VAMAS

Graphene and related 2D materials
Technical Work Area 41

Project 14

Measurement of spatial homogeneity in two-dimensional semiconductors

Objectives

This interlaboratory comparison project will assess the performance of a method for measuring the spatial homogeneity of two-dimensional semiconductors using photoluminescence (PL) spectroscopy. The proposed method is applied to monolayer 2D semiconducting transition metal dichalcogenide (TMD) samples.

Background

2D TMDs contain defect populations that limit the material properties and performance of devices made from them. Point-spectroscopy taken from representative locations on the sample can be misleading due to the limited spatial resolution and sampling. Spatially mapped spectroscopy can provide information about the distribution of defects across a range of length scales, but there are not currently any agreed methods for quantifying this homogeneity.

In this VAMAS project the aim is to compare the measurand of spatial homogeneity extracted from measurements of confocal PL spectroscopy carried out on monolayer samples of TMDs. Preliminary results obtained within NPL [1] are promising and suggest that the method proposed is suitable.

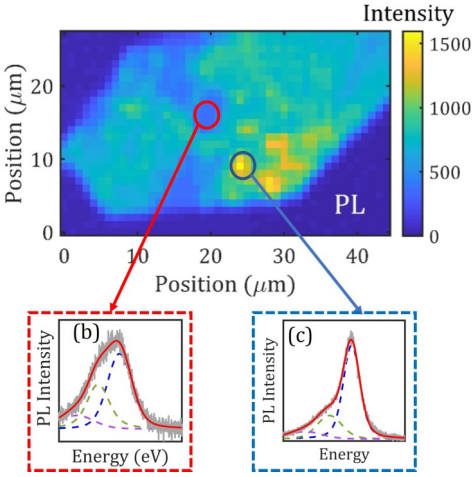
Standardisation Needs

There are no existing standards for this type of measurement. The most closely related existing standard is ISO/TS 21356-1 'Structural characterisation of graphene from powders and liquid dispersions' developed by ISO TC229 'Nanotechnologies', jointly with IEC. This suggests performing Raman spectroscopy at a "minimum of three different areas of the sample to understand the local variation across the sample" but is not designed to consider ways to quantify local variations nor how the degree of variation relates to sample quality. To understand this, the proposed interlaboratory comparisons will help to develop best practice and understand the associated uncertainties.

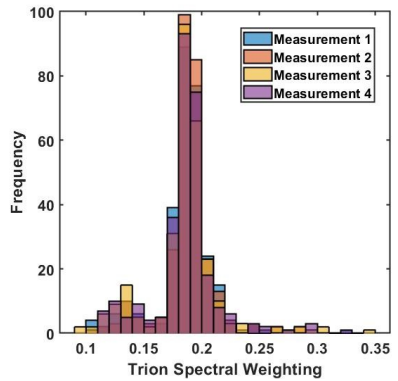
Work Programme

- Develop protocol and finalise sample preparation
- Prepare samples for round-robin
- Round-robin interlaboratory measurements
- Data analysis, evaluation and reporting

CALL FOR PARTICIPATION



PL map of monolayer WS_2 showing two locations with different spectral characteristics.



Histogram of the spectral weighting of trions associated with defects in WS_2, extracted from four repeated measurements of PL maps. The variance of this distribution represents the spatial homogeneity.

Duration

Two years beginning June 2022.

Deliverables and Dissemination

Report will evaluate the suitability of the candidate physical standard and associated measurement protocol to guide further development. Results will be published in peer-reviewed journal and may contribute to a documentary standard under ISO TC 229.

Funding

Participants in the interlaboratory comparison will fund their own involvement (approx. 3 days' work).

International Participation

Current participants represent the UK, Brazil, China and the USA, wider regional participation would be greatly welcomed.

For more information on participation, please contact:

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[1] Cao et al, Sci. Rep. 2021

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