Electrochemically functionalized graphene in a liquid environment: From fundamentals to device applications in sensing and energy storage

Kannan Balasubramanian [1,2]
L. Zuccaro[1], R.M. Iost[1], N.S. Kaya[1], A. Yadav[1], M. Wehrhold[1], T. Neubert[1], A. Kuhn[3], F. Crespilho[4], K. Kern[2]

[1] *School of Analytical Sciences Adlershof (SALSA), Dept. of Chemistry & IRIS Adlershof, Humboldt Universität zu Berlin, 10099 Berlin, Germany.*
[2] *Max-Planck-Institut für Festkörperforschung, Heisenbergstr. 1, 70569 Stuttgart, Germany.*
[3] *Université Bordeaux, ISM, UMR 5255, ENSCBP, 16, Pessac Cedex, France.*
[4] *Instituto de Química de São Carlos, Universidade de São Paulo, 13560-970, Brazil.*

nano.anchem@hu-berlin.de

Abstract

Nanoelectronic devices based on individual graphene sheets motivate the vision of portable and compact systems in liquid media for direct trace analysis of analytes and biomarkers as well as for energy conversion and storage on-site. In order to realize this vision, one of the fundamental challenges is to obtain a thorough understanding of the physics and chemistry of the graphene-liquid-interface especially the charge potential landscape, localized electron transfer properties, and the nature of chemical groups at the graphene surface. We utilize electrochemical modification to modify the surface properties such as modulation of the electrostatic charge distribution by aminophenyl groups, [1] selective modification of graphene peripheries by bipolar electrochemistry [2] and direct identification of attached chemical functionalities. [3] Through field-effect and electrochemical measurements we corroborate the physicochemical behaviour of the interface and exploit the gained knowledge in the realization of sensors and batteries. Specifically, sensors based on functionalized graphene enable the real-time measurement of binding kinetics in aqueous media, [4] while on-chip batteries [5] based on two graphene monolayers enable the operation of a pocket calculator for several hours.

References

[1] L. Zuccaro et al., Sci. Rep. 5 (2015) 11794
[2] L. Zuccaro et al., ChemElectroChem 3 (2016) 372
[3] L. Zuccaro et al., ACS Nano 9 (2015) 3314
[4] L. Zuccaro et al., ACS Nano 9 (2015) 11166
[5] R.M. Iost et al., IOP Nano 27 (2016) 29LT01