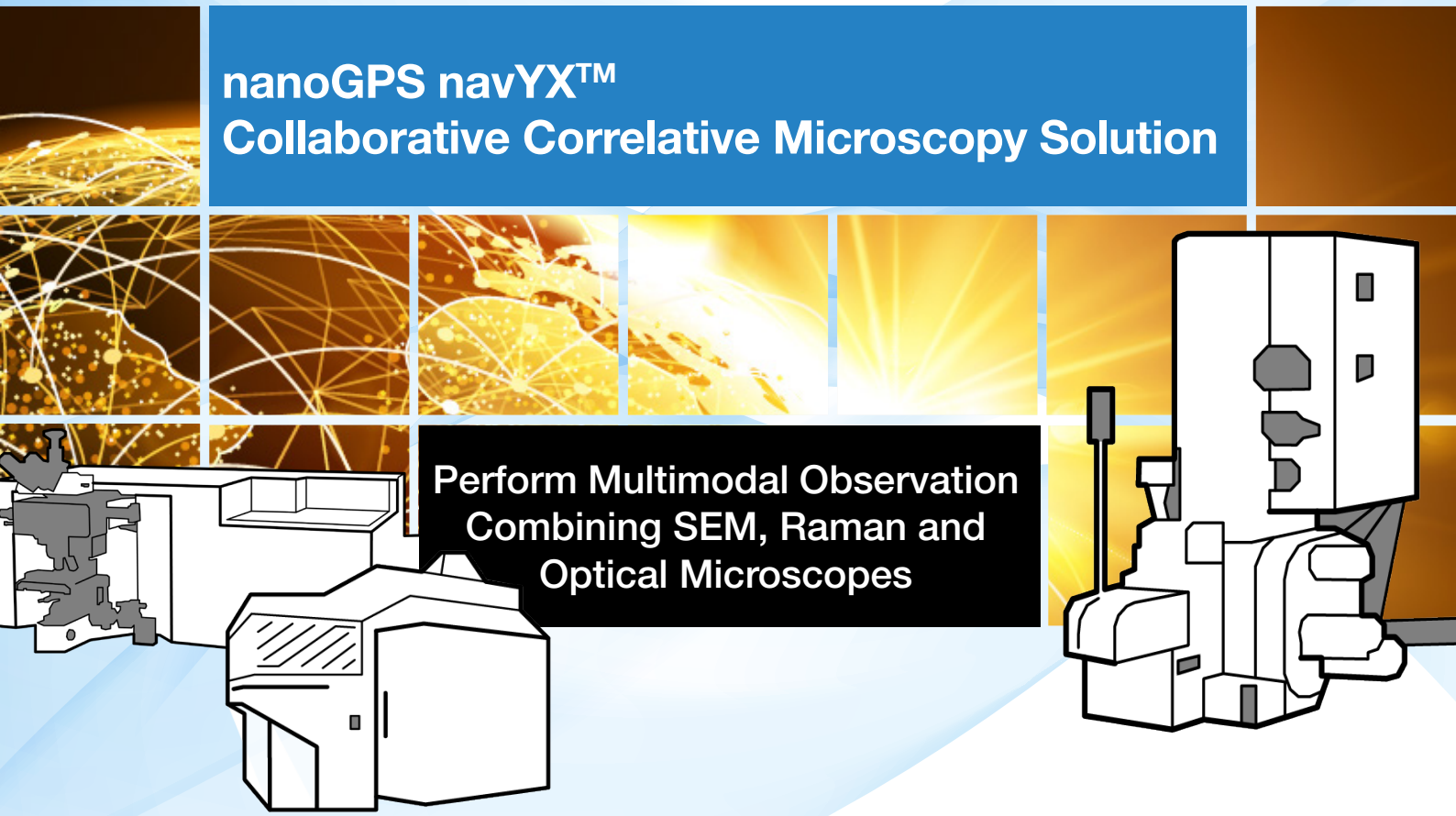
HORIBA
Scientific

nanoGPS navYX™
Collaborative Correlative Microscopy Solution



Perform Multimodal Observation Combining SEM, Raman and Optical Microscopes

JOBIN YVON
Technology

nanoGPS navYX

A revolution in correlative microscopy

nanoGPS navYX:

Relocate interesting regions in just a few seconds!

nanoGPS navYX allows fast relocalisation of points of interest between different microscopes and modalities: Raman microscopes, scanning electron microscope, cathodoluminescence and upright optical microscope.

Get more from your sample!

Save time

nanoGPS navYX saves time and opens new opportunities to researchers.

Relocating areas of interest without wasting time means more time for research. Sending samples to other laboratories to get additional information on specific zones of interest is made simpler, with no risk of confusion or misunderstanding.

Unlimited number of samples

The tags are affordable and can be purchased directly on the HORIBA e-store. They do not age and can be easily fixed permanently to your samples using carbon tape.

- Easy sample preparation
- Available for fast online purchase
- Kit for evaluating relocalization accuracy of your instrument

Collaborative characterization

With nanoGPS navYX, share samples with other scientists, using various characterization techniques (structural, elemental, molecular), even in other remote laboratories.

- SEM-Raman compatible with any SEM and optical microscope
- Provided with a Microsoft Windows based stand-alone software
- Only the sample travels with its long-lasting nanoGPS tag
- Share your analytical techniques and expertise with other scientists

An accuracy never achieved

One key technology behind nanoGPS navYX is image-based position sensing, with which the precise position and orientation can be determined from a single image of a patterned tag.

Precisions of a few nm and a few tens of µrad are achievable with nanoGPS technology. Even dust grains and scratches present on the tag have minimal impact on the performance of nanoGPS navYX. Typical relocalization errors with the various SEM and Raman microscopes range from 5 µm to 30 µm.

Why Raman?

Principle: Interaction of laser light with a sample results in a Raman spectrum - a detailed chemical fingerprint. Combined with an optical microscope, this provides sample identification and chemical imaging on a microscopic scale.

Raman is an ideal technique for research and industry offering high quality data, reliability, versatility and improved value for money over other analytical techniques. Benefits not only include the range of samples that can be analyzed but also the information content that is provided.

- Chemical identification
- Quality testing
- Process/product troubleshooting
- Contamination and inclusion analysis
- Raw materials inspection
- Structural information of semiconductors

Collaborative correlative microscopy

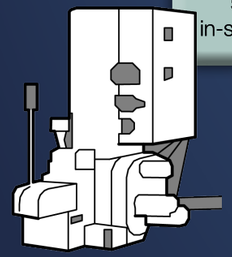
With Raman becoming a routine analytical technique in recent years for materials, life and environmental sciences there is an increasing number of scientists eager to combine micro-molecular analysis with other more conventional characterization techniques such as scanning electron microscopy, fluorescence microscopy, size and morphology analysis. Collaboration between specialists is paramount and transferring the sample from one technique to another has been forever a key issue to overcome.

nanoGPS navYX

Electron microscope to investigate nanostructure size, shape and defects by in-situ electron, EDX and CL

1. Calibrate your microscopes with your reference tag
2. Stick a tag onto your sample holder
3. Record coordinates of point of interest in one click

Raman/AFM/fluorescence/ PL/FLIM/micro XRF/optical microscope measurements at the same points of interest.



graphYX

1. Load your maps
2. Adjust the overlap
3. Experiment with layer rendering to highlight sample features

Superimpose images from different techniques. Fine adjustment to compensate for scale and orientation

Powered by Mountains

A patented technology

nanoGPS navYX is both an absolute sample position referencing solution for convenient cross-platform observations; and an accuracy estimator of microscope stability and translation stage reproducibility.

Patented nanoGPS technology provides a convenient way to create multiscale, multimodal correlative microscopy maps, with a registration accuracy that is limited only by the accuracy of the translation stage.

The positional reading of nanoGPS tags is not limited by the optical resolution of the system to contrary classical positioning with fiducial markers. Even though the accuracy of correlative microscopy systems is currently limited by stage accuracy, future progress in this field will make the super-localization capability of nanoGPS tags even more valuable.

1. A multiscale multimodal tag is stuck to the sample holder and used to create a sample coordinate system

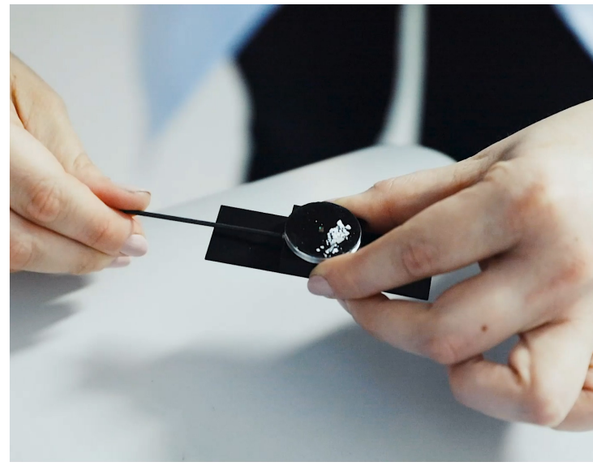
2. A single snapshot on the tag provides position and orientation with accuracy better than 10 nm and 50 µrad (super resolution regime)

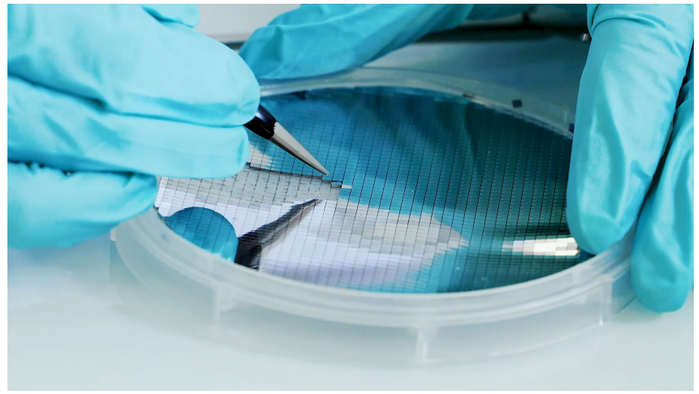
3. nanoGPS software suite provides correspondence between stage coordinates and sample coordinates, and manages Points of Interest (POI)

nanoGPS technology is documented in peer-reviewed Open Access publication, and citable:

"An efficient solution for correlative microscopy and co–localized observations based on multiscale multimodal machine–readable nanoGPS tags, Meas. Sci. Technol. (2020),"

https://iopscience.iop.org/article/10.1088/1361-6501/abce39





The tags are made of silicon with suitable doping so that charges can be evacuated on an SEM, with metal patterns that provide high contrast both when observed with an optical microscope under episcopic illumination and with an SEM. They are robust, solvent resistant for cleaning, and do not age. Even though it is not the recommended use, they can be re-used several times, for multiple samples.

In such case, they should be handled with care when placed and removed from the sample holder, in order to avoid scratching or breaking them.

Find your point of interest, anywhere, anytime

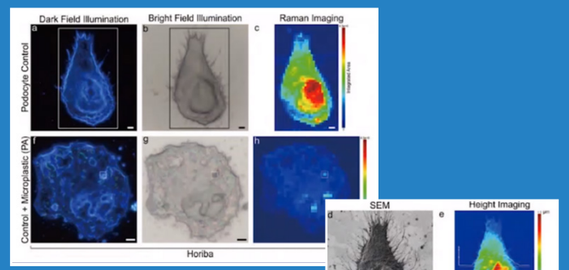
Material, life and environmental sciences, all benefit from quick relocalization!

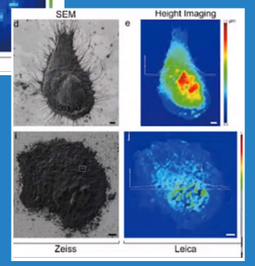
nanoGPS makes it easy to return to selected regions to perform more elaborate observations. When instruments are shared between several users or are operated as shared facilities, observations may have to be split between different sessions: easy relocalization between sessions saves scientists' time and increases the efficiency of the laboratory. In other cases, the ability to relocate between different elaboration steps is of great value to materials science and biology.

Microplastics

Studies of Microplastics involve several steps but two of the main ones are: An observation step to characterize the morphological properties which can be done with optical microscopy and/or scanning electron microscopy and an identification step to get the molecular fingerprinting which can be done by Raman microscopy (able to characterise plastic particles down to the submicron size) and/or infrared microscopy. **nanoGPS navYX** helps to correlate and overlay the optical/chemical images obtained with the different techniques and significantly improve microplastic characterization.

nanoGPS navYX, combined with **graphYX** software, saves hours of investigation, and enables quick re-investigation of the same sample of point of interest with an additional modality at a later time if need be. The nanoGPS tag is affixed to the filter membrane, next to the regions of interest, is not aging and robust against aggressive solvents.





Microplastics in biological cells are imaged with Dark-field, Raman, Electron microscopy

Fraunhofer IKTS, Forchheim, Germany, Professor Dr Silke H. Christiansen Head of Department, Correlative Microscopy

nanoGPS *is the mediating technology which allows us to easily overlay optical microscopy, electronic microscopy and Raman microscopy images and helps us a lot to combine these different techniques to have a more comprehensive picture of our samples*

Semiconductors and 2D materials

Optimizing optoelectronic devices, especially under operational conditions, requires non-destructive, simultaneous and nanoscale multi-parameter characterization of their surface properties. For this a physical coupling between a scanning probe microscope and a Raman/PL microscope is absolutely mandatory, and outstanding results have been achieved with HORIBA TERS and TEPL setups.

However, research on semiconductors often starts with *ex situ* sequential microscopic analysis: bandgap determination with photoluminescence, crystalline structure and defects with Raman; topographic and electrical characterization with AFM and SEM. This sequential approach can be advantageously obtained with the affordable nanoGPS navYX and graphYX suite combining ultra-low frequency Raman and PL images with SEM EBIC and SEM-CL for instance. For 2D material flakes, it is particularly relevant to use nanoGPS navYX to quickly relocate - in the jungle of candidates grown on the substrate - the very same "flake of interest" between the multiple microscopes.

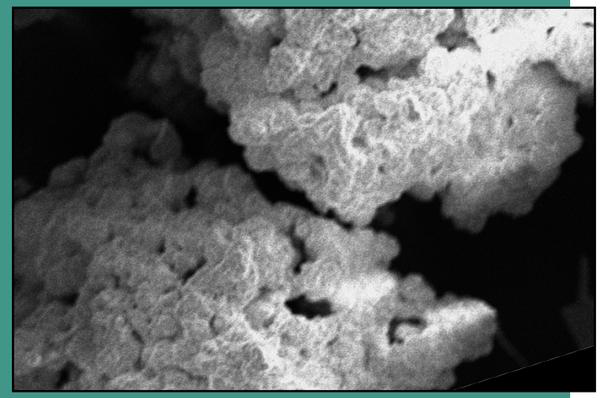
Advanced nanomaterials

Nanoflowers, metallic clusters, metal organic frameworks, quantum dots and many other novel nanostructures constitute very promising candidates as luminophores for applications in biotechnology because they are nanosized entities offering interesting properties including luminescence in different regions of the electromagnetic spectrum.

However, they often feature potential nanotoxic effects and they therefore need to be dispersed in a biocompatible matrix. Encapsulation in stable biocompatible nanoparticles for obtaining a good dispersity and a regular shape is a complex process and requires the combination of multiple techniques:

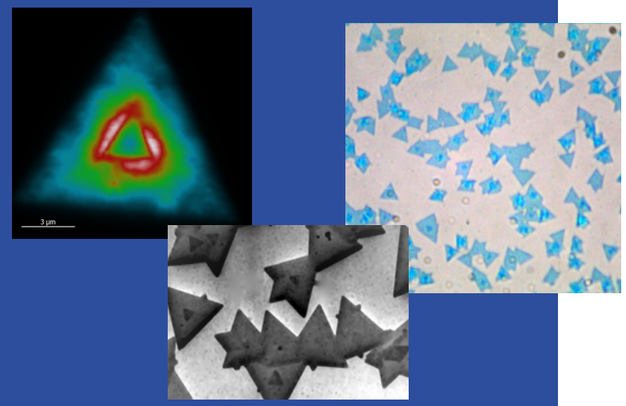
- **Scanning electron microscopy (SEM)** and dark-field imaging for morphology of particle
- **Raman and photoluminescence spectroscopy** for optical properties and monitoring the evolution of the structural and luminescence properties before and after encapsulation .

nanoGPS navYX is the ideal companion for scientists working with such powders, prone to aggregate, as nothing looks more like a nanoparticle cluster than another nanoparticle cluster!



Nanopowders imaged in SEM

WSe_2 flakes



The seamless integration of navYX in Labspec 6 makes calibration and quick relocalization of defects between Raman/PL microscope and SEM-CL a child's play.

A Collaborative Software Environment

navYX for LabSpec 6

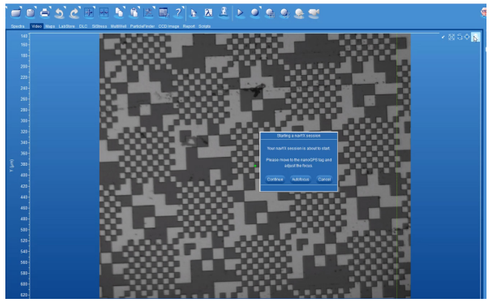
For LabSpec 6 users, integration of navYX is seamless, with a fully automated calibration procedure, and a fully embedded acquisition and image processing workflow.

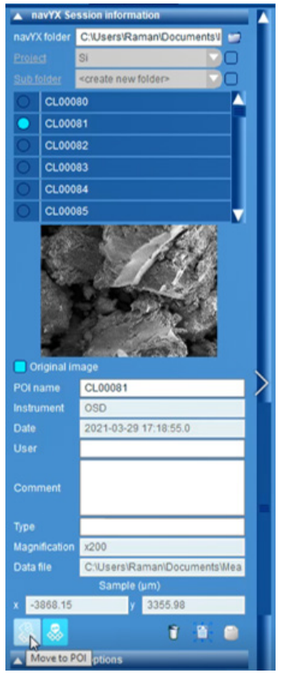
Quick Calibration

nanoGPS tags are multiscale and multimodal (compatible with optical, atomic force and scanning electron microscopes). Calibration simply consists of taking 3 or 7 snapshots in different positions of the tag and is fulfilled in a minute.

Stick a nanoGPS sample tag next to your sample, place your sample on your LabSpec 6 operated HORIBA system (Raman, cathodoluminescence or photoluminescence modular microscope), open a navYX session, and run your measurement as usual.

As and when needed, record the coordinates of a Point of Interest (POI) by clicking on “Save to POI”.





Next time you want to retrieve your POI on the same instrument, browse to the folder path in LabSpec 6, move to the sample tag and benefit from a direct visualisation of the POI (name, date, instrument measurement info are recorded together) next to your spectral acquisition parameters.

Simply select the point of interest, click “move to POI” and it will immediately appear in the video tab.

Tune your acquisitions parameters and benefit from the full power of LabSpec 6 user experience.

EasyImage, Particle Finder, χStain, MVAPlus are at your fingertips, and will enable quick acquisition and relevant interpretation of your hyperspectral dataset.

EasyImage: Optimized Analytical workflow

Particle Finder: Automated location, characterization and Raman analysis of particles.

χSTaiN: Instant Raman Analysis. Fully automated processing and analysis of Raman 2D images.

MVA Plus: the Multivariate AnaWlysis: App for all Raman Maps

navYX-connect for other microscopes

In order to use nanoGPS navYX on other microscopes, start with installing navYX-connect Windows-based software and calibrating using a nanoGPS calibration tag.

Because all POIs are recorded in the nanoGPS sample coordinates system, one can easily relocate them on virtually any microscope with a few microns accuracy.

The image and coordinates files can be uploaded in open-source software or in HORIBA graphYX software, which enables multilayered maps visualisation and further image processing.

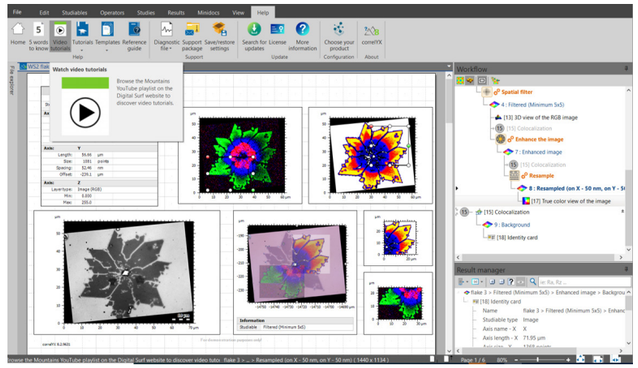
An evaluation kit is available for testing the capabilities of your lab microscope configuration. Precision of the relocalization depends on many parameters including the XY stage performance of your device.

graphYX, powered by Digital Surf Mountains

Obtaining a perfect overlap of the different observations can be achieved based on pattern matching or nanoGPS coordinates.

When you are done with spectral images analysis, load your maps in graphYX software, connected to your LabSpec 6 environment, and start your correlative microscopy workflow.

Overlay modalities, adjust their position and orientation, highlight sample features, smooth artifacts, play with palettes and transparencies, add 3D views, customize your report… The possibilities are endless!



LabSpec 6 with navYX and graphYX software suite saves your time and helps you to make a great impact!

Specifications

Guidelines for relocalization performance with nanoGPS navYX

The table below gives typical values for the accuracy of the relocalization between HORIBA Raman microscope and several other devices.

	HORIBA Raman microscope	Optical microscope with high precision XY stage	SEM with regular XY stage	SEM with high precision XY stage
HORIBA Raman microscope	5 - 15 µm	5 - 10 µm	15 - 30 µm	5 - 15 µm

Ilt is important to note that:

- Factors influencing the **relocalization error** are multiple and extensively detailed in the releated scientific paper https://doi.org/10.1088/1361-6501/abce39. **The error related to the nanoGPS tag reading is negligible** compared with the errors introduced by the microscopes stages.

- Both good positioning capability and good angular stability are required for the microscope stages to achieve the best results; **an evaluation kit is available** to test your own configuration relocalization performance.

- Relocalization errors increase with **distance from Point Of Interest (POI) to the nanoGPS tag**; It is recommended to keep this distance below 30 mm. Any angular error in the translation stage creates a localization error that is proportional to the distance between the calibration point and the POI.

- With all instruments investigated in https://doi.org/10.1088/1361-6501/abce39, a relocalization **accuracy of about 10 µm** is most often easily achievable.

- Information provided in this table is only an estimation and in any case can be considered as guaranted.

	LabSpec 6 nanoGPS navYX	navYX-connect	Comments
Absolute Precision of machine readable nanoGPS tag	Lateral 10 nm Angular 50 µrad		Super resolution regime: *a priori* knowledge of the design of the pattern permits an accuracy that exceeds the resolution of the pattern image.
Calibration	7 points automatic	3 points manual	No eye recognition needed, no ambiguity.
nanoGPS sample tags	2x2mm 25, 50, 100, 200 packs		1 large calibration tag and 24 small sample tags per pack.
nanoGPS calibration tags	4 x 5mm 10 units packs		Recommended for large sites equipped with a large number of distant microscopes.
POI management	Thumbnail/coordinates/date/user/comments available		Facilitate revisiting the sample POI at any time.
Compatibility	Raman, PL, CL microscopes. LabSpec 6 version 6.7.1 and above	Windows10 operated Scanning Electron Microscope	navYX-connect requires an activation licence provided by HORIBA.

Global HORIBA Support Center

Excellence Center, labs, reference customer labs

Our centers of excellence are located close to capital cities and easy to access regional hubs, like Tokyo, Kyoto, Paris, Lille, London, New York, Beijing, Shanghai, Singapore, or São Paulo. Our customers and new users are very welcome to visit us at any facility in the world, for sample analysis or application and service training.

Most of your application and reference customer laboratories worldwide are equipped with many techniques, and HORIBA users have access to the complete HORIBA portfolio, including techniques such as, GD-OES for fast elemental depth profiling with nanometric resolution, ICP-OES for elemental analysis, OHN and CS analyzers, spectroscopic ellipsometry for thin films measurement, AFM for surface analysis, fluorescence spectroscopy for molecular fingerprinting, X-Ray fluorescence, cathodoluminescence for defect detection, particle characterization analyzers…

No other Raman company can offer such a complementary product portfolio for solving analytical problems.

For more information on these techniques and the problems they typically solve, visit our website and ask for your handbook of spectroscopy, or contact your regional HORIBA office. Our regional application scientists are trained on several instruments, they can help you to understand the benefits of the various analytical techniques.

Our HORIBA Raman users' community is paramount to us. Our customers are our best sources of inspiration for new hardware and software developments, and close scientific cooperation is part of our DNA from the early days of Raman spectroscopy in the 1970's. New Raman users join every day and they always will find a HORIBA user next to them, providing support and sharing hints on how to best use their Raman system.

HORIBA is proud to entertain this dynamic Raman user community every year at the HORIBA RamanFest conference, which is organized alternatively in Europe, Asia and America.

For more information visit **www.ramanfest.org.**

RAMAN ACADEMY

HORIBA Scientific

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