Integration of ring nanoelectrodes into microwells for the bioelectrochemical analysis in sub-picolitre volumes - DTU Orbit (09/01/2019)

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In this work, we report the fabrication and the electrochemical characterization of recessed disk micro-electrodes (DME) and ring nanoelectrodes (RNE) integrated in microwell arrays. Such configuration has all advantages of microelectrodes arrays but is more suitable for electrochemical measurement in sub-picolitre volumes (∼0.3 pL). The technological process based on the reactive ion etching of a SiO₂/Ti/Pt/TiSiO₂ stack is optimized in order to integrate RNE arrays on transparent glass substrate. Multiphysic simulations and electrochemical characterizations are conducted in order to study and improve the amperometric behaviour of recessed ring nanoelectrodes according to their geometry. A good fit is shown between experimental, theoretical and simulation results, allowing full understanding of the electrochemical detection properties of RNE-based microwell arrays. Then, a “generation − collection mode” chronoamperometric approach is proposed to evaluate experimentally the collection ratio of RNE arrays and compare it with simulation results. Finally, first electrochemical characterizations in sub-picolitre volumes are conducted with anti-oxidant species. All these results demonstrate that recessed ring nanoelectrode arrays are fitted to the detection of bio-electrochemical species at the microscale and, consequently, to single mitochondrion or single sub-cellular organelle analysis.

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