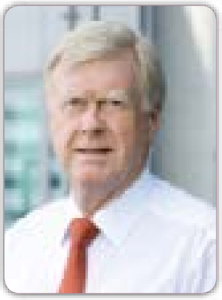
W Knoll, Biosens J 2018, Volume 7
DOI: 10.4172/2090-4967-C1-001

4th International Conference on **Electrochemistry**

June 11-12, 2018 | Rome, Italy



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Polyelectrolyte multilayer assemblies and brushes on reduced graphene oxide field-effect transistors for sensing applications

Graphene, a two-dimensional zero band gap semiconducting material, has gained considerable interest in material science, energy storage and sensor technology, due to its remarkable electronic and mechanical properties. It's high carrier mobility and ambipolar field effect, together with a great sensitivity towards changes in environmental conditions makes graphene perfectly suitable as transducing material for the use in various types of sensors. In this report, we first describe a novel biosensor exploiting the pH dependence of liquid gated graphene-based field-effect transistors for the enzymatic detection of urea. The channel between the interdigitated source-drain microelectrodes was non-covalently functionalized with bilayers of poly (ethylene imine) and urease using the layer-by-layer approach, providing a LoD below 1 μM urea. Next, we present a sensor based on a reduced graphene oxide field effect transistor (rGO-FET) functionalized with the cascading enzymes arginase and urease as recognition elements in a layer by layer assembly with poly (ethylene imine). The build-up of this nano-architecture was monitored by surface plasmon resonance spectroscopy. L-arginine was quantitatively detected by the change in current between source and drain electrode due to electrostatic gating effects conferred by the formation of OH^- ions upon enzymatic hydrolysis of the analyte L-arginine. And finally, we will describe first results on the coupling of calcium-responsive polymer brushes to graphene field-effect transistors. The presence of Ca^{+2} ions neutralize the charge of the phosphate groups leading to a change of the Dirac point by electrostatic gating effects. A formalism using the Langmuir adsorption model and the Grahame equation is used to obtain the surface coverage from the change of the Dirac point.

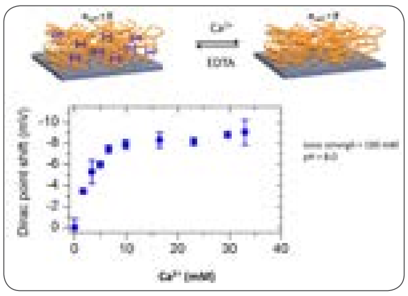

Figure 1: Coupling calcium-responsive polymer brushes to graphene field-effect transistors.

Recent Publications

1. Berninger T, Bliem C, Piccinini E, Azzaroni O and Wolfgang Knoll W (2018) Cascading reaction of arginase and urease on a graphene-based FET for ultrasensitive, real-time detection of arginine. Biosens. Bioelectron. https://doi.org/10.1016/j.bios.2018.05.027.
2. Piccinini E, Alberti S, Longo G, Berninger T, Breu J, Dostalek J, Azzaroni O and Knoll W (2018) Pushing the boundaries of interfacial sensitivity in graphene FET sensors: polyelectrolyte multilayers strongly increase the Debye screening length. J. Phys. Chem. 122(18):10181–10188

3. Piccinini E, Bliem C, Reiner Rozman C, Battaglini F, Azzaroni O and Knoll W (2017) Enzyme-polyelectrolyte multilayer assemblies on reduced graphene oxide field-effect transistors for biosensing applications. Biosens. Bioelectron. 92:661-667.
4. Reiner Rozman C, Larisika M, Nowak C and Knoll W (2015) Graphene-based liquid-gated field effect transistor for biosensing: Theory and experiments. Biosens. Bioelectron. 70:21-7.

Biography

W Knoll earned his PhD degree in Biophysics from the University of Konstanz in 1976. From 1991-1999 he was the Laboratory Director for Exotic Nanomaterials in Wako, Japan, at the Institute of Physical and Chemical Research (RIKEN). From 1993 to 2008, he was Director at the Max Planck Institute for Polymer Research in Mainz, Germany. Since 2008, he is the Scientific Managing Director of the AIT Austrian Institute of Technology. Since 2010 he is a Regular Member of the Austrian Academy of Sciences. He received an Honorary Doctorate from the University of Twente, the Netherlands in 2011 and became a Member of the Academia Europaea in 2017.

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