RENISHAW
apply innovation™

High performance Raman spectroscopy

inVia™ Raman microscope

www.renishaw.com/raman

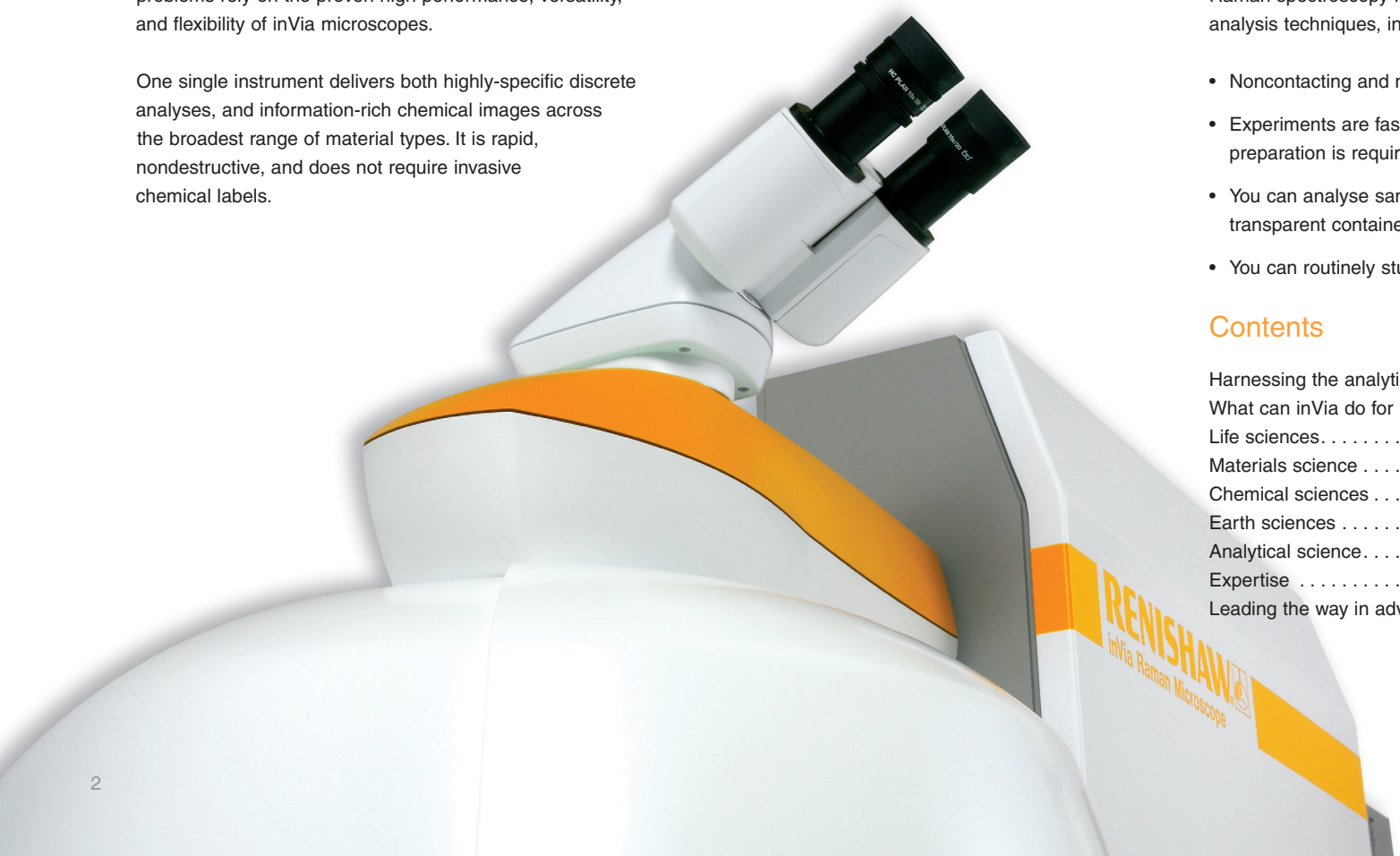
Harnessing the analytical power of Raman spectroscopy

inVia™ Raman microscope

inVia is Renishaw's material analyser, comprising a research-grade optical microscope coupled to a high-performance Raman spectrometer.

Researchers tackling the most challenging analytical problems rely on the proven high performance, versatility, and flexibility of inVia microscopes.

One single instrument delivers both highly-specific discrete analyses, and information-rich chemical images across the broadest range of material types. It is rapid, nondestructive, and does not require invasive chemical labels.



Raman spectroscopy

Raman spectroscopy reveals the vibrations of molecules and crystals. With this information you can identify substances and also determine other valuable details, such as the level of stress in crystals.

Raman spectroscopy has many advantages over other analysis techniques, including:

- Noncontacting and nondestructive analysis
- Experiments are fast because little or no sample preparation is required
- You can analyse samples contained within most transparent containers, and in aqueous solution
- You can routinely study particles as small as 1 µm

Contents

RENISHAW
apply innovation™

What can inVia do for me?

Give you control

Configure inVia to meet your current requirements; reconfigure as your requirements change.

- inVia supports laser wavelengths from the near infrared to the deep ultraviolet, with automated high performance filter and detector technology to match. You can easily select the best laser for the job.
- inVia's research-grade Leica microscope offers superb support for a wide variety of sample types and sample chambers (such as high- and low-temperature, high-pressure, and humidity cells).
- For specialist applications, configure inVia with inverted microscopes, custom large-frame microscopes, and a variety of fibre-optic probes. inVia can also be combined with other advanced techniques, such as scanning probe microscopy (see page 10).

Save you time

inVia collects your data quickly and automatically.

- Direct optical coupling to the microscope and separate light delivery paths, optimised for each wavelength, maximise the laser intensity on the sample. This increases efficiency and enables you to acquire data quickly.
- inVia is one of the easiest Raman microscope systems to understand, use, and maintain. Not only is the changing of laser wavelengths, filters, and gratings handled automatically, but also system alignment, maintenance, and calibration. Multiple users, minimal training.
- Map samples quickly using Renishaw's patented StreamLine Plus™ imaging technique. Map delicate samples without damage, and minimise acquisition times with inVia's array detector.

Give you peace of mind

inVia's high stability ensures repeatable and reliable data.

- inVia's research-grade microscope, ultra-stiff baseplate, and rigid spectrometer core ensure the highest levels of instrument stability.
- Automated checking routines and internal calibration standards confirm that inVia is optimised and working well.
- Key components, such as the diffraction grating stage and the optional motorised microscope stage, use Renishaw's encoder technology to ensure reliable, repeatable movement.
- inVia data files include full details of instrument configuration and can also record full audit logs of data processing. In addition inVia is compliant with US FDA 21CFR Part 11 guidelines. You can be confident that experimental parameters are recorded accurately.

Using inVia to research new silicone materials.

Image courtesy of Dr. Arnaud Labrosse, Dow Corning, Seneffe, Belgium.

Help you achieve results

Get the best data with inVia's high sensitivity and high resolution.

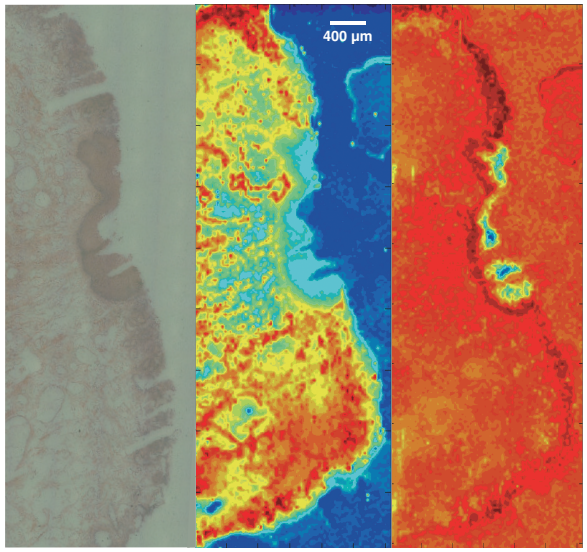
- inVia's sensitive cooled detector and efficient optical filters ensure high signal-to-noise ratios; you can acquire high quality data from even the tiniest traces of material.
- High spatial resolution and high spectral resolution come as standard with Renishaw's patented EasyConfocal™ spectrometer design. You can acquire excellent quality data quickly, even from large areas and volumes.
- inVia uses Renishaw's patented SynchroScan™ technology to collect light over a very wide spectral range, without artefacts: this makes inVia ideal for not only Raman, but photoluminescence spectroscopy too.

“The inVia Raman system with multiple lasers allows us flexibility in analyzing the wide variety of samples that come to our laboratory, including pharmaceutical contaminants, geological specimens, paintings being evaluated for authenticity, and forensic trace evidence.”

Dr. Kathleen Martin, McCrone Associates, Westmont, IL, USA.

Seeing tissues and cells

Researchers in the life sciences are increasingly using inVia to acquire information-rich chemical images. inVia's high signal-to-noise ratio, high resolution, and high speed enable the rapid acquisition of images that reveal subtle differences between tissue types, with the resolution to see structures within individual cells. And all without the need for time-consuming sample preparation or the use of invasive dye markers.



StreamLine Plus Raman images of oesophageal tissue, with: (left) visible histological section; (centre) Raman image showing submucosa and muscularis layer; (right) Raman image revealing normal surface, with darker areas highlighting metaplastic tissue.

Data courtesy of Prof. Nick Stone, Biophotonics Research Group, Royal NHS Trust, Gloucester, England.

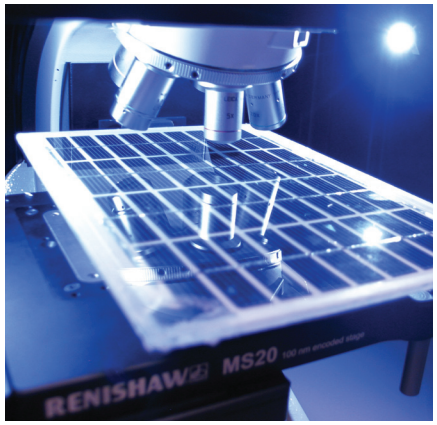
inVia with custom optical tweezers being used to characterise sperm cells for *in vitro* fertilisation.

Image courtesy of Dr. Alistair Elfick, School of Engineering & Electronics, University of Edinburgh, Scotland.

"The flexibility of both the inVia system and Renishaw personnel was key in enabling us to customise the instrument to integrate optical tweezing. We are looking forward to much exciting work in applying Raman to characterise cells for *in vitro* fertilisation for human reproduction and artificial insemination for domesticated animals."

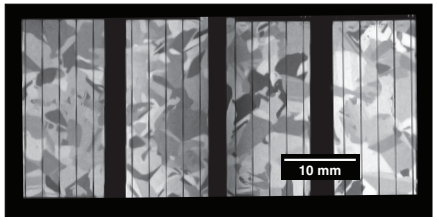
Dr. Alistair Elfick, School of Engineering & Electronics, University of Edinburgh, Scotland.

Materials science



Semiconductors

inVia Raman microscopes perform vital roles in many semiconductor applications, such as measuring stress in silicon microelectronics, and helping in the development of novel photovoltaic cells. inVia characterises both semiconductor materials and completed devices, and can assess crystalline quality, local stress/strain, dopant/impurity levels, and even temperatures in operating devices, on a sub-micrometre scale.



inVia Raman image of crystal domains in a polycrystalline photovoltaic cell. The size and shape of these domains is used to study cell efficiency.

This Raman image was acquired from a commercial photovoltaic module through the glass encapsulation.

"I have a project on ultra-long (up to centimeters) carbon nanotubes. In order to characterize the local structures along the whole length, it is better to do Raman imaging in large area (> mm × mm) with fine spatial resolution (< 1 µm) within reasonable time. Renishaw's StreamLine Plus Raman can scan samples line-by-line without compromising the resolution. This operation mode can save time significantly, and thus meet my needs."

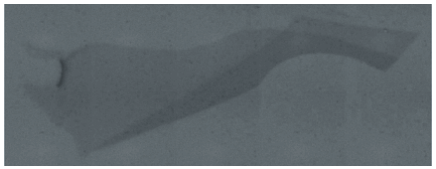
Dr. Zheng Lianxi, Division of Engineering Mechanics,
Nanyang Technological University, Singapore.

Polymers, composites, catalysts, and more…

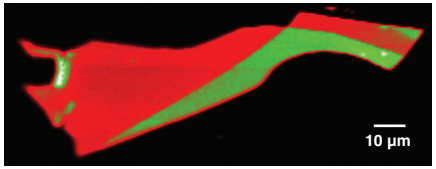
The inVia Raman microscope is ideally suited for the analysis of the varied and challenging range of samples encountered in materials science. Typical applications include the *in situ* determination of homogeneity, phase, and crystal orientation, identification of surface contaminants, and measurement of layer thickness. inVia quickly maps these chemical and physical properties using Renishaw's patented StreamLine Plus™ imaging technique, ensuring that you gain a full understanding of your samples.

Nanotechnology

Nanotechnology poses particular challenges because of the novel materials and intrinsically small distance scales involved. inVia locates and analyses these nanoscale structures: for example, a single layer of graphite (graphene) can be distinguished from double and triple layers, and a single carbon nanotube can be found and its diameter and chirality determined. inVia can be coupled with scanning probe microscopes if you need even higher (nanometre) spatial resolutions (see page 10).



White light microscope image of graphene on optically enhancing substrate: different regions are difficult to distinguish.



inVia Raman image of graphene: the Raman 2D band shape is used to distinguish between a single graphene layer (green) and multiple graphene layers (red).

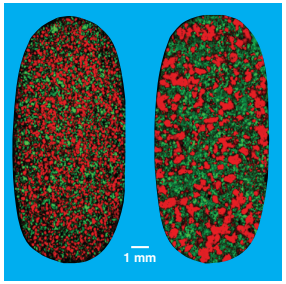
Chemical sciences

Pharmaceutical

inVia Raman microscopes fulfil critical analytical roles at many stages of the drug discovery and development process. Applications range from monitoring for new polymorphs during pharmaceutical development, to troubleshooting problems such as poor tablet dissolution. In the former, inVia's flexibility maximises the range of drugs that can be investigated; in the latter, inVia's rapid imaging technologies enable the acquisition of chemical images of tablets in minutes. inVia gives you the sophisticated information you need.

Cosmetic

inVia's capabilities aren't just skin deep. Products like face creams can be analysed for their organic ingredients (such as collagen and oils), their inorganic ingredients (such as pigments), and chemical imaging can reveal the size distribution of particles within emulsions and suspensions. From formulation to development, through scale-up to production and quality control, inVia helps you understand the chemistry of your preparations.



inVia Raman images showing the effect of milling an active pharmaceutical ingredient (API) prior to tablet formulation. Milled API (left) affects not only the uniformity and distribution of the API (red), but also that of the excipient (green). It is vital to control particle uniformity and distribution during manufacture, since these parameters can influence tablet effectiveness.

Data courtesy of Pascal Chalus,
Pharmaceutical Division - PTDF,
F. Hoffmann-La Roche Ltd., Basel, Switzerland.

Chemical

inVia's flexibility ensures you are ready for any sample. You can identify chemical structure and phase, and even monitor the subtle changes produced by temperature, pressure, or humidity. Reactions can be followed 'live', with inVia's advanced chemometric software identifying intermediate species. Even where reference spectra are unavailable at the start of the reaction, they can be identified after the reaction is complete using Renishaw's unique 'Empty Modelling' technique. You cannot afford to be without an inVia in your laboratory.

Researching new applications for Raman spectroscopy at the University of Bradford's Vibrational Spectroscopy facility.

Image courtesy of
Dr. Ian Scowen,
University Analytical Centre,
University of Bradford,
England.

"Our decision to purchase the Renishaw inVia Raman microscope was largely influenced by the high flexibility of the instrument and the broad area of application which is very valuable to us. Additionally Renishaw proved to be very open for flexible solutions tailored to our very specific needs regarding both hardware and software modification. In the brief period since we installed our Renishaw Raman microscope we were able to successfully implement it in our solid state screening process where we specifically benefited from the fully integrated hot/cold stage."

Dr. Karsten Fähnrich,
Labmanager Thermoanalytics,
F. Hoffmann-La Roche Ltd.,
Pharma Technical Development Actives,
Basel, Switzerland.

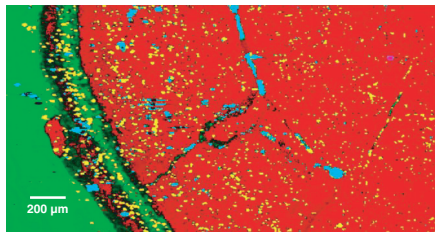
Earth sciences

Geology and mineralogy

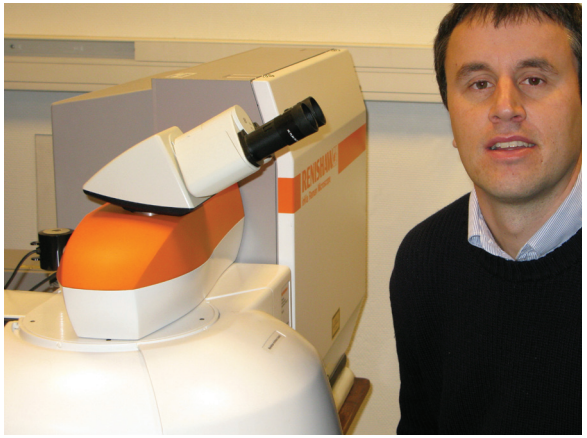
inVia incorporates a research-grade optical microscope, allowing you to use traditional petrographic techniques, but the power of Raman spectroscopy brings you so much more. Chemical images of sections reveal mineral content and textural relationships on a microscopic scale, without any need for wet chemical treatments; analysis becomes more rapid and more accurate.

"We chose the inVia system for its excellent Raman mapping module combined with high spectroscopic capabilities which are both needed for studying complex and heterogeneous objects of geological interest."

Dr. Olivier Beyssac, Institute of Mineralogy and Physics of Condensed Media, National Centre for Scientific Research, Paris, France.



StreamLine Plus Raman image highlighting the zonation of iron minerals from a drill core. Crack infill material and polishing residues are visible.



Geological research into the evolution of carbonaceous material in the natural environment.

Image courtesy of Dr. Olivier Beyssac, Institute of Mineralogy and Physics of Condensed Media, National Centre for Scientific Research, Paris, France.

Gemmology

It's very easy to identify a gemstone using an inVia microscope; the difference between tourmaline and ruby, for example, is obvious. The analysis can be performed on gemstones in their settings and is much more rapid than traditional specific gravity and refractive index methods, thus saving the gemmologist considerable time.

inVia brings other capabilities too. Gemmologists can nondestructively analyse the composition of mineral, liquid, and gas inclusions within gemstones, providing information about the conditions prevailing during their formation.

In addition, inVia can spot the subtle differences between synthetic gemstones, natural gemstones, and adulterated natural gemstones. A good example of this is its ability to distinguish between high-value diamonds and poor-quality diamonds whose colour has been artificially improved by high-temperature/high-pressure treatment. Use inVia to discover the true value of your gemstones.

Art and cultural heritage

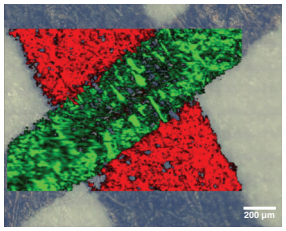
The sympathetic restoration of works of art and historical artefacts is a major concern for conservators, historians, and archaeologists, and relies on the accurate identification of the materials involved. With inVia you can analyse the composition of paints, pigments, and corrosion products *in situ*, nondestructively.

inVia's flexibility ensures that you can study all sizes of item, from small figurines (that can be analysed under inVia's optical microscope) to larger paintings (that can be analysed with remote fibre-optic probes or with custom large-frame microscopes).

inVia has analysed many historic items, including the Vinland Map and the Lindisfarne Gospels. What are you going to analyse?

Analysis of works of art with an inVia and custom large sample chamber.

Courtesy of
Dr. Steven Saverwyns,
Royal Institute for
Cultural Heritage,
Brussels, Belgium.



inVia Raman image of crossing black ink lines on a questioned document. The different Raman spectra from the two black inks are indicated with green and red, clearly showing that the stroke represented by green was applied on top of that represented by red.

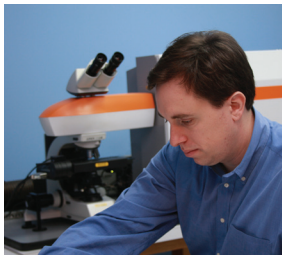
Forensic sciences

Enforcement agencies need to support prosecutions with reliable and detailed forensic information. inVia's high sensitivity and high resolution imaging capabilities enable forensic scientists to find and identify the tiniest traces of evidence, such as microscopic particles of explosive in a fingerprint. Investigators also get results they can trust, thanks to inVia's intrinsic stability, backed up by comprehensive system performance validation tools.

inVia's flexibility makes it valuable in numerous areas, including narcotics, explosives, paints and pigments, fibre-analysis, questioned documents, and gunshot residues. You can maximise the usage of your inVia in your laboratory.

“After evaluating several instruments, we selected the inVia because we felt it offered the best hardware, software, and system support. The inVia was the only Raman system to meet our expectations, and we have been extremely impressed with all aspects of this instrument in the 5 years we have been using it.”

Dr. Christopher S. Palenik,
Microtrace LLC, Elgin, IL, USA



inVia at Microtrace LLC

Image courtesy of
Dr. Christopher S. Palenik,
Microtrace LLC, Elgin, IL, USA.

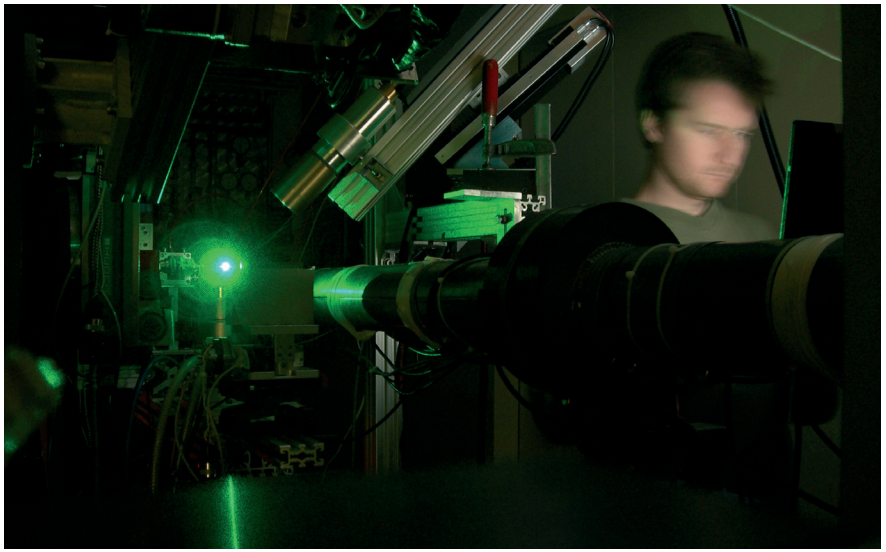
Here to help

Renishaw's team of highly qualified and experienced scientists and engineers are here to help you. From design, to production, installation, service, support, and training, there's a friendly expert available to make sure that you get what you need.

Whatever your application, our scientists (drawn from the fields of physics, chemistry, and biology) will work with you to understand your analytical needs and help you develop the best methodology for your samples.

Wouter van Beek using the combined Raman / high resolution powder diffraction (HRPD) / x-ray absorption spectroscopy (XAS) equipment at the Swiss-Norwegian Beam Lines at the European Synchrotron Radiation Facility.

Photograph courtesy of Dr. Dewi Lewis, Department of Chemistry, University College London, England.



"I decided to work with Renishaw, first because their engineers immediately understood my complex specifications with respect to applications and implementation, and second because they were able to build upon our ideas, suggest novel solutions to implement them, and even surpass our requests."

Wouter van Beek, Swiss-Norwegian Beam Lines at the European Synchrotron Radiation Facility, Grenoble, France.

Need a custom solution?

We have produced more than one thousand customised products, including highly complex systems on synchrotron beam lines (where the power of Raman spectroscopy augments that of other techniques, such as x-ray scattering). Contact us if you have a special requirement: Renishaw's top design engineers and application scientists will work with you to realise a suitable custom solution.

Leading the way in advanced analysis

Involve inVia

Techniques such as electron microscopy, atomic force microscopy, and confocal laser-scanning microcopy enable us to study materials at high spatial resolutions and gain new information such as elemental content. However, on their own, these techniques do not provide direct chemical data. Renishaw has therefore developed a range of interfaces that enable inVia to be coupled to these systems.

Nanoscale studies

Researchers in nanotechnology need tools that enable them to not only image sub-microscopic structures, but to chemically analyse them too.

Renishaw has developed high optical efficiency interfaces that directly couple the inVia microscope to a wide variety of scanning probe microscopes. Now you can augment high spatial resolution imaging techniques, such as atomic force microscopy, with the chemical analysis power of Raman spectroscopy.

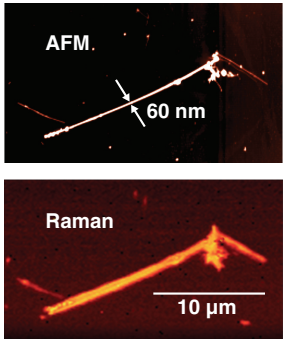
inVia also supports the new optical techniques of tip-enhanced Raman spectroscopy (TERS) and near-field optical microscopy (NSOM/SNOM); these offer you the potential of Raman spectroscopic data at unparalleled spatial resolutions.

inVia microscope coupled with a Bruker Nano Catalyst atomic force microscope.

Image courtesy of
Prof. dr hab. Aleksander Balter,
Institute of Physics,
Nicholas Copernicus
University, Torun, Poland.

"The Nano Research Group of Southampton University has a Renishaw inVia Raman spectrometer integrated to the MV4000 and Cryo CV2000 SPM systems from Nanonics…"
"The integration process itself is flawless and involved software exchange and direct optical coupling from the inVia."

Dr. Harold Chong,
Nano Research Group,
University of Southampton, England.



Simultaneously collected AFM and Raman images of a 60 nm diameter Si nano-wire.

Sample courtesy of Prof. Martin Kuball,
University of Bristol, England, and
Prof. Joan Redwing,
Penn State University, USA.

"Direct optical coupling of NTEGRA-Spectra with inVia system provides reliability and stability for the challenging research with TERS. This, combined with the relative ease of use of inVia system and expertise of Renishaw, promotes our confidence in performing these experiments. We are getting new data with TERS now...actually we can resolve 14 nm."

Prof. Sergei Kazarian,
Chemical Engineering and Chemical Technology,
Imperial College London, England.

Elemental information

Raman spectroscopy is an ideal tool for identifying and distinguishing between organic and inorganic molecules and crystals. However, Raman spectroscopy cannot determine the elemental distribution in a sample, something that a scanning electron microscope (SEM) equipped with elemental energy dispersive x-ray spectroscopy (EDS) can do with ease.

The chemical and structural analyser (SCA) unites inVia with a range of SEMs, resulting in a powerful and unique instrument that enables morphological, elemental, chemical, physical, and electronic analysis from the same spot on your sample. This not only saves you time by eliminating the need to move the sample between instruments, realigning it each time, but also enables you to collect cathodoluminescence spectra, allowing you to study trace elements and defects.

"The multi-analytical approach of the SEM-SCA provides me with elemental EDS, molecular Raman analyses, and high resolution images from the same sample spot. These techniques can be used as guides for each other. Often, doped substances show only subtle modification of the Raman spectral feature, and correct interpretation can be given with the EDS information. Vice versa, the EDS map can guide the Raman analysis to the unambiguous characterization of features of interest in the sample, identifying not only the chemical composition, but also different molecular and crystalline structures, undistinguishable with the elemental analysis."

Dr. Francesca Ospitali,
Cultural Heritage Conservation Scientist,
Department of Physical and Inorganic Chemistry,
University of Bologna, Italy.

Confocal laser-scanning microscope

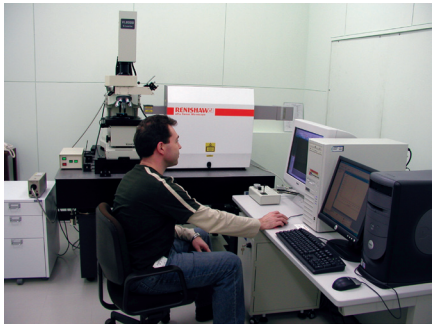
Confocal laser scanning microscopes (CLSM) create high-resolution optical sections and surface profiles, and are being used increasingly in fields where complex structures need to be investigated, such as in the biological sciences. They can create images relatively rapidly, but only provide limited chemical information, based on the use of fluorescent dyes. Coupling an inVia microscope to a CLSM enables you to gain full chemical information without the need for invasive dyes. Now your CLSM can see what is really going on!

Zeiss EVO electron microscope and SCA

Image courtesy of
Dr. Daria Prandstraller,
University of Bologna, Italy.

inVia Raman microscope coupled to a Lasertec Blue Laser Microscope VL2000.

Image courtesy of
Dr. Yamaguchi,
Technical Research Institute, Japan Society for the Promotion of Machine Industry, Tokyo, Japan.



Renishaw plc

Spectroscopy Products Division,
Old Town, Wotton-under-Edge,
Gloucestershire. GL12 7DW
United Kingdom

T +44 1453 524524
F +44 1453 523901
E raman@renishaw.com

www.renishaw.com

RENISHAW
apply innovation™

Safety features

- Class 3B laser product in standard configurations
- Optional Class 1 laser safe enclosure
- Deep UV use requires Class 4 laser safety precautions
- Fully enclosed laser paths for multiple lasers
- Fully interlocked with interlock self-test features

About Renishaw

Renishaw is an established world leader in engineering technologies, with a strong history of innovation in product development and manufacturing. Since its formation in 1973, the company has supplied leading edge products that increase process productivity, improve product quality, and deliver cost effective automation solutions.

A worldwide network of subsidiary companies and distributors provides exceptional service and support for its customers.

Products include:

- Dental CAD/CAM scanning and milling systems
- Encoder systems for high accuracy linear, angle and rotary position feedback
- Laser and ballbar systems for performance measurement and calibration of machines
- Medical devices for neurosurgical applications
- Probe systems and software for job set-up, tool setting and inspection on machine tools
- Sensor systems and software for measurement on co-ordinate measuring machines

inVia: the single instrument that delivers both highly specific discrete analyses and information-rich chemical images across the broadest range of material types, rapidly, nondestructively, and without using invasive chemical labels.

Join the group of users who rely on the proven high performance, versatility, and flexibility of inVia microscopes to help them tackle the most challenging analytical problems.

Contact your local Renishaw supplier for further information about inVia, or to discuss any special requirements you may have.

www.renishaw.com

0111 L-9836-4018-01-A

inVia has been manufactured under the controls established by a Bureau Veritas Certification approved management system that conforms with ISO 9001:2000.