Fully Inkjet-Printed Electrochemical Sensors for the Detection of Living Bacteria

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Electroanalytical sensors – amperometric, voltammetric, and impedimetric – are promising diagnostic tools for the detection of bacterial cells and antimicrobial resistance (AMR). Rather than targeting DNA, RNA, or lysed-cell biomarkers, we follow the general approach of detecting living bacterial cells using metabolic redox markers. These markers, which act as alternative final electron acceptors in the bacterial respiratory chain, can be electrochemically monitored to provide rapid, quantitative readouts. Adding antibiotics to the test enables concurrent antimicrobial susceptibility testing (AST).

However, in diagnostically relevant fluids like blood, low bacterial counts typically require extended bacterial culture periods. To overcome this, we previously demonstrated that antibody-coated paramagnetic beads can locally enrich bacteria at the sensor surface, enhancing sensitivity and reducing detection time [1]. Still, for real-world point-of-care (POC) use, systems must be simplified to minimize manual handling while upgrading performance.

Herein, we shall present fully inkjet-printed, miniaturized electrochemical platforms integrating bacterial capture, detection, and culture on a single chip. We will present our portfolio of inkjet-printed working electrode materials, functionalized and non-functionalized. All sensor layers are fully fabricated using drop-on-demand inkjet printing enabling the production of miniaturized sensors with minimal material waste and often combined with irradiation sources for simultaneous photochemical syntheses, i.e., Print-Light-Synthesis. We shall show in more detail for instance the thermal modification of the surfaces of graphene electrodes to significantly increase the sensitivity to bacterial redox markers [2]. Furthermore, porous, photopolymerized 3D matrices with integrated bacterial capture receptors are printed near the working electrode surface. Finally, we demonstrate the electrochemical detection of *Escherichia coli* and the results are confronted with those obtained with conventional bacteria detection.

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References

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