Measurement of ripples spectrum in suspended graphene

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The existence of graphene in stable form remains an astonishing phenomenon since 2D lattice was predicted to suffer from enormous undulations due to thermal oscillations. This was highlighted when the intrinsic roughness of suspended graphene was revealed [1]. The ripples affect graphene's properties and places additional limit of conductivity [2]. The rippling are governed by severely anharmonic dynamics [3], and there are several considerably different models have been presented in literature so far, that stems from the lack of experimental data on ripples spectrum in suspended graphene and its behaviour under varying conditions.

Here we present a technique for measurement of ripples spectrum of suspended graphene. The technique is based on electron diffraction patterns analysis. The study of suspended graphene allows carrying out *in-situ* measurements of ripples spectrum under varying temperature, strain etc. Temperature dependence of ripples spectrum shows growth of ripples' average wavevector with temperature as predicted by theory, while average amplitude slightly decreases. The latter can be explained in terms of anharmonic behaviour of graphene ripples.

The technique can be also applied to graphene deposited on a thin enough substrate that, in turn, makes possible its validation by AFM or STM. It is shown that roughness of suspended graphene is lower that that of graphene attached to the substrate.

The technique has shown itself to be quite fruitful in context of the graphene-related studies, but it can also be applied to study of roughness of any low-dimensional structure.

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