APPLICATION NOTE

BAYSPEC

Pervasive Spectroscopy

1064 nm Dispersive Raman Systems for Analysis of Petroleum Products

Raman now works on lubricants and petroleum-based samples

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Raman spectroscopy is an *in situ*, non-invasive, and sensitive technology to probe and analyze chemical compositions and structures with high specificity, in a near real-time manner. As a non-contacting optical method, it essentially does not require sample preparation. However, in the past it has not found much usefulness on petroleum and petroleum-based products such as lubricants, due to the high level of photoluminescence (e.g., fluorescence and phosphorescence) intrinsically existed in those samples. Their fluorescent background, thousands of times stronger than Raman emission, can easily overwhelm any Raman signals when excited by visible wavelengths.

This issue is now relieved by BaySpec, Inc.'s 1064 nm excitation dispersive Raman systems that offer maximum reduction in fluorescence interference. By moving to a much longer excitation wavelength, far away from most pigments and fluorophores' absorption range, it fundamentally eliminates, or minimizes the excitation of the fluorescence.

For example, most lubricants are based on heavier petroleum fractions in a yellow or brownish color. They play critical roles in almost all machines with moving parts to reduce friction, transfer heat or keep the parts clean by moving away debris and contaminates. Lubricants degrade with time. Understanding them in a quantitative manner is crucial in the design and use of machineries. Traditionally, they have to be sent to a laboratory for analysis using wet chemistry techniques such as GC or HPLC, which are costly and time-consuming. High-throughput and real-time Raman spectroscopy would be ideal. But traditional Raman instruments based on visible and NIR (e.g., 785 or 830 nm) lasers induce strong fluorescent background from these samples thus render the method useless.

Only now, BaySpec's 1064 nm Raman systems offer the means to minimize interference from fluorescence and unmask Raman spectra for those highly fluorescent samples. Here we demonstrate methods using 1064 nm dispersive Raman to characterize a common type of engine oil, and quantitatively analyze a mixture of two common machine lubricants. The spectra were taken by BaySpec's benchtop *RamSpec*™ systems. All spectral acquisition times were less than 10 seconds.

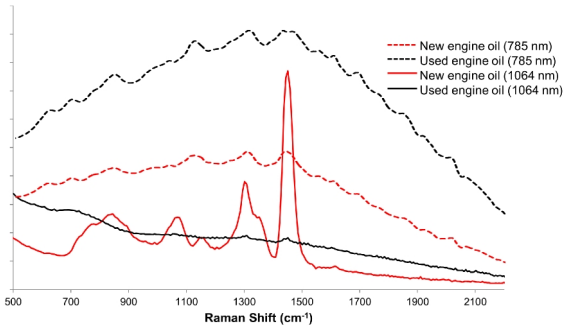

Figure 1*. New (red lines) and used engine oil (black lines) characterized by 785 (dotted lines) and 1064 nm (solid lines) Raman spectroscopy. 785 nm laser excites high fluorescence from the samples which masks their Raman markers. Only 1064 nm produces high-quality Raman markers that clearly characterize the difference between new and used engine oils.*

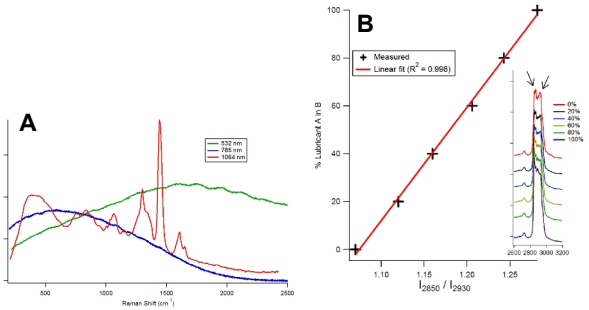

Figure 2*. (**A**) Comparison of Raman spectroscopy of a machine lubricant using 532 (green line), 785 (blue line), and 1064 nm (red line) excitations. Only 1064 nm excitation produces high-quality Raman markers. (**B**) The intensity ratios of two Raman markers around 2850 cm^{-1} and 2930 cm^{-1} measured by RamSpec™-1064 are used to quantify the mixing percentage of two types of lubricants. The Raman ratio is linearly correlated to the percentage of the mixtures.*

Based on these experiments, highly fluorescent samples such as lubricants and petroleum derivatives in their native states can now be characterized by 1064 nm dispersive Raman spectroscopy in a real-time, quantitative manner.

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