Graphene Growth Dynamics and Phonon Engineering using Isotopes

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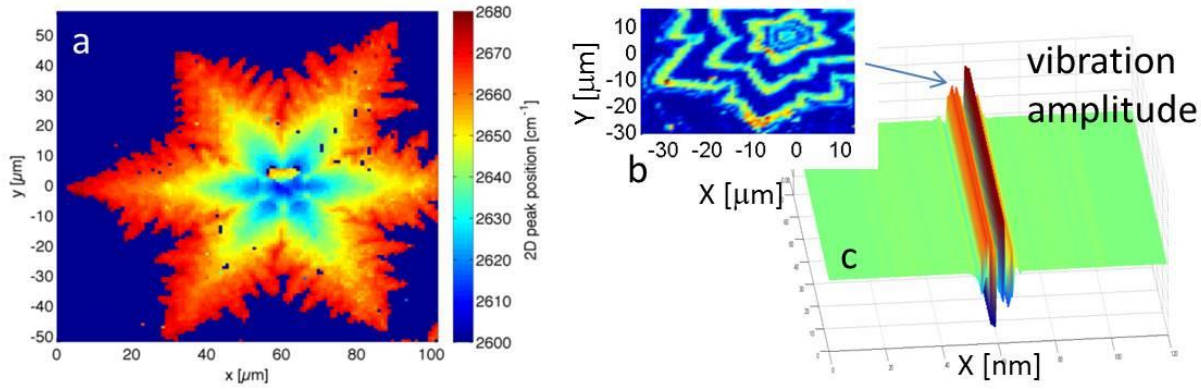
Abstract

Graphene is grown by chemical vapor deposition (CVD) on copper using different relative concentrations of C12 and C13 isotopes. This allows us to extract the growth history by correlating the isotope concentrations with the Raman peak positions [1] as shown in figure (a) and extract important growth parameters. This is done for regular shaped graphene as well as for fractal graphene (graphlocons) [2], which can be modeled using phase field models. This approach can also be applied to multilayer growth. Beyond growth dynamics, graphene with different or alternating isotopes enables the experimental realization of new phonon modes such as phonon Anderson localization for random distribution of isotopes, or phonon waveguides, like phonon quantum wires in alternating isotopes as shown in figure (b) and (c), or more generally phonon engineering. Some of these modes have particular signatures in the Raman spectrum, particularly at high frequencies and can be spacially detected via Raman spectroscopy and will also be discussed here.

References

[1] S Bernard, E Whiteway, V Yu, DG Austing, ans M Hilke, Phys. Rev. B, **86**, (2012) 085409
[2] M Massicotte, V Yu, E Whiteway, D Vatnik, and M Hilke, Nanotechnology, **24** (2013) 325601.

Figure:



Caption: CVD graphene grown with different carbon isotopes. -a- shows the Raman map of the 2D peak position of graphene for C13 carbon varying between 0 and 100%. -b- the colormap indicates the Raman G-peak height of C12 graphene. –c- a numerical evaluation of a high energy phonon mode corresponding to a 1Dconfined mode.