2D Chemical Mapping using Confocal Raman Microscopy

From pharmaceutical tablets to commercial paints to plastics, it is all but impossible to find products that are not some combination of a multitude of components. In addition to the primary component itself, additives are often provided to impart desirable characteristics to final products. In the pharmaceutical industry, excipients (non-active materials) are added to provide bulk to the active ingredients, generate more visually appealing tablets, and help control the dose release rates as the tablets dissolve. Similarly in the colorant industry, common inks often are composed of not only pigments, but also additives to control their viscosity, adhesion, and solubility.

Raman spectroscopy has become an invaluable tool to analyze the spatial and chemical composition of these components. With a horizontal spatial resolution of ~360 nm and a vertical spatial resolution of ~500 nm, the instrument can obtain high quality chemical maps to aid in the understanding of the distribution of elements in a system. Importantly, the confocal microscope only obtains signal from the focal plane of the microscope; all information from out-of-focus light is rejected from the detector. This helps reduce background noise and allows the collection of 3D images in optically transparent samples.

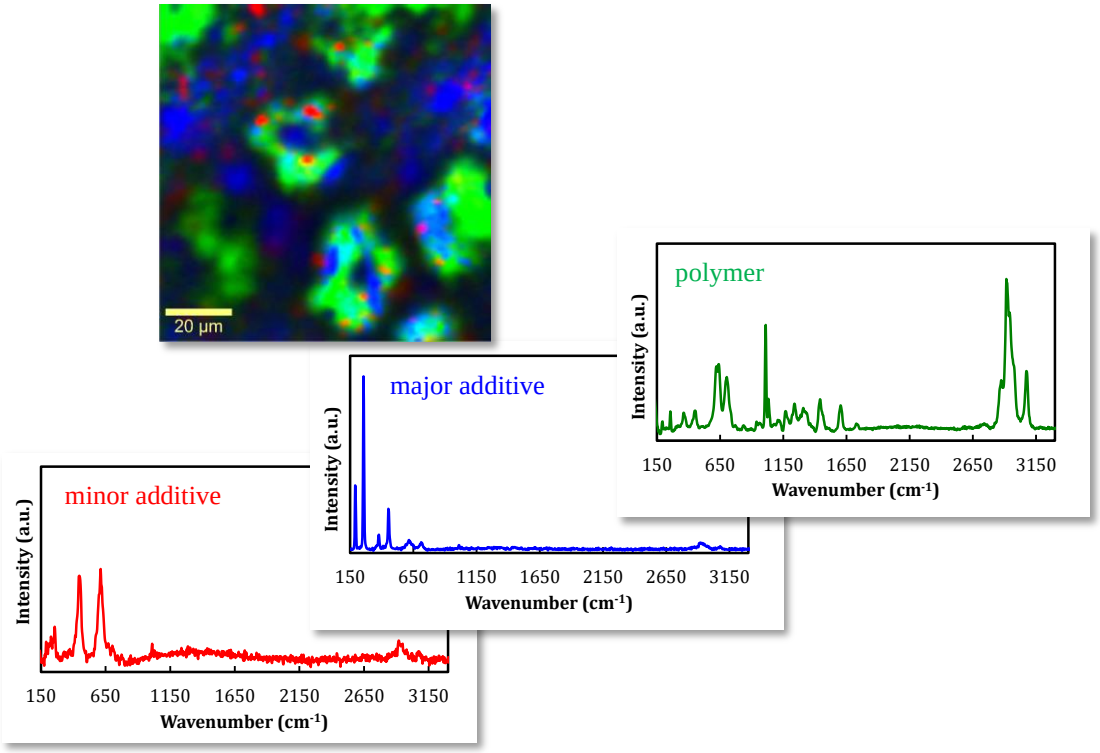

Figure 1. Chemical map of a polymer composite structure and corresponding Raman spectrum of the components. Scan information: scan area = 100um x 100 um, 100 x 100 pixels, 10000 spectra, 84 ms/spectrum, excitation using a 532 nm Nd:YAG laser.

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To illustrate the mapping power of Raman microscopy, a flexible polymer material was imaged at a scan image size of 100 um x 100 um at 100 x 100 pixels (10,000 spectra, 84 ms/spectrum) using a 532 nm laser excitation source. The total acquisition time was 14 min. Figure 1 shows the color-coded Raman image obtained by analyzing the distinct spectra extrapolated from the area scan. The corresponding spectra are also shown in Figure 1. The green region represents the organic polymer component, and the image indicates that the polymer exists in small clusters approximately 20-30 um in size. One major and one minor additive (blue and red, respectively) are also observed.

In a different example, an generic pain relief tablet was imaged at a scan image size of 50 um x 50 um at 50 x 50 pixels (2500 spectra, 84 ms/spectrum) using a 532 nm laser excitation source. The total acquisition time was 4 minutes. Figure 2 shows the color coded Raman image obtained by analyzing the distinct spectra corresponding to the three active ingredients: acetaminophen (red), aspirin (green), and caffeine (blue). The black area is excipient (spectrum not shown).

As can be seen from the previous two illustrations, Raman spectroscopy is an invaluable tool in determining the spatial relationship between material components in a sample. Additionally, the scans were obtained in 14 minutes and 4 minutes, respectively, illustrating the high throughput capacity of the instrument. Due to its fast rate of data acquisition, strong direct spatial imaging capabilities, and non-destructive excitation laser source, confocal Raman spectroscopy is well suited for the analytical demands of almost any industry.

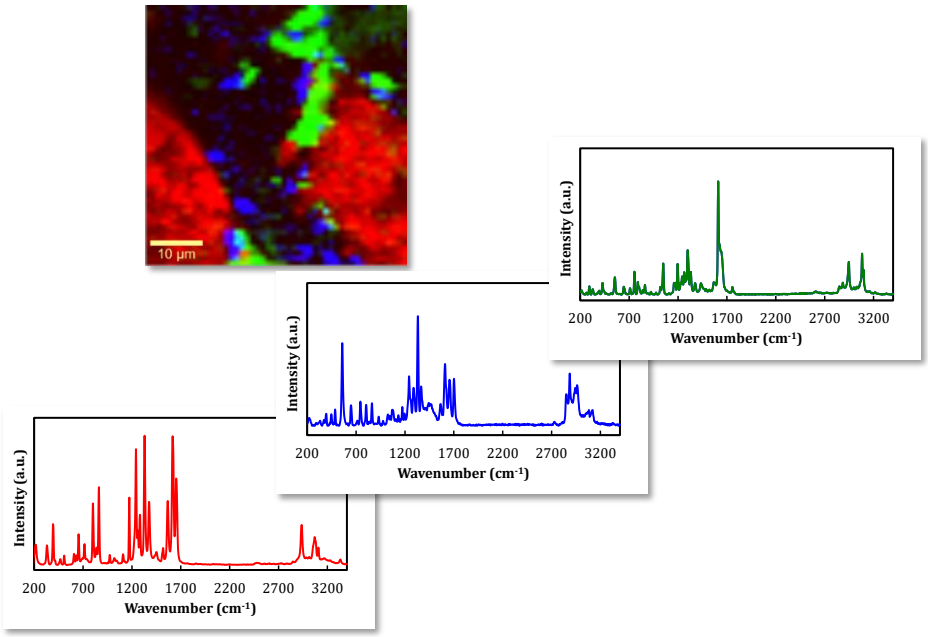

Figure 2. Chemical map of a polymer composite structure and corresponding Raman spectrum of the components. Scan information: scan area = 100um x 100 um, 100 x 100 pixels, 10000 spectra, 84 ms/spectrum, excitation using a 532 nm Nd:YAG laser.