Airborne Particulate Matter: Understanding its Composition with Raman Spectroscopy

The increasing worry about **the effect of particulate matter on air quality and public health** is leading to a more thorough investigation into its intricate characteristics. Airborne particles consist of a wide range of solids and aerosols, such as liquid droplets, dry solid fragments, and solid cores coated with liquid. **These particles vary in their size, shape, and especially chemical composition.** To better understand their effects and evaluate their hazards, a molecular-level investigation is imperative. For this purpose, Raman microspectroscopy emerges as a powerful tool to unveil the chemical composition of airborne particles on a microscopic scale.

In this newsletter, we delve into **three notable research papers** that utilize Raman microspectroscopy to advance our understanding of airborne particles and its implications for air quality and public health.

To know more on this topic, click here.

Chemistry at level of individual aerosol particle using multivariate curve resolution of confocal Raman image.

S. Sobanska, G. Falgayrac, J. Laureyns, C. Bremard
Laboratoire de Spectrochimie Infrarouge et Raman, UMR-CNRS 8516, CERLA FR-CNRS 2416, University of Sciences and Technologies of Lille
2005

This article focuses on the Raman analysis of airborne particles with diameters between 1 and 10 µm, using HORIBA's automated confocal Raman microspectrometer. The heterogeneity of the aerosols at the level of the spatial resolution generates **overlap of the characteristic Raman peaks of several pure compounds** in a pixel spectrum. To overcome this, the authors applied a sophisticated combination of multivariate curve resolution (MCR) methodologies: SIMPLISMAX and MCR-alternating least square (ALS). The study demonstrates the effectiveness of **automated high-resolution 3D Raman mapping, coupled with MCR techniques**, in analyzing individual tropospheric particles. This refined approach contributes significantly to the exploration of air particles, particularly in the context of urban air pollution toxicity, thereby advancing our understanding of the intricate dynamics governing atmospheric aerosols.

Resolving the internal structure of individual atmospheric aerosol particle by the combination of Atomic Force Microscopy, ESEM–EDX, Raman and ToF–SIMS imaging

S. Sobanska, G. Falgayrac, J. Rimetz-Planchon, E. Perdrix, C. Brémard, J. Barbillat
Laboratoire de Spectrochimie Infrarouge et Raman, UMR-CNRS 8516, 2416, Université de Lille
2013

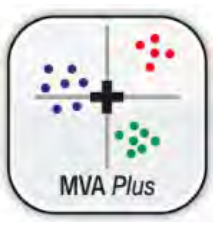
This article showcases a comprehensive micro-analytical approach, integrating Raman Microspectrometry (RMS), Atomic Force Microscopy (AFM), Environmental Scanning Electron Microscopy coupled with Energy-Dispersive X-ray analysis (ESEM–EDX), and Time-of-Flight Secondary Ion Mass Spectrometry (ToF–SIMS), to describe the **internal structures of individual aerosol particles.** Noteworthy is the pioneering application of Raman, using HORIBA's confocal microspectrometer, which gives molecular information on microscopic volumes under ambient conditions, presenting a direct characterization of particle composition. This study underscores the crucial role of Raman microspectrometry coupled with complementary techniques for a holistic approach in unraveling the internal structures of individual aerosol particles, and enhancing our comprehension of atmospheric processes which is essential for their environmental and health impacts.

Identification and characterization of individual airborne volcanic ash particles by Raman microspectroscopy

N.P. Ivleva, S. Huckele, B. Weinzierl, R. Niessner, C. Haisch, T. Baumann
2013

This research marks a major achievement in **volcanic ash** (VA) analysis, presenting the inaugural application of Raman microspectroscopy to identify and characterize individual airborne VA particles collected during research aircraft flights in April/May 2010 near the Eyjafjallajökull volcano eruption. Raman microscopy, performed using the HORIBA LabRAM HR, enabled precise identification of VA amid diverse atmospheric particulate matter (soot, nitrates, sulfates, and clay minerals). Cluster analysis further compared Eyjafjallajökull VA particles from different sites and with a range of minerals, providing valuable insights into their composition and structure. This research shows the success of Raman microspectroscopy, as a rapid, non-destructive and high-resolution technique, in efficiently discriminating VA particles from other atmospheric constituents, offering crucial insights into ash clouds and their implications for air traffic and public health.

MVA Plus, Multivariate Analysis App for all Raman Maps



Despite the efficacy of Raman spectroscopy in identifying and quantifying chemical compounds, some samples, like airborne particles, require the use of mathematical tools to accurately distinguish their different compounds. To do so, the **Multivariate Analysis (MVAPlus)** module within LabSpec 6 by HORIBA steps in as an ideal tool melding spectral and optical data to produce thorough maps of the sample. It offers three main groups of multivariate methods: Decomposition for component identification, clustering for grouping similar spectra, and quantitative analysis for concentration prediction based on known data. **Fully integrated in LabSpec 6**, MVA Plus streamlines the determination of reference spectra, swiftly compares different multivariate algorithms, and provides a user-friendly workflow interface **for accurate Raman image generation.**

Coming Webinars

QC and Fundamental Analysis of Li-Ion Batteries with Raman Spectroscopy

In this webinar, we will present the Raman spectra of commonly used metal oxides, NMC and LFP; discuss the effect of the measurement conditions; and explore chemical imaging of the electrodes (active materials, binder, carbon, etc.)

December 6, 2PM EST, 11 AM PST, 8PM CET, 7PM BST

Webinar replay is coming soon

Nanoscale Chemical Characterization of Novel Semiconductor Materials using Tip-Enhanced Optical Spectroscopy

presented by Naresh Kumar, Senior Scientist, Department of Chemistry & Applied Bio., ETH Zürich

Join us for an exclusive webinar featuring Naresh Kumar, distinguished **winner of the prestigious 2023 Masao Horiba Award**. Kumar's webinar unveils the potential of Tip-Enhanced Optical Spectroscopy (TEOS), probing the nanoscale intricacies of two-dimensional transition metal dichalcogenides (TMDs) and organic photovoltaic (OPV) devices.

December 14, 2PM GMT, 3PM CET, 6AM PST, 9AM EST

Register here

Stay connected!

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