Ultra-Fast Raman Microscopy: Line Scanning Confocal Raman Microscopy using Diffraction Limited Optics

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One of the greatest benefits of Confocal Raman Microscope design is the ability for spatially resolved chemical microanalysis of very small sample areas or volumes. Modern Raman microscopes can perform statistically valid microanalysis from sample volumes as small as 0.04µm³, when using a 100x oil immersion objective lens (NA=1.4).

By combining micro-Raman analysis with automated focusing and x, y, z movement, it is possible to produce ‘chemical’ images of a sample micro-volume; yielding chemical localization, distribution, phase and other sample specific information.

Historically Raman microscopy has suffered from long image (map) acquisition times, however the use of laser line-scanning confocal optics can now generate very fast Raman maps in either x, y scanned regions or in simple spot (point) analysis mode.

Line-scanned image modalities also have the added benefit of minimizing radiation damage of sensitive samples, an important consideration because the acquisition of fast Raman maps requires significant laser power to achieve good counting statistics with a line shaped illumination source.

Another advantage of line scanning optics is the elimination of x,y sample stage motion, enabling microscopy of wet samples, an example of which is shown in Figure 3 below.

Early Raman microscopy was limited to inspection of flat samples, but this limitation has been overcome recently by the advent of hardware and software capable of mapping sample topography and applying sample height variations to Raman spectral acquisition (see Figure 4 below).

Examples of contemporary Raman microscopy shall be presented, including data from Materials and Biologic applications.
FIG 1.
Example of Fast Raman Mapping at high resolution of CNT Bridge in Battery Technology, showing RBM of CNTs.

FIG 2.
Example of Fast Raman Mapping differentiating single and multiple Graphene layers.

FIG 3.
Example of Fast Raman Mapping during *in vitro* cell division.