CMOS Electrochemical Imaging Arrays

Electrochemistry Posters: E8

CMOS Electrochemical Imaging Arrays

C. Gunasekaran[1]***, M. Donora***[1]***, I. Underwood***[1]***, A. J. Walton***[1]***, U. Mitrikeviciute***[2]***, A. R. Mount***[2]***, A. Wain***[3]***, F. Castro***

[1]School of Engineering, The University of Edinburgh, Edinburgh, UK
[2]School of Chemistry, The University of Edinburgh, Edinburgh, UK
[3]National Physical Laboratory, Edinburgh, UK
Email c.gunasekaran@ed.ac.uk

Abstract: Energy conversion devices make use of thin films and functional materials that exhibit microscopic spatial heterogeneity in their efficiency. The relationship between the distribution of such irregularities and their impact on device performance is not well understood. Hence there is a requirement to map the electrochemical activity in a range of thin films and functional materials. This is termed "electrochemical imaging" [1]. This need is presently addressed by high resolution electrochemical current mapping techniques. One such approach is the use of scanning electrochemical microscopy (SECM) [2]. However high-resolution mapping techniques (example: SECM) are slow (order of minutes) over a wider area (~cm² scale). Hence there is a need to do 2D spatial electrochemical activity mapping at a faster rate (~µs/ms) than those obtained from the conventional techniques. A potential solution is the CMOS active-matrix electrochemical imager – an integrated circuit whose high-level architecture is similar to that of an CMOS optical imager but whose optically sensitive element (photodiode) is replaced by an electrochemically sensitive element (a working electrode (WE)). This is an interdisciplinary project between Schools of Chemistry and Engineering, in collaboration with NPL to develop an electrochemical array imaging sensor. The main aim is to produce an integrated sensor system with active matrix read-out capability for 2D electrochemical imaging. This has been achieved by the design and fabrication of micro-electrode array with active CMOS circuits on a single silicon CMOS chip. The device would potentially be used as an imager, functionally similar to the existing scanning electrochemical microscopy (SECM) technology. As a result, the device will be a lab-on-a-chip, allowing to get images of samples of interest within milli-seconds/micro-seconds rather than much longer times required for typical SECM images.

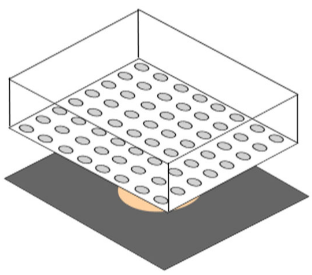

Fig. 1 Illustrative example: CMOS chip integrated with arrays of electrodes placed over a surface to be imaged [1]

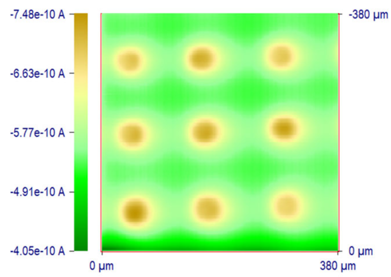

Fig. 2 A sample current map from a conventional SECM [3]

References

1 A. Wain, F. Castro: Nano-scale Electrode arrays with active CMOS circuits and their application to electrochemical imaging, NPL-Edinburgh Joint Project Plan, 2014, 1-3.

2 A. J. Wain, Electrochemical scanning probe microscopy for catalytic characterization, National Physical Laboratory, Teddington, 2013.

3 U. Mitrikeviciute, Application of Nanoband and micro single electrode and array devices to electrochemical imaging, Edinburgh/NPL project