Process control by Raman spectrometry: From the graphite to reduced graphene oxide

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Abstract:
Raman spectrometry allows non-destructive examination of materials, which enables a further processing with the sample. The physical and chemical properties of the sample can be obtained by surface analysis. Information on material distribution and crystallinity is gained from collected data mappings. The process from the starting material (graphite 325mesh and graphenium crystal) to the desired reduced graphene oxide (rGO) is recorded by Raman spectroscopy.

Results and discussion:
The starting materials graphite 325mesh (Figure 1) and the graphenium crystals were synthesized to graphene oxide (GO) by the improved Hummers Method with additional parameters and cleaning steps in order to gain a high purity [1]. GO was deposited on a siloxane coated Si/SiO_2-wafer via spin coating and further reduced to rGO in a RTP-oven (Rapid Thermal Processing) in Ar/H_2 atmosphere. Graphite consists of sp^2 bonded planar graphene sheets. Fig. 1 shows the Raman spectrum of the graphite 325mesh with the typical bands G:1560 cm^{-1} and G': 2637-2706 cm^{-1}(several underlying bands → different interlayer interactions [2]). The rGO (Fig. 2 B) exhibits: D*: 1205 cm^{-1}, D:1328 cm^{-1}, G: 1598 cm^{-1}, D'': 1492 cm^{-1} (amorphous phase)[3], D`: 1741 $cm^{-1}$ and G`: 2893 cm^{-1}. The $I_{D`}/I_G$, I_D/I_G ratio and the position of the G-band contain information about the crystallinity and the successful reduction to rGO [4].

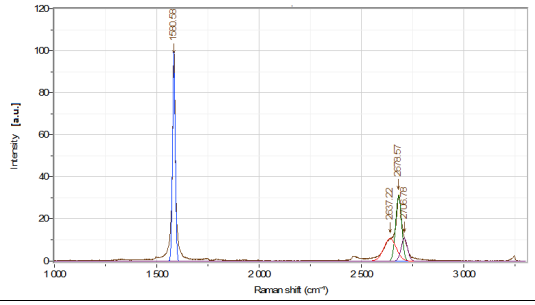

Figure 1: Raman spectrum of starting material graphite 325mesh (600 nm laser beam)

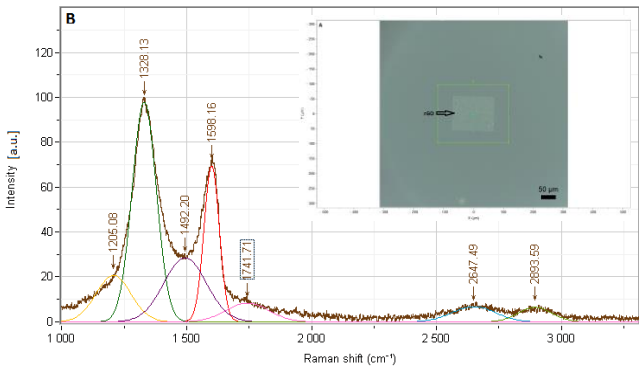

Figure 2: A: Mapping of the structured rGO area 100x100 µm²; B: single Raman spectrum of rGO with 660 nm laser beam (starting material graphite mesh)

Conclusion:
The mapping technique combined with the Raman spectroscopy allows a precise determination of the coated and structured 1-2 nm thick GO layer.

References

[1] D. C. Marcano, D. V. Kosynkin et al., ACS Nano, VOL. 4, NO. 8 (2010) 4806
[2] A. C. Ferrari, Solid State Communications, 143 (2007) 47.
[3] S. Claramunt et al., J. Phys. Chem., C 119 (2015) 10123
[4] G. T. S. How et al., Scientific Reports, 4 (2014) 1