

Monolayer Graphene Edge: Selective Functionalization and Electrochemical Studies

Anur Yadav¹, R. M. Iost¹, T. J. Neubert^{1,2}, M. Wehrhold¹ and K. Balasubramanian¹

¹School of Analytical Sciences Adlershof (SALSA), Department of Chemistry and IRIS Adlershof, Humboldt Universität zu Berlin, 10099 Berlin, Germany.

²Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Institut für Silizium-Photovoltaik, Kekuléstr. 5, 12489 Berlin, Germany
anur.yadav@hu-berlin.de

Graphene functionalization is explored widely for modifying its physical and chemical properties (e.g. introducing band gap, improving its poor dispersion in aqueous and organic solutions and modulating the interfacial charge distribution). [1] The characteristic properties of graphene differ between the basal plane and the edge. Exclusive functionalization of either of them is expected to yield differences in the ensuing physical and chemical properties. We focused on the graphene edge (GrEdge), whose role becomes dominant while narrowing down to nanoribbons. [2]

We fabricated GrEdge electrodes by using photolithography and reactive ion etching. Graphene edges obtained in this manner were functionalized with two different kinds of functionalities: metal nanoparticles (Au or Pd) and organic moieties (polymeric aromatic amino groups). [3] The functionalities were attached to the edge in a non-covalent manner using electrochemistry. This was the first time that GrEdge was selectively functionalized under ambient conditions. The deposition of metal nanoparticles gives an additional advantage of surface-enhanced Raman scattering (SERS) effect at the edge. For the pristine GrEdge, we observe the typical edge-related Raman modes, while for the functionalized GrEdge, we obtained the vibrational fingerprint of the attached functional groups. Further, we did electrochemical studies at the edge electrode (before and after functionalization with Au nanoparticles) using classical redox couples, which shows microelectrode behavior in contrast to conventional graphene and carbon electrodes. In this way, we can tune the interfacial properties by functionalization of GrEdge with different chemical groups, and additionally investigate using electrochemical and spectroscopic methods.

References

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Figures

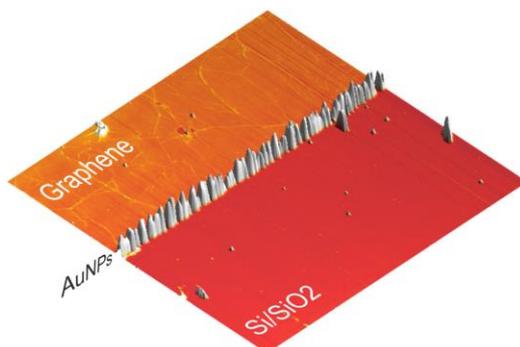


Figure 1: A 3D view of an AFM image showing gold nanoparticles at graphene edge on Si/SiO₂ substrate. [3]