

# Interlaboratory comparison on the quantification of the number of layers of graphene by Raman spectroscopy

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**Chiara Portesi<sup>1</sup>**

Alessio Sacco<sup>1</sup>, Keith R. Paton<sup>2</sup>, Andrew Pollard<sup>2</sup>, Charles Clifford<sup>2</sup>

<sup>1</sup>*Istituto Nazionale di Ricerca Metrologica (INRiM), Strada delle Cacce 91, 10135 Torino (Italy)*

<sup>2</sup>*National Physical Laboratory, Teddington, TW11 0LW, UK*

[c.portesi@inrim.it](mailto:c.portesi@inrim.it)

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As of today, in Europe alone there are more than a hundred commercial producers of products advertised as “graphene”. Still, these materials are often uncharacterised and present great variability even on a batch-to-batch basis, and they are often ascribable to graphite. Considering the widespread impact that graphene is predicted to have on so many industry and research areas, the need for standard characterisation procedures is high; however, these cannot be developed without proven and reproducible methods, established by international efforts and validated through interlaboratory comparisons.

VAMAS (Versailles Project on Advanced Materials and Standards [1]) promotes international efforts on measurement standardisation and harmonisation; the work presented here is a VAMAS project (project 11) under technical working area (TWA) 41 — Graphene and Related 2D Materials — concerning an interlaboratory comparison on the use of Raman microspectroscopy to characterise two types of graphene-related materials: flakes originating from commercially available electrochemically exfoliated powder containing few-layer graphene; and samples of mechanically exfoliated graphene from highly ordered pyrolytic graphite, both deposited on SiO<sub>2</sub>/Si substrates. By using a standard operating procedure for measurements using Raman spectroscopy and its parameters [2], including instrumental calibration [3], and making use of a micro-patterned substrate for unambiguous sample location and measurement, the typical variability in results obtained by different users and laboratories across the world will be evaluated. The objectives of the study are the validation of a standard method for the determination of the number of layers in few-layer graphene, determining the uncertainties associated with measurement and data analysis, and to steer input into a future revision of ISO/TS 21356-1 “Structural Characterization of Graphene” [4].

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## References

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- [1] Website: [www.vamas.org](http://www.vamas.org)
- [2] Pollard, Andrew J., et al. “Characterisation of the Structure of Graphene — Good Practice Guide No. 145”, The National Physical Laboratory (NPL) (2017)
- [3] Choquette, Steven J., et al., *Applied spectroscopy* 61.2 (2007) 117
- [4] ISO 21356-1:2021. “Nanotechnologies — Structural characterization of graphene — Part 1: Graphene from powders and dispersions”, ISO/TC 229/JWG 2 (2021)