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International Interlaboratory Comparison of Raman Spectroscopy for CVD-grown Graphene

There is an urgent requirement for reliable, reproducible, accurate and consistent measurements of Graphene to enable this growing industry, which is now producing large-scale quantities of material. To this end, several measurement standards are underdevelopment within the Nanotechnologies committees of ISO and IEC. To develop high quality international standards, protocols must be developed and verified, with the associated uncertainties determined.

Towards this effort, we report the procedure and the initial results of a VAMAS interlaboratory study conducted under TWA 41 Project 1 (Graphene and Related 2D Materials) for Raman spectroscopy of chemical vapour deposition (CVD) grown graphene. This project will directly support the development of the ISO/IEC standard “PWI 21356-2 - Nanotechnologies - Structural Characterisation of CVD-grown Graphene”. This interlaboratory study gathered data from 15 participants across academia, industry (including instrument manufacturers) and National laboratories. This study investigates the measurement uncertainty contributions of both instrumentation and data analysis, with all the participants performing measurements on a commercially-supplied CVD-grown graphene sample using the same measurement protocol.

By comparing reported Raman metrics with the measurements of the same regions made by the lead participant, variations in the reported peak intensity ratios and peak fits could be explored. While many of the reported measurements were relatively consistent, significant and meaningful outliers were observed due to differences in both the instrumentation and data analysis. These variations ultimately resulted in inconsistent reports of the coverage of single layer graphene and must be understood to provide reproducible and comparable measurements for the growing graphene industry worldwide.

Figures

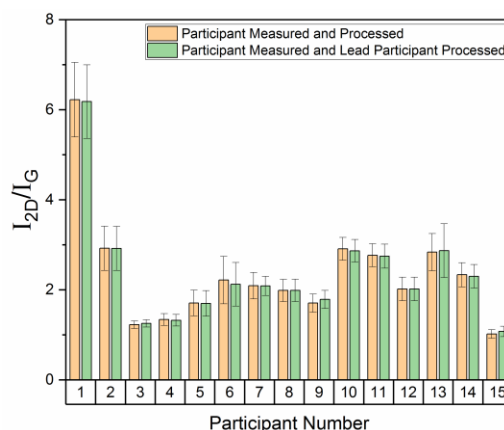


Figure 1: I_{2D}/I_G Raman peak intensity ratios reported by the VAMAS participants. Differences in peak intensity ratios due to the data analysis being performed by the participants (green) and one lead user (orange) are also shown.