Non-invasive Raman tomography for 2D-material applications

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Graphene has extraordinary mechanical and electronic properties, making it a promising material for membrane-based nanoelectromechanical systems (NEMS). Here, chemical vapor deposited graphene is transferred onto target substrates to suspend it over cavities for pressure sensor applications. The development of such devices requires suitable metrology methods, i.e. large-scale characterization techniques to confirm and analyze successful transfer with intact suspended graphene membranes. We propose fast and non-invasive Raman spectroscopy mapping to distinguish between free-standing and substrate-supported graphene, filtering bands of a typical graphene fingerprint and utilizing the different strain and doping levels (see Fig. 1). For further in depth analysis of the identified and intact membrane the technique is expanded to combine two-dimensional area scans with cross-sectional Raman spectroscopy, resulting in three-dimensional Raman tomography imaging of membrane-based graphene NEMS (see Fig. 2). Raman Tomography can be used to determine materials not only at the surface but also inside the device in 3D space [1]. The technique is not limited to graphene, but can be used to identify and analyze other 2D-materials, material stacks or covered layers, e.g., the graphene hot electron transistor (GBT) [2] or MEMS. Furthermore, it could be used to determine the chemical content of nano bubbles [3] or micro chemical reactors [4] as well as microfluidic devices or other applications.

References

[1] S. Wagner *et al.*, *Nano Lett.*, 2016, under Review.
[2] S. Vaziri *et al.*, *Nano Lett.*, 2013.
[3] T. Georgiou *et al.*, *Appl. Phys. Lett.*, 2011.
[4] B. Ding *et al.*, *J. Mater. Chem. A*, v, 2012, pp. 1096–1101.

Figures

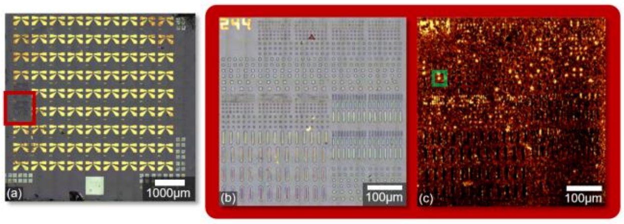

Figure 1: a) Stitched white light image of the complete chip; b) stitched white light image of the test structures; c) Raman image of the test structures displaying 2D peak intensity (yellow: intact membrane; black: broken membrane).

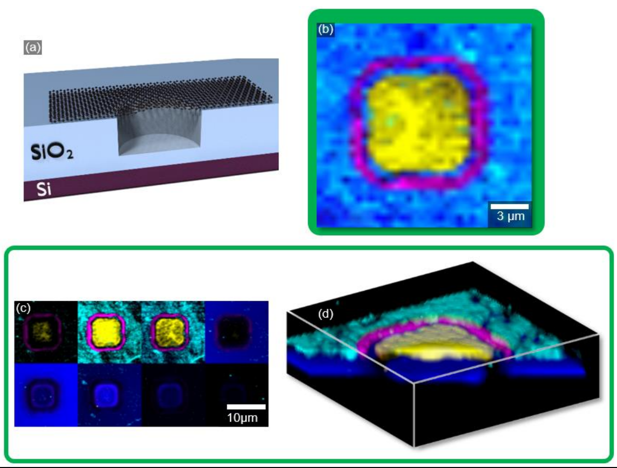

Figure 2: a) cross-section schematic of one device; b) 2D-Raman scan of one cavity from the test structures (top view) indicated by a green square in Fig. 1c; c) Sequence images of a cavity for the taken at different z-positions; d) 3D tomography image of a cavity.