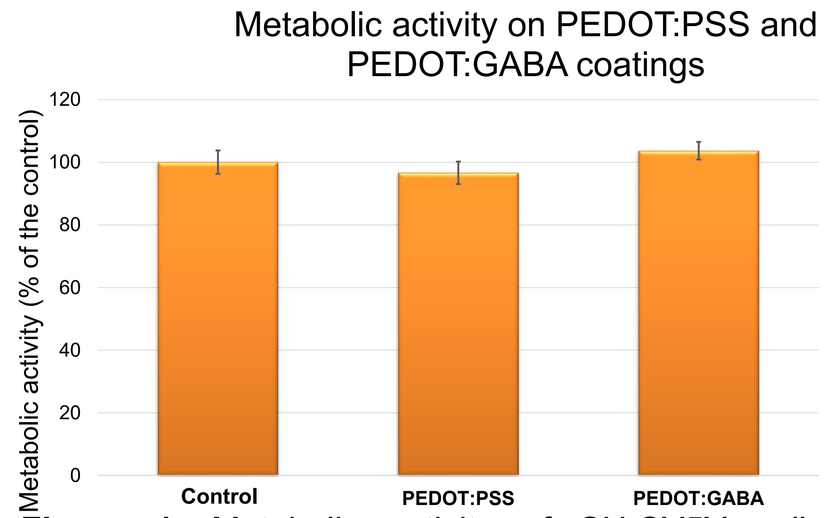


PEDOT:PSS was used as a conducting polymer matrix due to its electrical conductivity, softness and compatibility with bioelectronic interfaces. GABA was incorporated into the coating to provide a neurotransmitter-loaded material designed for electrically triggered release and local interaction with neural-related cells (2,3).

The biocompatibility of PEDOT coatings was evaluated using SH-SY5Y neuroblastoma cells as a neuronal model. Cells were cultured PEDOT:PSS and PEDOT:GABA coatings for 48 h, and metabolic activity was assessed using the resazurin-based Alamar Blue assay. The assay relies on resazurin reduction by metabolically active cells; therefore, the measured fluorescence was used as an indicator of cell viability and cytocompatibility. Results were normalised to untreated control cells.

The functional response of U87 glial cells cultured on PEDOT:GABA coatings was investigated using calcium imaging. Intracellular Ca^{2+} dynamics were used as a functional readout because calcium transients are closely associated with cellular activation and signalling. Electrical stimulation was applied to the PEDOT:GABA coating to promote neurotransmitter release. Changes in fluorescence intensity were then analysed to determine whether stimulation of the coating produced a detectable cellular response.

RESULTS & DISCUSSION



PEDOT:GABA coatings showed good cytocompatibility with SH-SY5Y neuroblastoma cells, as metabolic activity remained close to control values after 48 h of incubation.

Figure 1. Metabolic activity of SH-SY5Y cells after 48 h incubation on PEDOT:PSS and PEDOT:GABA coatings. Results normalised to control; error bars indicate SD.

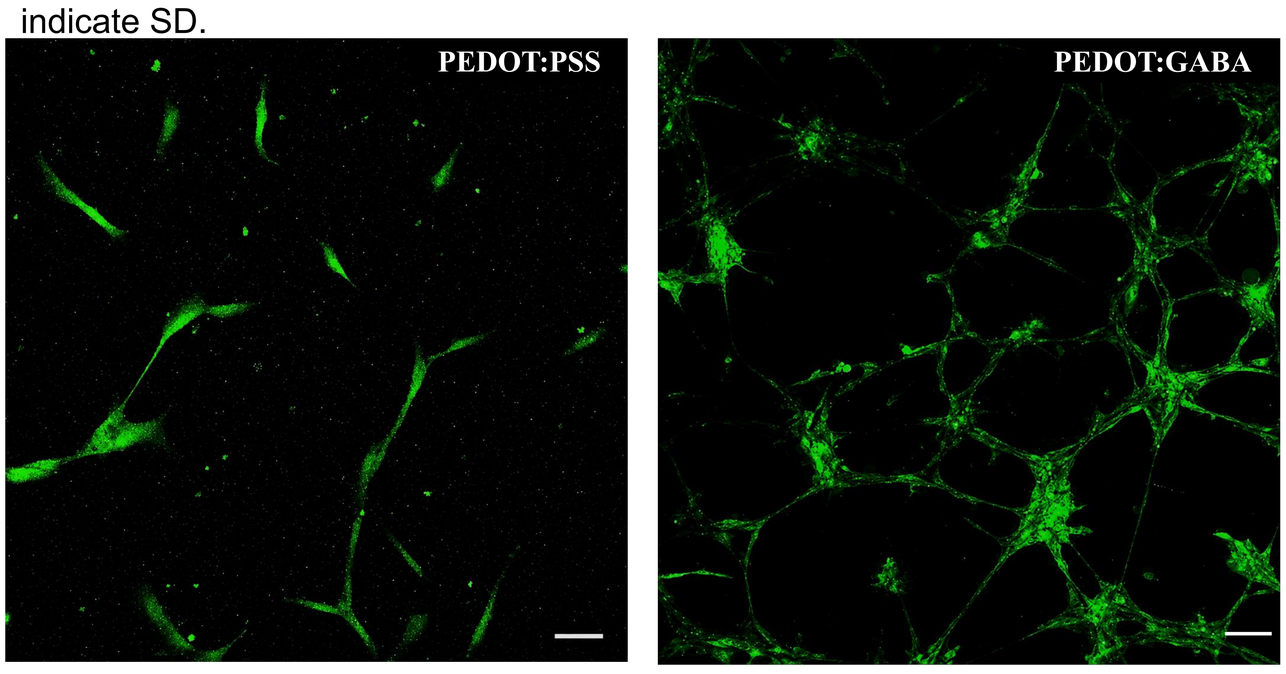


Figure 2. U87 cells after 24 h incubation on PEDOT:PSS and PEDOT:GABA coatings. Scale bar: 20 μm.

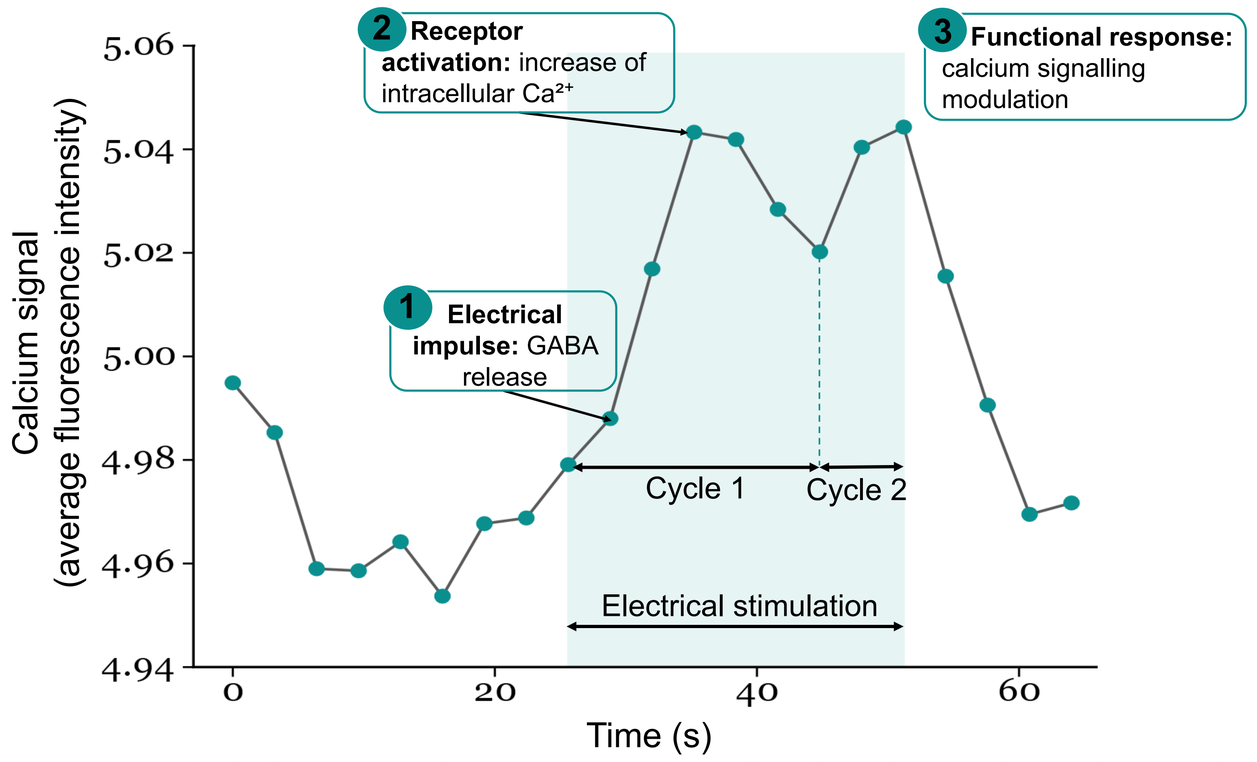


Figure 3. Calcium signal changes in U87 cells after electrical stimulation of PEDOT:GABA coatings.

Microscopy observations showed clear differences in U87 cell morphology between the two coatings. Cells cultured on PEDOT:GABA displayed improved adhesion, more pronounced spreading and a more developed cellular network compared with PEDOT:PSS.

Calcium imaging revealed stimulation-associated changes in intracellular Ca^{2+} levels in U87 cells cultured on PEDOT:GABA. Since Ca^{2+} fluctuations are a key indicator of cell signalling activity, this response suggests that electrical stimulation of the coating was translated into a measurable biological signal. These results support the role of PEDOT:GABA not only as a passive cytocompatible substrate, but also as an active interface capable of modulating cellular behaviour.

CONCLUSIONS

- PEDOT:GABA coatings showed good cytocompatibility with SH-SY5Y neuroblastoma cells, as metabolic activity remained close to control values.
- U87 glial cells cultured on PEDOT:GABA displayed improved adhesion and more developed morphology compared with PEDOT:PSS, suggesting favourable cell–material interactions.
- Electrical stimulation of PEDOT:GABA coatings was associated with intracellular Ca^{2+} signal changes in U87 cells, supporting their functional responsiveness and potential role in electrically controlled neuromodulation.

REFERENCES/ACKNOWLEDGMENT

References

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Acknowledgement

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