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Graphene as a standard material for accurate dimensional measurement of the focal volumes of Raman microscopes

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Abstract:
Raman microscopy is a versatile vibrational spectroscopy technique that allows fast, non-destructive chemical identification and characterization of materials at the microscopic scale. Nowadays, it is used in a wide range of research and industrial fields, spanning from fundamental studies and materials characterization to biological and pharmaceutical applications. As of now, Raman is mainly employed as a qualitative characterization tool, and sometimes for relative quantification; however, absolute quantification traceable to the International System of Units (SI) is still unfeasible. One of the reasons is that the community currently lacks standard procedures and reference materials for the accurate measurement of the dimensions of the focal volumes of Raman microscopes.
In this work, a graphene flake with a straight edge (tolerance within 10 nm) is proposed as a standard material to quantify the three dimensions of confocal volumes of three Raman microscopy setups. Graphene has a high Raman cross section, is chemically and mechanically stable in ambient conditions, and has a very low thickness. These properties make it an ideal candidate as a Raman probe. By scanning the surface of the graphene layer and its straight edge in different directions, Raman intensity profiles can be acquired and analyzed to reconstruct the geometry of the focal volume and focused beam waist. Furthermore, with this concept a technique to obtain actual projections of the focal volume on planes parallel to the optical axis ("side views" of the volume) is applied. These data, combined with theoretical knowledge and precise definitions of the profiles and their boundaries, allow the metrological dimensional characterization of the focal volumes and beam waists of Raman microscopes and the estimation of measurement uncertainties, which is a fundamental step towards traceable Raman microspectroscopy quantification in all its fields of application.

Keywords: Raman spectroscopy, metrology, Raman quantification, focal volume, dimensional analysis, vibrational spectroscopy.

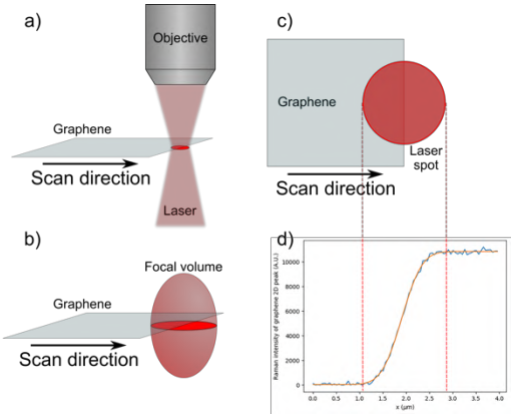

Figure 1: Schematization of the graphene method for the Raman microscope lateral profile measurement of the beam waist. a) Perspective side view of the system (the focused spot is shown in dark red). b) Same view with the focal volume explicitly shown. c) Top view of the system. d) Actual measurement of a profile (blue line) and least-squares functional regression (orange line). Note that this is a cumulative function of the intensity at each position. The vertical dashed lines indicate a profile delimited by an intensity threshold of $1/e^2$ of the maximum.

References:

1. Kim, Y., Lee, E. J., Roy, S., Sharbirin, A. S., Ranz, L. G., Dieing, T., & Kim, J. (2020). Measurement of lateral and axial resolution of confocal Raman microscope using dispersed carbon nanotubes and suspended graphene. *Current Applied Physics*, 20(1), 71-77.