application note

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Ultrafast Confocal Raman Imaging - Application Examples

In Confocal Raman Imaging, a complete Raman spectrum is acquired at each image pixel with a lateral resolution down to 200 nm. Raman images can be generated by evaluating dedicated peak characteristics, revealing information about the distribution of the sample's compounds, stress fields or crystallinity. With the Ultrafast Confocal Raman Imaging Option the acquisition time for a single Raman spectrum can be as low as 760 micro-seconds. As a Confocal Raman image typically consists of tens of thousands of spectra, the new option reduces the total acquisition time for a complete image to only a few minutes.

For example, a complete hyperspectral image consisting of 250 x 250 pixels = 62,500 Raman spectra can be recorded in less than a minute. The latest spectroscopic EMCCD detector technology combined with the high throughput optics featured in the alpha300 R Confocal Raman Imaging System are the keys to this improvement which can also be advantageous when performing measurements on delicate and precious samples requiring the lowest possible levels of excitation power. Time-resolved investigations of fast dynamic processes can also benefit from the ultrafast spectral acquisition times.

The following examples of applications demonstrate the capabilities of the Ultrafast Confocal Raman Imaging Option on a variety of samples.

Toothpaste
In the following study a standard, commercially available toothpaste was imaged with the alpha300R using the Ultrafast Confocal Raman Imaging Option.

The scan range was 60x60 µm and 20x20 µm respectively at 200x200 pixels (40 000 Raman spectra). The Acquisition time for a single spectrum was **760 microseconds,** resulting in 42 seconds for the complete images. The Raman images in Fig 1a and 1b show the distribution of the toothpaste's main compounds. Fig 1 c shows the corresponding spectra (color-coded).

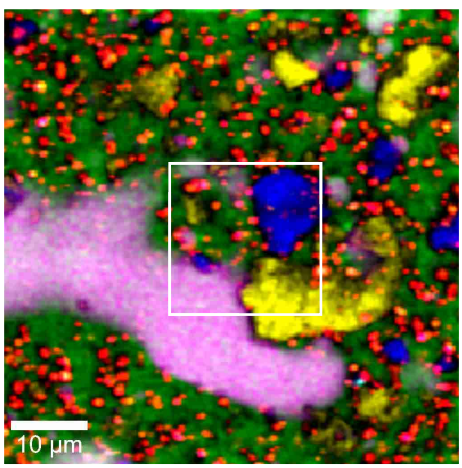

Fig. 1a: Raman image of toothpaste. Scan range: 60 x 60 µm, 200 x 200 pixels, 40,000 spectra, excitation: 532 nm Nd:Yag), 760 microseconds/spectrum, 42 seconds/image.

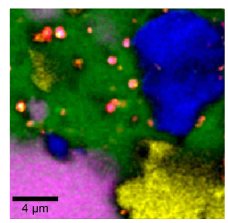

Fig.1b: Zoom-in of the marked area in Fig 1a, scan range 20x20 µm, 200x200 spectra, 40,000 spectra, acquisition time: per spectrum: 760 µs, per image: 40 s.

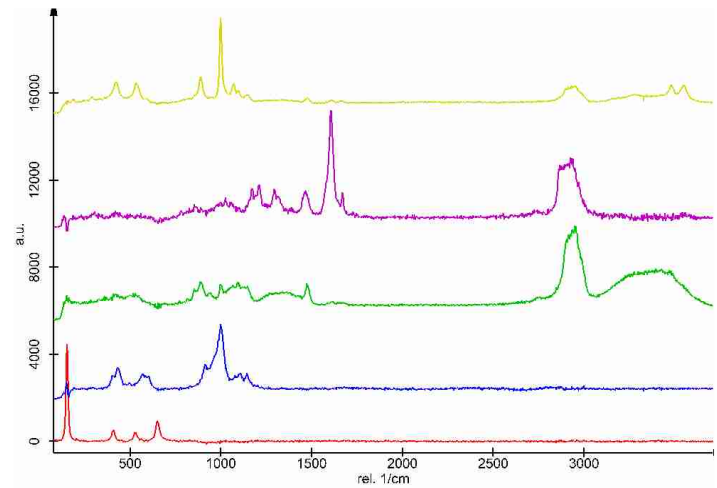

Fig.1c: Corresponding Raman spectra.

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Ointment

A very brief acquisition time is crucial in pharmaceutical screening experiments to solve problems quickly and bring products to market as fast as possible. In this study, the distribution of multiple components in a pharmaceutical ointment was imaged with the Ultrafast Confocal Raman Imaging Option with a scan range of 20x20 µm and 200x200 pixels. In total, 40,000 spectra were acquired in 42 seconds. The resulting image is shown in Fig 2a, the color-coded corresponding spectra are shown in fig. 2b. The blue areas in Fig 2a and the blue spectrum in Fig 2b correspond to Dexpanthenol whereas the red and green areas and spectra correspond to the ointment bases.

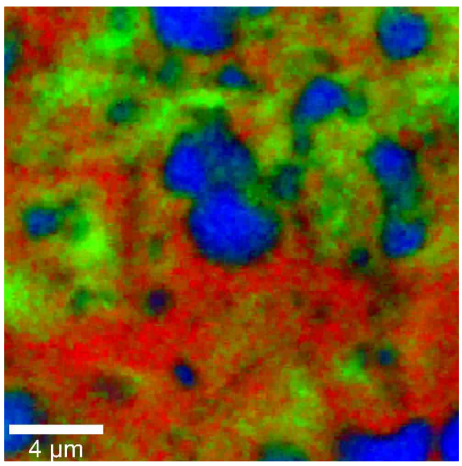

Fig. 2a: Raman image of an ointment containing Dexpanthenol. Scan range: 20 µm x 20 µm, 200x200 pixels (=40,000 spectra), 532 Nd:Yag Laser for excitation, Blue: Dexpanthenol, Red + Green: ointment bases.

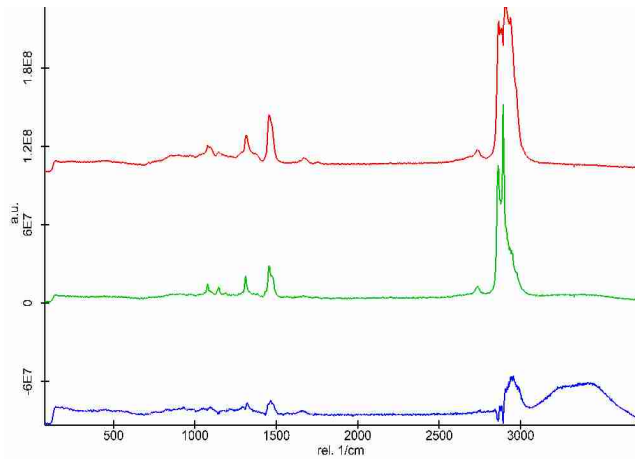

Fig. 2b: Corresponding spectra of the compounds contained within the ointment. Blue: Dexpanthenol, Red + Green: ointment bases.

Emulsions

Emulsions play an important role in various production processes e.g. in the food, pharmaceutical and cosmetics industries. As an example of an emulsion, a mixture of oil, alkane and water was imaged with the Ultrafast Raman Imaging Option. The scan range was 60x60 µm and 200x200 pixels, resulting in a total of 40,000 spectra. The acquisition time was 760 microseconds per spectrum and 42 seconds per image. The results are shown in Figs.3a and 3b respectively.

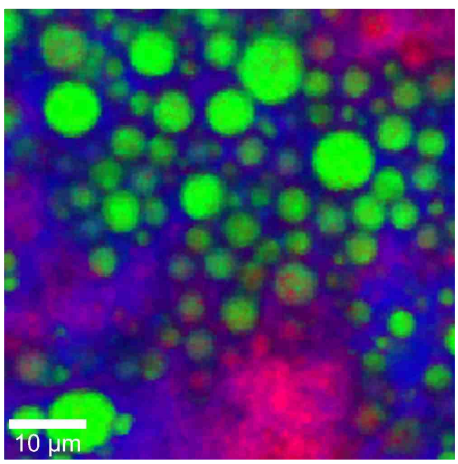

Fig. 3a: Raman image of oil-alkane-water; scan range: 60 x 60 µm, 200 x 200 pixels, 40,000 spectra, 760 µs/spectrum, 42 seconds/image, excitation: 532 nm Nd:Yag, Green: oil, Red: alkane Blue: water.

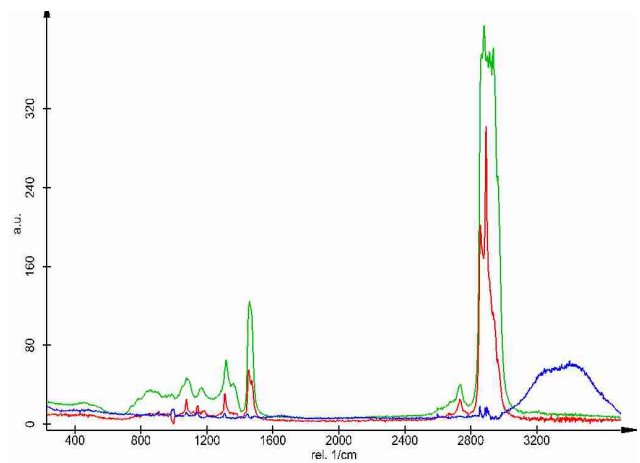

Fig. 3b: Corresponding spectra; Green: oil, Red: alkane, Blue: water.