# Tuning topography of graphene using monodisperse nanoobjects

**Jana Vejpravova**[1], Barbara Pacakova[1], Alice Mantlikova[1], Timotheus Verhagen[1], Vaclav Vales[2], Otakar Frank[2] and Martin Kalbac[2]

[1]Institute of Physics CAS, Na Slovance 2, Prague 8, Czech Republic
[2]JH Institute of Physical Chemistry CAS, Dolejskova 3, Prague 8, Czech Republic
vejpravo@fzu.cz

## Abstract

The topography of graphene transferred on a substrate of interest is characteristic by network of topographic aberrations with a specific curvature, termed wrinkles. Consequently, the density and mobility of the charge carriers in wrinkles show significant difference with respect to the ideally flat graphene sheet and can be profited in design of nanosized sensors, controlled functionalization of graphene or local generation of giant magnetic pseudofields. A promising strategy is to create a defined network of wrinkles with optimal modulation of the inter-atomic distances and carrier density. In our work, we focused on control of wrinkling of a single-layer graphene with the help of strictly monodisperse nanoobjects. In order to manage the wrinkling process, we engineered graphene – nanoparticle (NP) or graphene - fullerene $C_{70}$ quasi two-dimensional structures [1, 2], constituted of graphene monolayers (grown by chemical vapour deposition) transferred over substrates decorated with the monodisperse nanoobjects acting as local sources of the graphene corrugation. The strain and doping in the model nanostructures were inspected by Raman spectro-microscopy, while their topography was evaluated by scanning electron microscopy (typical micrographs shown in the Figure 1) and atomic force microscopy (AFM) [1-3]. Typical fingerprint of the delaminated fraction of the graphene is identified as a substantial contribution to the principal Raman active modes (G and G'), which show dominant ($G_1$, $G'_1$) and red-shifted ($G_2$, $G'_2$) subbands [1,4] (shown in the Figure 1 - left). G-G' correlation analysis of the Raman shift of the two components of the G and G' modes clearly resolved the fraction of the graphene layer in contact and delaminated from the substrate, respectively. Finally, we put in context the results of the advanced AFM processing and Raman map analysis and obtained a general linear dependence between the delaminated area of the graphene (wrinkles) and Raman intensity of the related subbands [1]. Our approach thus enables robust control over the graphene topography up to ~ 60% of wrinkling and facile quantification of the amount of wrinkles using Raman spectroscopy as the most convenient probe for graphene.

## References

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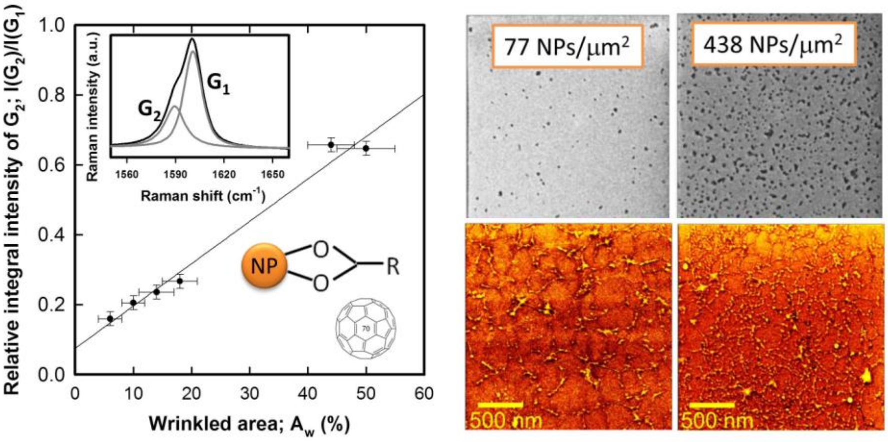

**Figure 1** Correlation of the relative intensity of the $G_2$ subband to the amount of wrinkles obtained from AFM (left). HR SEM images of substrates decorated with 9 nm NPs (right top) and final graphene - NP nanostructures (right bottom).