APPLICATION NOTE:
RAMAN APPLICATIONS

Techniques

- Raman

Keywords

- Biomedical Applications
- Raman

Doctor holding a Colonoscopy Instrument

Abstract

Raman spectroscopy utilizes inelastic scattering of photons off of covalently bound molecules to identify functional groups, crystallinity, and stresses and strains. It is a widely used tool in the spectroscopy community for both quantitative and qualitative molecular analysis, with applications ranging from high-end university research to airport security screening. Because of the extensive range of applications for Raman spectroscopy, it can often be confusing to determine which spectrometer is best suited for any given application. To help alleviate this challenge this application note will provide an overview of three common applications, biomedical diagnostics, silicon wafer stress monitoring, and incoming material verification, along with suggestions of a preferred spectrometer for each application.

Medical Diagnostics

Raman spectroscopy has been repeatedly shown to have massive potential for point-of-care medical diagnostics and monitoring due to its ability to provide a non-contact non-destructive molecular fingerprint of many common physiological biomarkers. In the field of cancer detection alone there have been thousands of research papers published ranging from applications such as interoperative cancer boundary detection during breast, brain, and oral tumor removal to urine testing for monitoring lung cancer response to treatment. Not only are most common biomolecules, such as nucleic acids, proteins, lipids, and fats highly Raman active due to their nonpolar molecular structure, but perhaps, more importantly, the abundance of water in these samples does not interfere with the spectra due to the extreme polarity of water molecules. This dichotomy between the scattering cross-sections of biological macromolecules and water is what allows Raman to be used on both tissue and bodily fluids for the identification of pathogens, blood disorders, cancers, and other abnormalities.

Because of the complexity of biological molecules, they tend to produce much broader spectral features than most other Raman active molecules. While this lends itself to a reduction in overall signal efficiency requiring longer integration times, it also means that the spectral range and resolution requirements of the device are often quite relaxed. This is particularly evident in fit-for-purpose instrumentation which is designed to only look at a select few spectra features. For this application a spectrometer such as the AvaSpec-Hero, model number AvaSpec-1024X58-HSC-EVO, due to its deep cooling and high-sensitivity back-thinned CCD detector. Additionally, the AvaSpec Hero also boasts an extremely wide dynamic range of 40,000:1, which makes it much easier to detect the subtle variations which can often mean the difference between healthy and diseased tissue.