RENISHAW
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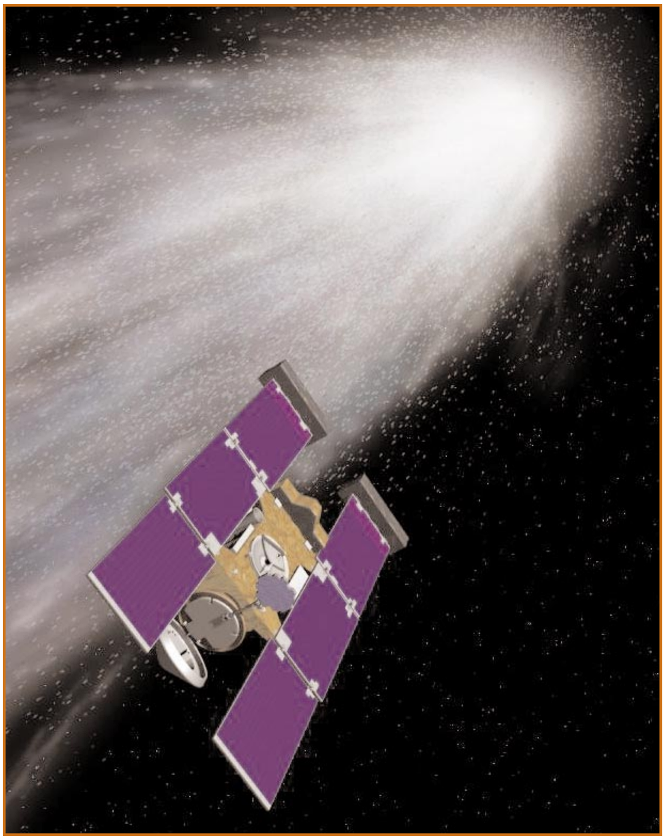
News from the spectroscopy group at Renishaw

Renishaw Raman microscope used as part of NASA space mission



Stardust meets Wild 2 in 2004

illustration courtesy of NASA STARDUST

In July as part of the NASA STARDUST space mission the Jet Propulsion Laboratories, Pasadena, CA took delivery of a Renishaw Dual System 1000 Raman microscope. The instrument will be used for the study of cometary material brought back to Earth for the first time ever for analysis by scientists worldwide. Set for launch in February 1999, Stardust will be the first U.S. mission dedicated solely to a comet and the first robotic return of extraterrestrial material from outside the orbit of the Moon. Its primary goal is to collect comet dust and volatile samples during a planned close encounter with comet Wild 2 in January of 2004.

Additionally, the Stardust spacecraft will also bring back samples of interstellar dust including the recently discovered dust streaming into the solar system from the direction of Sagittarius. These materials consist of ancient pre-solar interstellar grains and nebular condensates including remnants left over from the formation of the solar system. Their analysis

continued on next page...

Raman study of 13th century Byzantine painting

A Renishaw Raman system has been used to help experts repair a damaged 13th century wall-painting in Greece, by identifying the pigments originally used.

Dimitrios Bikiaris of the Diagnostic Centre for the Research and Study of Byzantine Hagiography has used a Renishaw Raman microscope (with a 633 nm HeNe laser) to identify the pigments used in the wall-painting of St. Merkourios in Protato church in Chalkidki. Small particles of paint (up to 1 mm^2) were removed from the painting. Raman studies of the particles, which in some cases consisted of three layers of paint, identified nine pigments: azurite (deep blue), cinnabar (red), caput mortuum (violet), calcium carbonate (white), red ochre, minium orange, limonite (yellow), green earth, and carbon black.

Wall-painting of St. Merkourios in Protato church, Greece

This edition also contains articles on:

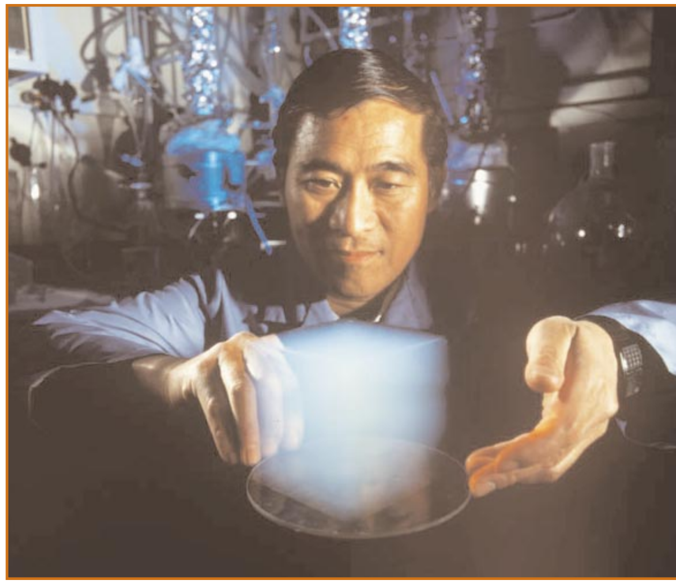
- **novel imaging technology**
- **laser trapping of microdroplets**
- **Renishaw focus tracking system**

Renishaw Raman microscope used as part of NASA space mission

(continued from front cover)

is expected to yield important insights into the evolution of the sun and planets and possibly into the origin of life itself.

The spacecraft will make three loops around the sun. On the second loop, the trajectory of the spacecraft will intersect that of Wild 2. To collect the particles without damaging them, STARDUST will use an extraordinary substance called aerogel - a silicon-based solid with a porous, sponge-like structure in which 99 percent of the volume is empty space. Aerogel is 1,000 times less dense than glass, another silicon-based solid. When a particle hits the aerogel, it will bury itself in the material, creating a carrot-shaped track up to 200 times its own length, as it slows down and comes to a stop. The innovator and maker of this aerogel material is Peter Tsou of the Jet Propulsion Lab, Peter serves as Deputy Investigator for the mission. Peter will use the Renishaw Raman microscope to characterize the aerogel prior to the mission and to then identify particles caught and trapped by the aerogel once it is returned to earth. The analysis benefits from the confocal ability and very high sensitivity of the Renishaw system. The Renishaw instrument has already been used to characterize extraterrestrial particles brought back from previous missions, however this will be the first mission to collect particles from a comet.



Peter Tsou of NASA with an aerogel

photograph courtesy of NASA JPL

Further information on the STARDUST mission can be found at http://stardust.jpl.nasa.gov

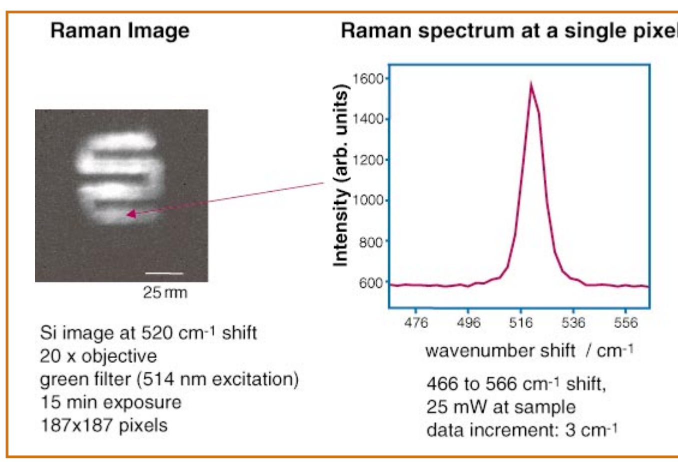
Novel imaging technology for Renishaw spectrometers

Renishaw and Spectral Dimension Inc. of Olney, MD, USA have collaborated to provide a Raman imaging solution based on the Renishaw Raman microscope.

Capitalizing on the unique imaging and spectroscopic capabilities of liquid crystal tuneable filters (LCTFs), this product enables the complete integration of Raman spectroscopy and high-resolution digital imaging, creating a hyperspectral imaging system. The LCTF is a solid state device with no moving parts that allows for high speed scanning over a broad spectral range. The optical quality of the LCTF is superb, contributing no image degradation to the optical microscope system. By integrating this novel device into the Renishaw Raman microscope operated in global illumination mode, narrow bandpass (~8 cm^{-1}) images can be collected continuously over intervals spanning thousands of wavenumbers, creating a hyperspectral data set. Additionally, individual image planes can be collected at discrete wavelengths, with rapid and non-sequential tuning between specific Raman bands.

The Raman imaging system incorporates new Windows-based, user-friendly data collection, hyperspectral data/image processing and visualization software. The user can seamlessly collect image sequences containing tens of thousands of spatially resolved Raman spectra, and automatically generate and display color images of material distribution and heterogeneity within the sample. As the spatial distribution of components within complex materials strongly influences both physical and chemical properties, the vast amount of spatially resolved data contained within a Raman imaging data set can be invaluable for anyone investigating chemical heterogeneity.

Completely integrated LCTF Raman imaging filters have been added to Renishaw's Raman microscopes, and LCTF imaging upgrades are possible for present users of the Renishaw System 1000 and 2000 instruments. These new Renishaw LCTF imaging systems are already being used by groups at the US National Institues of Health and Dupont to characterize biological systems and polymer formulations respectvely.

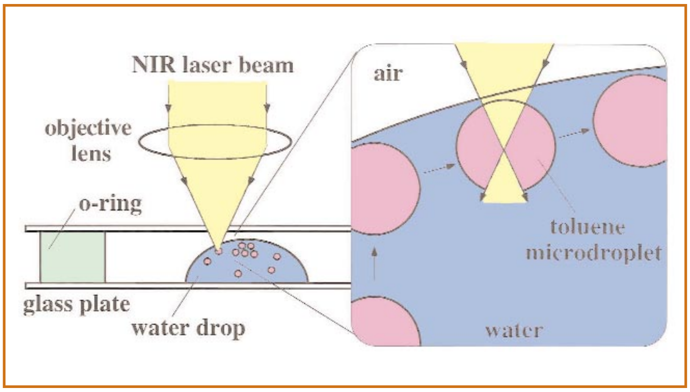


Raman image of a test sample (left), and a spectrum taken from one point (right)

Figure courtesy of Drs. E. Neil Lewis, Pina Colarusso, and Ira Levin at the National Institutes of Health in Bethesda, Maryland, USA

For further information please contact:
Andrew Whitley (USA - West Coast), or
Ken Williams (UK) Contact details are given on the back cover.

Researcher makes light work of trapping droplets



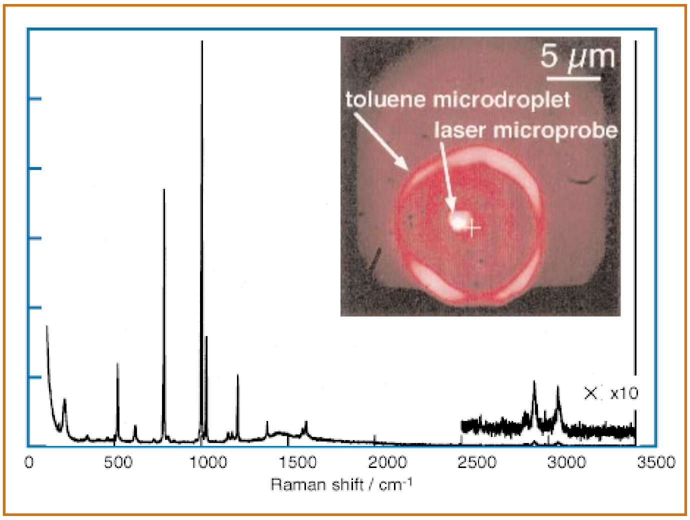
Schematic diagram of the experiment

Katsuhiro Ajito of NTT Basic Research Laboratories, Kanagawa, Japan, has used a Renishaw System 2000 microscope to trap and analyze small (10 µm to 30 µm) toluene microdroplets in water.

He used a x100 microscope objective to bring the laser (a 780 nm Ti:sapphire) to a 1 µm focus. The radiation pressure of the light traps the microdroplets, allowing their Raman spectrum to be measured.

This technique is of interest to biologists, who can use it to study cells containing bacteria and virus. It is particularly attractive as the same laser beam is used to trap and analyze. The long wavelength of laser is of note as it prevents photolytic and thermal damage to the sample, and reduces fluorescence that might obscure the Raman bands of interest.

Dr. Ajito used 80 mW of optical power at the focus, and obtained high signal-to-noise ratio spectra with an exposure time of only 5 s. The spectra of the toluene microdroplets do not exhibit features from the surrounding water because of the confocal optics of the Renishaw Raman microscope.



Spectrum from a toluene microdroplet (exposure 5 s)

This Renishaw System 2000 is particularly suited to this work as it allows direct imaging of the droplets; the researcher can ensure that a droplet has been trapped and determine its dimensions.

For more details see:
K. Ajito, Applied Spectroscopy, Vol. 52, No. 3, 1998, 339-342.
http://www.brl.ntt.co.jp/people/ajito/index.html

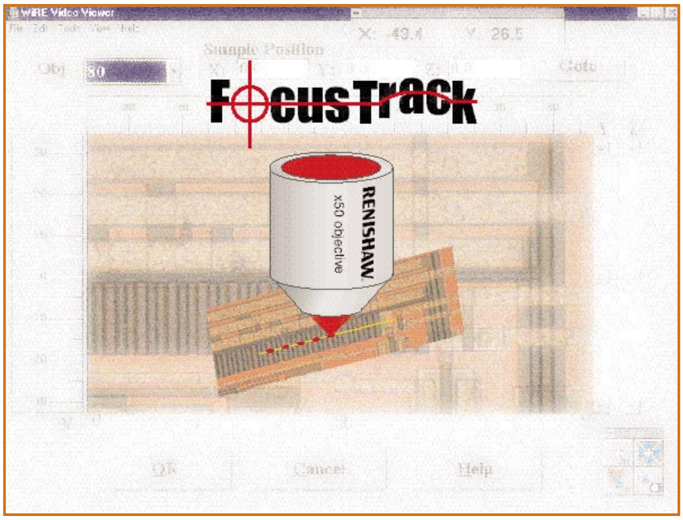
Renishaw FocusTrack - a valuable aid to mapping

The Renishaw FocusTrack system makes Raman mapping easier because it maintains a good focus on the sample surface during line- or area-mapping experiments. Now stepped, curved, or sloping surfaces can be mapped with ease.

The Renishaw Raman microscope is a highly confocal instrument, having a small collection volume. Therefore, if a sample surface is being studied, the surface must be in good focus as each spectrum is acquired. This can be a problem with samples having rough surfaces and when large area maps are being made on angled flat surfaces.

The FocusTrack system solves this problem by moving the sample vertically at each spectrum acquisition point to focus the laser spot. It can also be used to fine-focus the sample prior to making a manual measurement.

The Renishaw FocusTrack system requires a Renishaw Raman microscope equipped with a Renishaw XYZ mapping stage and a Renishaw video viewer system.



Please contact your local representative for more details

Conferences

Two of the many conferences we will be attending throughout 1999:

7-12 March 1999

50th Anniversary Pittsburgh Conference (Pittcon '99)
Orlando, FL, USA
http://www.pittcon.org/

22-25 March 1999

International Symposium on Instrumentalized Analytical Chemistry and Computer Technology (InCom)
Heinrich-Heine Universität, Düsseldorf, Germany
http://www.incom-symposium.de/

Meet the UK Renishaw spectroscopy group

We like to introduce some of the spectroscopy group to you in each issue, so that you can put faces to the voices you hear on the telephone. Here are some of the UK software group personnel:

L to R: Brian Smith, Frank Gibbs, Russ Taylor, Ian Bell.

This group develops new software for the Renishaw instruments, their accessories, and customer specific applications. It provides world-wide software support for subsidiaries, distributors, and customers.

Renishaw worldwide companies with spectroscopy support

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If you or any of your colleagues would like to be added to our mailing list or if you have any queries or comments about the contents of this newsletter, please contact us at any of the addresses above or simply email us at raman@renishaw.co.uk.

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