**Transfer and weighing of graphene flakes by using a nanowire mass sensor**

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## Abstract

This work demonstrates an experimental method for the transfer and characterization of individual graphene flakes *in situ*.
The experimental setup includes a nanomanipulation system staged inside a scanning electron microscope. A germanium nanowire is integrated into the nanomanipulation system as a moving element. The nanowire is used for graphene sampling and transferring to a substrate. Graphene samples are produced by splitting thin flakes from the surfase of highly oriented pyrolytic graphite. These graphene flakes consist of few graphite layers.
The transfer is based on balancing of the adhesion interaction between the surfaces. Due to high adhesion between germanium nanowire and graphitic structures, graphene sample can be picked up onto the free end of a single-clamped nanowire (Figure 1a). We demonstrate the individual graphene sample transfer to selected position on the substrate (Figure 1b). The sample transfer from the nanowire to the substrate is performed by varying contact areas, thus balancing adhesion interaction. Factors,that can facilitate deposition are investigated.
Besides graphene transfer, the nanowire is used for sensing mass of the sample. Nanowire has its own specific resonant frequency which is dependent on nanowire's shape, mass and Young's modulus. We apply AC electric field for inducing oscillations in the nanowire and determine the resonance of the nanowire from SEM images (Figure 1c). Loading the nanowire with graphene sample causes decrease of its resonant frequency. The mass of the graphene sample to be transferred is calculated from the resonant frequency shift between the empty and loaded nanowire [1]. We explore factors that affect operating of the nanowire mass sensor inside SEM and its application for graphene characterization *in situ*.
Shape of the sample is determined from SEM pictures (Figure 1a). By knowing the graphene mass, geometry and interplanar spacing between the graphite layers, it is possible to estimate the number of layers in the flake.
A controlled transfer of graphene facilitates the fabrication of nanodevice prototypes under laboratory conditions. The graphene transfer and characterization *in situ* prevents environmental impact during the preparation of samples for future experiments.

## References

[1] J.Zhoua, C. Shi Laoa, P. Gaoa, W.Maia, W.L.Hughesa. S.Zhi Dengb. N.Sheng Xub, Z.Lin Wang, Solid State Communications, **139** (2006) 222-226

## Figures

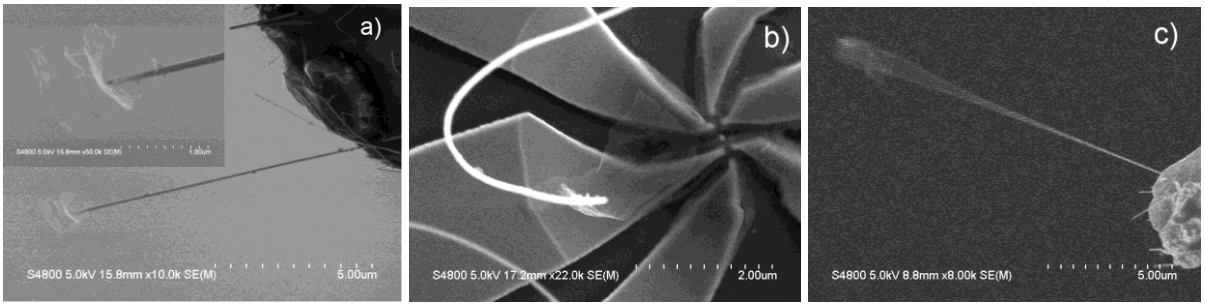


Figure 1 : a) graphene sample on the end of single-clamped nanowire; b) graphene transfer from the nanowire to the substrate; c)nanowire at the resonant frequency