César Pascual García et al., Biosens J 2018, Volume 7
DOI: 10.4172/2090-4967-C1-002

Electrochemical regulation of the acidity in miniaturized electrochemical cells: The route to increase flexibility and multiplexing of chemical control

César Pascual García[1], **Wouter Olthuis**[2] and **Divya Balakrishnan**[1, 2]
[1]Luxembourg Institute of Science and Technology, Luxembourg
[2]MESA+ Institute - University of Twente, Netherlands

Better computer controlled systems to perform nanoscale chemical tasks is a demand for the fabrication of high-throughput microarrays and reprogrammable sensors dedicated to precision personalized medicine. The very limited tools that we have today to control chemical reactions in miniaturized devices is one of the main barriers for the control of massive multiplexing (>1 Mega spots). The proton concentration is one of the building blocks that could be used to control the kinetics of chemical reactions. Currently the multiplexed systems for high-yield *in-situ* synthesis of commercial microarrays are driven by optically triggered acid-labile groups. The electrochemical control of the proton release would be a natural way to control the acidity due to the high speed efficiency of redox processes, and would allow combining microarrays and programmable electrochemical sensors. However, only a couple of attempts can be found in literature to control chemical reactions in miniaturized environments by an electrochemically driven proton concentration. The limited surface to volume ratio of the electrodes and the fast diffusion of protons decreased the performance of these systems. Here we present our studies to control reversibility of redox processes that can be used to change the pH in microfluidic environments during many cycles, and a microfluidic design to control the fast diffusion of protons. With our system we show a pH swing comparable to the highest achieved by electrochemical systems of few milliliters, but in a device where the acid is confined in nano-litter volumes. The design promises high yield *in-situ* chemical synthesis since the system is compatible with lateral resolutions in the micron range assuring the stability of acid contrast between close spots.

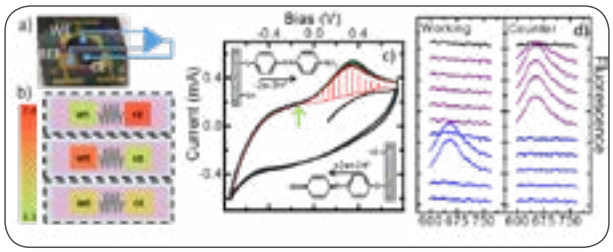

Figure 1: A) Chip with nano-litter reaction cells. B) Schematic representation of the acid control in the nano-fluidic reactor. C) CV of proton exchange reactions driven by Amino-thiol-phenol. D) Evolution of the pH dependent fluorescence in one of the cycles.

Recent Publications

1. A Courbet, E Renard and F Molina (2016) Bringing next-generation diagnostics to the clinic through synthetic biology. EMBO Mol. Med. 8(9):987.
2. K Maurer, J Cooper, M Caraballo, J Crye, D Suciu, A Ghindilis, J A Leonetti, W Wang, F M Rossi, A G Stöver, C Larson, H Gao, K Dill and A McShea (2006) Electrochemically generated acid and its containment to 100 micron reaction areas for the production of DNA microarrays. PLoS ONE 1(1):e34.
3. Wang Y C, Lin C B, Su J J, Ru Y M, Wu Q, Chen Z B, Mao B W and Tian Z W (2011) Electrochemically driven large amplitude pH cycling for acid-base driven DNA denaturation and renaturation. Anal. Chem. 83:4930.
4. D Balakrishnan, G Lamblin, J S Thomann, J Guillot, D Duday, A van den Berg, W Olthuis and C Pascual Garcia (2017) Influence of polymerization on the reversibility of low-energy proton exchange reactions by para-aminothiolphenol. Scientific Reports 7(1):15401.
5. Balakrishnan D, Lamblin G, Thomann J S, van den Berg A, Olthuis W and Pascual Garcia C (2018) Electrochemical control of pH in nano-liter volumes. Nano Lett. 18(5):2807-2815.

Biography

César Pascual García graduated in Solid State Physics from the Universidad Autónoma of Madrid in Spain with a dissertation of electronic optical transitions in III-V semiconductors. He obtained his PhD in Condensed Matter Physics in 2007 from the Scuola Normale Superiore of Pisa in Italy with the thesis: "Low lying excitations of few electrons quantum dots". At the beginning of his career he collaborated in fundamental topics centered on the electron correlations of semi- and super- conductor materials, but then his interest shifted to biology-applied topics as he started working as Scientific Officer at the Institute for Health and Consumer Protection of the European Commission. Currently he is an ATTRACT fellow and Lead Research Scientist at the Luxembourgish Institute of Science and Technology where he leads the activities for electrochemical sensors and actuators for medicine applications at the Materials Research and Technology Department. His current research focus is semiconductor nanowires for bio-sensing and the miniaturized control of chemical reactions.

cesar.pascual@list.lu

Notes: