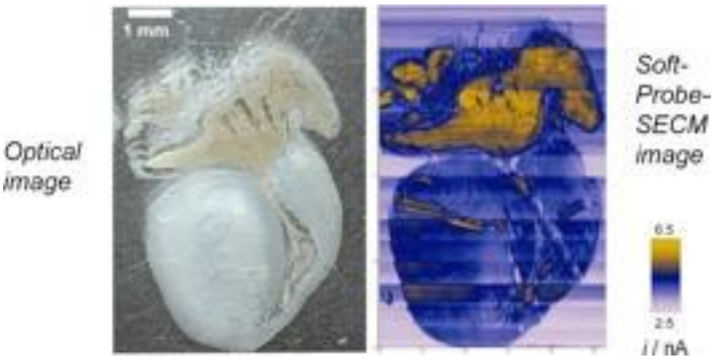
Scanning electrochemical microscopy of biological tissues and amperometric bacteria detection.

Yingdi Zhu, S. Dervichi, Milica Jović, Andreas Lesch and Hubert H. Girault*

Laboratoire d'Electrochimie Physique et Analytique, EPFL EPFL Valais Wallis Sion, Switzerland
hubert.girault@epfl.ch

Abstract: Electrochemicalbioimaging of cells and tissues with micrometric electrodes or pipettes and microelectrode arrays gains in importance. These tools can record for instance the respiratory activity of alive biological samples or detect the release of metabolic compounds from such into the extracellular environment. By reducing the size of the probes to the nanoscale, intracellular measurements have been realized through the insertion of the probe tips into the alive cells. Fixation and permeabilization of cells or the biopsy of tissues enable the immunolabelling of proteins for the specific detection of intracellular enzymatic activity. The investigation of tissues is attractive towards diagnostic applications [1,2]



Optical image and Soft-Probe-SECM image of a mouse heart section recorded in feedback mode. Yellow areas indicate the location of redox active proteins in the tissue. An array of eight soft microelectrodes was operated in a gentle brushing mode. Figure adapted from reference [2]. Owing to the over-prescription of antibiotics, improper diagnosis, lack of proper antibiotics dosage, their widespread availability and overuse in agriculture and poultry farming has led to the escalation of the antimicrobial resistance. Numerous pathogens have become resistant to commonly used antibiotics. The need for rapid diagnostic tests has been highlighted by the World Health Organisation as a way to reduce unnecessary prescription. In the same way, that electrochemical glucose sensors have been a game changer in the fight against diabetes, point-of-care bacteria detection could help to alleviate infectious diseases. Here, we shall describe an electrochemical biosensor for the identification and counting of bacteria in a sample. First affinity methods are used to collect bacteria that are cultured for one hour in an Eppendorf tube at

37°C. The bacteria are then transferred in a disposable 3-electrode electrochemical cell, where redox indicators, such as Resazurin, are then used as a viability test sensing the NADH production by the bacteria. The electrochemical reduction of Resazurin is performed on inkjet-printed carbonnanotubes electrodes, which are little prone to fouling and are therefore highly suited to carry out voltammetry measurements in complex biological samples [3,4].

References:

[1] T. E. Lin, A. Bondarenko, A. Lesch, H. Pick, F. Cortés-Salazar, H. H. Girault, Angew. Chem. Int. Ed. 2016, 55, 3813-3816.

[2] T. E. Lin, Y. J. Lu, C. L. Sun, H. Pick, J. P. Chen, A. Lesch, H. H. Girault, Angew. Chem. Int. Ed. 2017, 56, 16498-16502.

[3] M. Jović, Y. Zhu, A. Lesch, A. Bondarenko, F. Cortés-Salazar, F. Gumy and H.H. Girault, J. Electroanal. Chem., 786 (2017) 69–76

[4] Y. Zhu, M. Jović, A. Lesch, L. Tissières Lovey, M. Prudent, H. Pick and H.H. Girault, Angew. Chem., 57 (2018) 14942 –14946

- **e-mail:** hubert.girault@epfl.ch, https://pt.wikipedia.org/wiki/Hubert_Girault