Raman Metrology - Towards Traceable and Quantitative Measurements

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Raman spectroscopy/microscopy is a powerful surface analytical technique for rapid, non-destructive characterization of materials. It works under ambient conditions, often without requirement of any sample preparation. Its applications span biomedical, microelectronics, pharmaceutical, security and fundamental investigations of nanomaterials such as the novel 2D and nanocarbon materials. More recently, miniaturized hand-held Raman instruments enable an even broader range of measurement capabilities, such as environmental monitoring, screening of explosives and analysis of illicit drugs, to be brought into field and increasingly these measurements are carried out by non-experts of the scientific or spectroscopic community. Despite nearly a century of development, Raman spectroscopy remains a qualitative analytical technique. A major obstacle in the use of Raman data in regulatory applications is the lack of traceable quantification and the absence of certified reference and documentary standards. This poster summarizes activities under development by the international Raman Metrology Team (RMT) to develop traceable and quantitative measurements for various Raman measurands. The RMT is composed of Raman experts from 15 National Measurements Institutes (NMIs) throughout the world that collaborate through monthly meetings on the development of quantitative and traceable Raman measurements as well as standards relevant to Raman spectroscopy. This poster covers the CCQM-SAWG pre-pilot study on the Raman confocal volume measurements and strategy towards traceable and quantitative Raman measurements; Raman shift calibration interlaboratory comparison carried out under VAMAS TWA42; Structural characterization of CVD-grown graphene under VAMAS TWA41 and Raman spectroscopy for the quantification of phases within TiO2 nanoparticle mixtures.

Traceable Quantitative Measurement with Raman Microscopy
Confocal Volume and Traceable Concentration Measurements
Contact: Li-Lin Tay (NRC-CNRC, Canada)

Objective is to develop methodology for traceable quantitative measurement with Raman spectroscopy
• CCQM-SAWG pre-pilot project was carried out to measure the Raman confocal volume
• Intensity calibration in confocal Raman microscope using samples (solutions / solids) of known traceable concentrations
• Using the calibration curve, concentration of an unknown sample can be measured
• If of molecule = Traceable concentration X Confocal Volume

Raman Spectroscopy for Validation and Quantification of Titanium Dioxide Nanoparticle Mixtures
VAMAS TWA 42: Raman Spectroscopy and Microscopy
Contact: Andrea M. Rossi and Chiara Portesi (INRIM, Italy)

Objective is to develop validated procedures based on Raman spectroscopy, for the identification and quantification of the three TiO2 polymorphs in titanium dioxide nanoparticles (NPs) binary mixtures.

Due to the different crystalline structure and subsequent different spatial distribution of the atoms, anatase, brookite and rutile provide different Raman fingerprint spectra.

Raman Spectroscopy for the Structural Characterization of CVD-Grown Graphene
VAMAS TWA 41: Graphene and Related 2D Materials
Contact: Andrew Pollard & Piers Turner (NPL, UK)

Graphene is a 2D material with exceptional properties with potential for many industrial applications. Raman spectroscopy and microscopy is particularly powerful technique for studying carbon nanomaterials. The goal of this international interlaboratory study is to determine the uncertainties in measurement of the surface coverage of graphene, number of layers and level of disorder using Raman spectroscopy.

Calibration of Raman Spectral Shift
VAMAS TWA 42: Raman Spectroscopy and Microscopy
Contact: Erlon H. M. Ferreira (INMETRO)

Objective is to develop a methodology for wavenumber (Raman Shift) calibration with traceability to SI and dissemination through reference materials. Currently the only published Raman wavenumber standard, ASTM-E1840, does not provide traceability nor uncertainty analysis for wavenumber calibration.

Raman Spectroscopy for the Structural Characterization of CVD-Grown Graphene
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