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# Multifunctional bioelectronics with organic electrochemical transistors: biosensors, integrated amplifiers and iontronic multiplexers

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The interfacing of electronics with biology is a rapidly growing field fuelled by the development of new materials and device. Organic electrochemical transistors (OECTs) are triggering attention and several bioelectronic applications based on OECT devices have been demonstrated [1]. OECTs combine the advantages typical of organic technologies, including for example biocompatibility, mechanical softness and easy tailoring of the bio-chemical properties, with their volumetric ionic-electronic charge coupling, thus enabling the seamless integration of bioelectronics. While current approaches mostly focus only on material or device properties, enhanced bioelectronics require multifunctional device architectures and circuits. Here, starting from the OECT fundamentals, [2] high-sensitivity atto-molar protein detection [3], complementary push-pull amplifiers for real time ion detection and monitoring [4], current-driven cell monitoring [5–7], and spatiotemporal multiplexing of ionic signals [8] will be presented and discussed. Guidelines useful for the design of OECT-based ehanched bioelectronics will be provided. The talk will summarize the key achievements of a beautiful journey that I am doing with various multidisciplinary and geographically-distributed research groups, comprising my collaborators at the University of Brescia, Prof. Luisa Torsi and her collaborators at the University of Bari, Dr. Eleonora Macchia at the Åbo Akademi University, Prof. Paul Blom and Dr. Paschalis Gkoupidenis and their collaborators at Max Planck Institute for Polymer Research.

## References

[1] J. Rivnay, S. Inal, A. Salleo, R.M. Owens, M. Berggren, G.G. Malliaras, Organic electrochemical transistors, Nat. Rev. Mater. 3 (2018). https://doi.org/10.1038/natrevmats.2017.86.

[2] P. Romele, M. Ghittorelli, Z.M. Kovács-Vajna, F. Torricelli, Ion buffering and interface charge enable high performance electronics with organic electrochemical transistors, Nat. Commun. 10 (2019). https://doi.org/10.1038/s41467-019-11073-4.

[3] E. Macchia, P. Romele, K. Manoli, M. Ghittorelli, M. Magliulo, Z.M. Kovács-Vajna, F. Torricelli, L. Torsi, Ultra-sensitive protein detection with organic electrochemical transistors printed on plastic substrates, Flex. Print. Electron. 3 (2018) 1–17. https://doi.org/10.1088/2058-8585/aad0cb.

[4] P. Romele, P. Gkoupidenis, D.A. Koutsouras, K. Lieberth, Z.M. Kovács-Vajna, P.W.M. Blom, F. Torricelli, Multiscale real time and high sensitivity ion detection with complementary organic electrochemical transistors amplifier, Nat. Commun. 11 (2020) 1–11. https://doi.org/10.1038/s41467-020-17547-0.

[5] L. V Lingstedt, M. Ghittorelli, M. Brückner, J. Reinholz, N.I. Crăciun, F. Torricelli, V. Mailänder, P. Gkoupidenis, P.W.M. Blom, Monitoring of Cell Layer Integrity with a Current-Driven Organic Electrochemical Transistor, Adv. Healthc. Mater. 8 (2019) 1900128. https://doi.org/https://doi.org/10.1002/adhm.201900128.

[6] K. Lieberth, M. Brückner, F. Torricelli, V. Mailänder, P. Gkoupidenis, P.W.M. Blom, Monitoring Reversible Tight Junction Modulation with a Current-Driven Organic Electrochemical Transistor, Adv. Mater. Technol. 2000940 (2021) 2000940. https://doi.org/10.1002/admt.202000940.

[7] K. Lieberth, P. Romele, F. Torricelli, D.A. Koutsouras, M. Brückner, V. Mailänder, P. Gkoupidenis, P.W.M. Blom, O.B.A. Field, Current-Driven Organic Electrochemical Transistors for Monitoring Cell Layer Integrity with Enhanced Sensitivity, 2100845 (2021). https://doi.org/10.1002/adhm.202100845.

[8] D.A. Koutsouras, M.H. Amiri, P.W.M. Blom, F. Torricelli, K. Asadi, P. Gkoupidenis, An Iontronic Multiplexer Based on Spatiotemporal Dynamics of Multiterminal Organic Electrochemical Transistors, Adv. Funct. Mater. 2011013 (2021) 1–11. https://doi.org/10.1002/adfm.202011013.