Contribution (Poster)

Comparison of different Graphene Materials and their Electrochemical Application

Wendy Patterson*[1], Alexander Zöpfl[1], Masoumeh Sisakthi[2], Thomas Hirsch[1],
Otto S. Wolfbeis[1], Christoph Strunk[2], Frank-Michael Matysik[1]

[1]Institute of Analytical Chemistry, Chemo- and Biosensors, University of Regensburg
[2]Institute of Experimental and Applied Physics, Micro- and Nanophysics
Universitätsstrasse 31, 93053 Regensburg, Germany
wendy.patterson@chemie.uni-regensburg.de

Carbon materials are extensively used in electrochemistry due to their wide electrode potential window, low cost, chemical stability, and electrocatalytic activity for various redox reactions [1]. In particular, graphene is popular because of its high electrical conductivity and its potential in terms of device miniaturization, and also in lowering sensor detection limits, and is proving to be a versatile material for many applications. The most common synthesis routes to obtain graphene are the Scotch-tape method, chemical vapor deposition (CVD), and chemical preparation of reduced graphene oxide (rGO). All of these methods require varying amounts of effort, and result in materials differing in size, quality and uniformity of coverage.

We have systematically evaluated and compared each type of these graphene materials using microscopy to study their varying morphology, with Raman spectroscopy to obtain chemical and structural information, and with electrochemical methods to investigate electron transfer characteristics. The density of defects has a considerable effect on the electronic properties of graphene, with a higher concentration of defects resulting in lower electrical conductivity. Such defects are visible in the Raman spectra. Whereas graphene flakes obtained by the Scotch-tape method are nearly defect-free, the CVD graphene contains structural defects, and rGO is ill-defined as can be seen from the Raman spectra (Fig. 1).

For electrochemical applications, it is important to transfer the graphene to an insulating substrate, and also to provide electrical contacts. Each of the preparation methods require different transfer methods, each varying in effort. CVD graphene was transferred by a standard stamping process [2] onto electrodes with preexisting electrical contacts. The Scotch-tape graphene was not transferred, but rather the electrical contacts were applied afterwards by a laborious electron beam method. In contrast, since rGO can be dispersed in water, easy transfer to any substrate or preexisting electrode was possible by spin coating or drop casting. Characterization by Raman spectroscopy and microscopy reveals better layer uniformity for the CVD graphene as compared to rGO and Scotch-tape derived graphene. In this work, electrochemical characterization is also presented. Furthermore, the electrocatalytic activity towards H_2O_2 was investigated.

Graphene has excellent potential for wide spread sensor applications due to its exceptional structural, electrical, electrochemical, optical and mechanical properties. However, practical considerations such as differences in the ease of synthesis, transfer, and electrode construction for the various types of graphene must be considered for future widespread industrial applications and mass production.

The research was supported by Deutsche Forschungsgesellschaft (GRK 1570).

References

[1] M. Zhou, Y. Zhai, S. Dong, *Anal. Chem*. 81, 5603–5613 (2009)

[2] X. Li, Y. Zhu, W. Cai, M. Borysiak, B. Han, D. Chen, R. D. Piner, L. Colombo, R. S. Ruoff, *Nano Lett.* 9 (12), 4359–4363 (2009)

Figures

Figure 1:
Raman spectra of graphene materials derived from chemical, CVD, and Scotch-tape methods.