Photon etc
A spectrum of solutions

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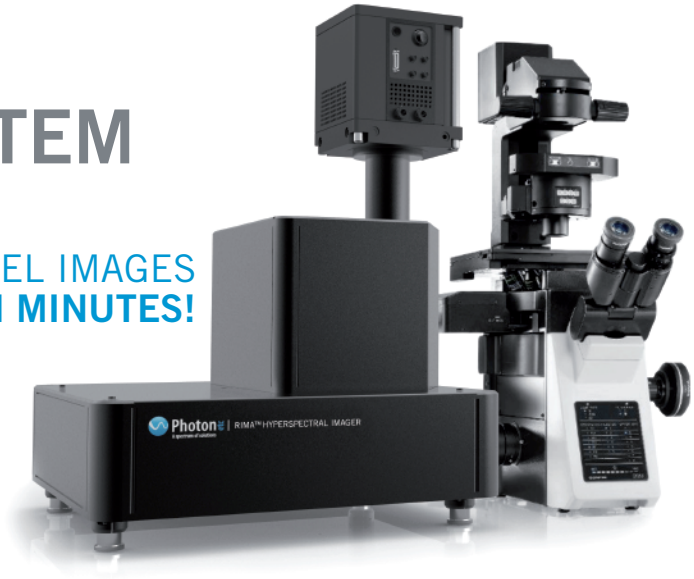
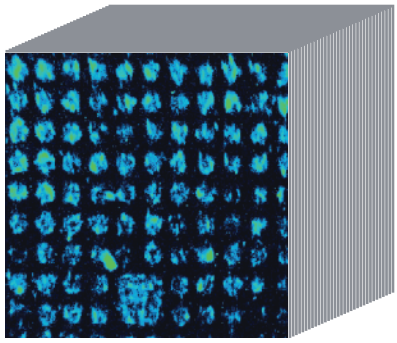
CANADA

RIMA™
RAMAN IMAGING SYSTEM



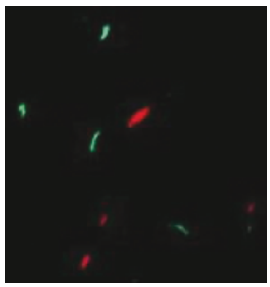
MEGAPIXEL IMAGES **IN MINUTES!**

The perfect Raman imager for the analysis of nanomaterials from graphene to carbon nanotubes, RIMA is a state-of-the-art ultrafast hyperspectral imaging system available at various excitation wavelengths (532 nm, 660 nm, 785 nm). RIMA is also a tool of choice for non-invasive monitoring and analysis of biological tissue.



FAST RAMAN HYPERSPECTRAL CUBES OF PRINTED SURFACES
See more details at the back.

FIGURE 1



RAMAN HYPERSPECTRAL IMAGES OF ISOLATED SINGLE CNTs

TECHNICAL SPECIFICATIONS	RIMA 532	RIMA 660	RIMA BIOMED
Spectral Range*	190 to 4000 cm^{-1}	100 to 4000 cm^{-1}	130 to 3200 cm^{-1}
Spectral Resolution	< 7 cm^{-1}	< 6 cm^{-1}	< 5 cm^{-1}
Microscope	Upright	Upright	Inverted
Objectives	20X, 50X, 100X	20X, 50X, 100X	20X, 60X, 100X
Excitation Wavelengths*	532 nm	660 nm	785 nm
Spatial Resolution	Sub-micron		
Maximum Scanning Speed	250 μm^2/min at full spectral range		
Wavelegth Absolute Accuracy	1 cm^{-1}		
Camera*	Back-illuminated CCD or sCMOS camera 1024x1024 px		
Video Mode	Megapixel camera for sample vizualisation		
Preprocessing	Spatial filtering, statistical tools, spectrum extraction, data normalization, spectral calibration		
Hyperspectral Data Format	FITS, HDF5		
Single Image Data Format	JPG, PNG, TIFF, CSV, PDF, SGV		
Software	Computer with PHySpecTM control and analysis software included		

UPGRADES*	RIMA 532	RIMA 660	RIMA BIOMED
	Low-Noise Back-Illuminated Camera,EMCCD Additional excitation wavelengths available Spectral Range Extension: Anti Stokes Broadband COL Camera: Color 3MP Camera	Low-Noise Back-Illuminated Camera,EMCCD Additional excitation wavelengths available Broadband COL Camera: Color 3MP Camera	Deep-depletion camera, EMCCD Broadband COL Camera, Motorized stage with piezo positioning on z-axis Spectral Range Extension: Anti Stokes Additional excitation wavelengths available

APPLICATIONS

RAPID ANALYSIS OF NANOMATERIALS BY RAMAN IMAGING

Global Raman imaging is an exceptional technique for the analysis of large surfaces of thin films and advanced materials. Its rapidity makes it a great tool not only for universities and research institutes, but also for industrial laboratories. With no or minimal sample preparation, RIMA™, Photon etc's new hyperspectral Raman imager, can easily take part in routine analysis, where the prompt access to information about sample composition is crucial for the development of new materials.

With systems based on point-to-point or scanning technologies, the acquisition of maps of large areas is often tedious and time consuming: the analysis of a sample may take hours. RIMA™ expedites in minutes the acquisition of the whole area in the field of view, rendering full maps of a sample with unmatched rapidity. In fact, the hyperspectral cube is built image by image, along the spectral window of interest, with a spectral resolutionbetter than 7 cm^{-1}. Since a spectrum is recorded for each pixel, it is possible, with a 1024x1024 pixel camera, to collect more than one million spectra without moving the sample. Moreover, the size of the maps can be as large as 650×650 µm, depending on the magnification of the objective used for the analysis. Photon etc's filters used for hyperspectral imaging are based on holographic gratings, and provide very high efficiency (70%, unpolarized light) for an optimal acquisition of the weak Raman scattering. Combined with top of the line low noise CCD or EMCCD cameras, RIMA™ is the most efficient Raman imaging system on the market.

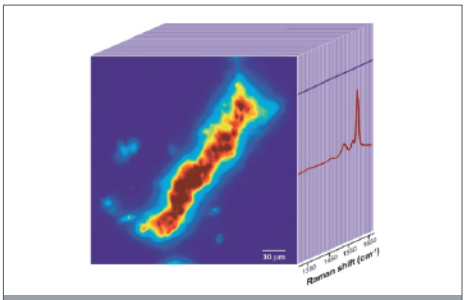


Fig. 1: Raman hyperspectral cube of CNTs upon excitation at 532 nm. The front image represents the maximum intensity map at 1597 cm^{-1}

In order to show the advantages of RIMA™ in the analysis of nanomaterials in biological systems, carbon nanotubes (CNT) have been incubated with a sample of Candida Albicans yeast cells and exposed to a homogeneous (flat-top) laser excitation of 532 nm on the entire field of view. With a 50× objective, an area of 260×130 µm was imaged, with a step of 4.5 cm^{-1} and an exposition time of 15s. The complete analysis took 20 minutes, for a total of more than 60,000 spectra.

Figure 1* shows the Raman hyperspectral cube of a portion of the imaged area containing the yeast. The monochromatic Raman images revealed the position of the aggregated yeast cells stained with the CNTs. The typical signal of CNTs (red line) confirmed their presence on the yeast cells, while in other areas the hyperspectral camera did not detect any CNT Raman signal (blue line).

Results kindly provided by Nicolas Cottenye, Étienne Gaufrès, Nathalie Tang and Richard Martel, at Université de Montréal, Canada.

RAMAN MULTIPLEXING

The potential of Photon etc. Raman Imaging Platform, RIMA™, was demonstrated by Pr. R Martel's group at Université de Montréal in a recent publication in Nature Photonics on the development of Raman nanoprobes.1

These new kind of nanoprobes are based on single-wall carbon nanotubes and J-aggregated dyes, such as α–sexithiophene (6T), β-carotene (βcar) and phenazine (Ph). Compared to fluorescent probes, Raman probes have the advantages of being more stable over long periods of times (weeks and years) and they produce a unique signature with narrow peaks that allows easy multiplexing of 3 probes or more using the same excitation laser energy. This nanomaterial shows a very high Raman scattering cross-section, without any photobleaching or fluorescence background, even at high laser intensities.

In this work RIMA™ enabled the imaging and multiplexing of three different probes with sensitivity down to the single object as seen in Figure 1. The different probes were deposited on a SiOx/Si surface and characterized by taking a single hyperspectral image. We were able to determine, without a doubt, the position of each isolated probe (diameters: 1.3 ± 0.2 nm), and even identify the co-localized probes (Fig 1b, Ph and βcar). The sensitivity, efficiency and hyperspectral properties of RIMA™ were essential to the development of these probes.

The carbon nanotube, which serves as a capsule for the probe, can be covalently functionalized to selectively target biomolecules, such as streptavidin. We demonstrated RIMA™'s potential in the detection of probes in a biological context by imaging the βcar probe functionalized with PEG-biotin groups that targeted streptavidin.

A pattern of 10 µm spots of streptavidin was created by microcontact printing and then incubated with the probes. The pattern was maintained hydrated under a cover slip during imaging and the probes were detected where streptavidin was located. Figure 2 shows Raman hyperspectral images at 1520 cm-1 of two printed surfaces, where streptavidin was deposited either inside (main figure) or around the dots (inset). With a single acquisition, a sample area of 133 x 133 µm2 was studied using RIMA™ with laser excitation at 532 nm. Damages to the samples were also limited due to a uniform illumination over the portion of the sample in the field of view. In terms of spectral resolution and large surface area imaged, RIMA™ provided hyperspectral images in a much shorter time then conventional point-by-point mapping Raman imagers.

Raman hyperspectral imaging is a powerful technique to study a wide range of materials, from nanopatterned surfaces to biological systems. Because of its high throughput, RIMA™ allows the acquisition of spectrally resolved maps of large area samples, without damaging the surface.

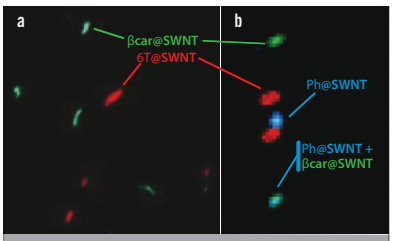


Fig. 1: Raman hyperspectral image at λ = 532 nm of isolated bundles of 6T@SWNTs (red), and βcar@SWNTs (green) and Ph@SWNT (blue).

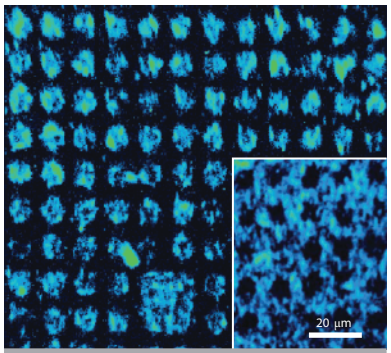


Fig. 2: Raman hyperspectral images at 1520 cm^{-1} of two printed surfaces, where streptavidin was deposited either inside (main figure) or around the dots (inset)

Text by Nathalie Tang and Marc Verhaegen. Images reprinted by permission from: 1E. Gaufrès, N. Y.-Wa Tang, F. Lapointe, J. Cabana, M.-A. Nadon, N. Cottenye, F. Raymond, T. Szkopek & R. Martel, Nature Photonics 8, 72-78 (2014). Copyright 2014 Macmillan Publishers Ltd. This material may be downloaded for personal use only. Any other use requires prior permission of the author and the Macmillan Publishers Ltd.