

Enabling Reproducibility and Robust Measurement: International Interlaboratory Comparisons for Graphene Standardisation

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With graphene now being used in real-world products, industry needs internationally standardised procedures more than ever, to determine the material properties of graphene and related 2D materials (GR2Ms), so that different materials produced by different manufacturers in different countries can be reliably compared. This work has been ongoing within international standardisation bodies for several years, with international standards recently being published [1].

However, to ensure accurate and reproducible standards are produced, measurement protocols must be verified through international interlaboratory comparisons (ILCs), testing the same method for the same one material across many laboratories around the world. To introduce this session of the Industry Forum, focused on the metrology research undertaken within the EU-funded ISO-G-SCoPe project and through the Versailles Project on Advanced Materials and Standards (VAMAS), the current landscape of graphene standards within ISO and IEC will be discussed, as well as the overall strategy of addressing the measurement of different types of material properties of GR2Ms and how VAMAS ILCs can be used to verify the methods that are being standardised. How these studies reveal the sources of uncertainty, which allow us to improve the precision or accuracy of a measurement and quantify the associated uncertainty, will be discussed and a recent example detailed for Raman spectroscopy of graphene produced using chemical vapour deposition [2]. The impact of this work on industry demonstrates how metrology is an important part of providing different companies the confidence in both their products and materials produced around the globe.

References

- [1] ISO/TS 21356-1:2021: Nanotechnologies — Structural characterization of graphene — Part 1: Graphene from powders and dispersions
- [2] Turner *et al.*, 2D Materials, **9** (2022) 035010.

Figures

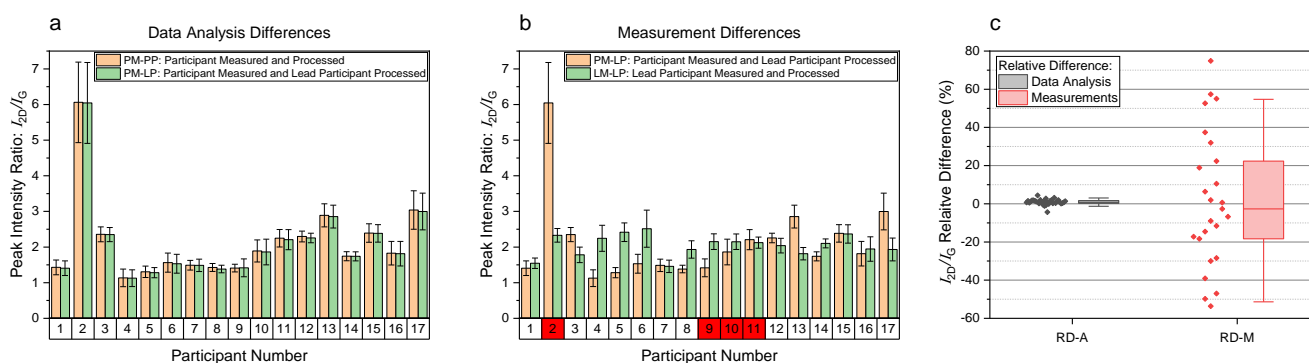


Figure 1: Example results from an international interlaboratory study to determine the source of uncertainties in the measurement of graphene using Raman spectroscopy [2].