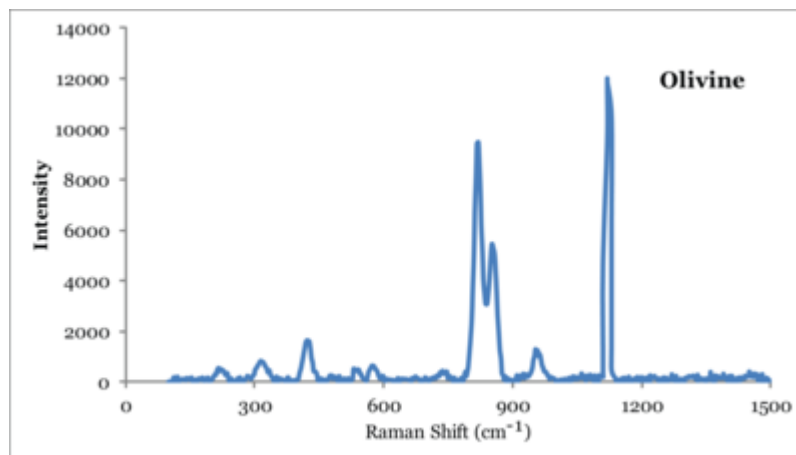


WHAT DOES A RAMAN SPECTRUM LOOK LIKE?

A Raman spectrum plots light intensity (unit, e.g., counts, counts per second or arbitrary units) versus light frequency (relative wavenumbers). A Raman spectrum consists of three parts, the intense Rayleigh line and less intense Raman bands in the Stokes (red shifted, low-energy) and Anti-Stokes (blue shifted, high-energy) parts of the spectrum, whereby the latter two parts are equal in energy. Generally, only the Stokes bands are recorded, because they are more easily detectable due to their higher intensity. The Rayleigh line equals 0 Raman shift, so that Anti-Stokes lines have negative wavenumbers and Stokes lines have positive wavenumbers. The wavenumber shift is characteristic for a material.



Instrumentation

The main components of a Raman system are a 1) light source, 2) optical components, such as lenses and mirrors, to focus the light onto a sample and collect the scattered light, 3) a spectrometer, and 4) a detector. The light source is typically a UV, VIS, or NIR **laser** emitting monochromatic light. Types of lasers are gas lasers (e.g., Ar⁺, diode-pumped solid state lasers, or tunable lasers. **Notch filters** are used to filter the Rayleigh line intensity before the scattered light is entering the spectrometer and the detector (**CCD camera**). In the majority of experiments **dispersive spectrometers** are used (see IR section for details) in combination with back-scatter, forward scatter or 90° geometries. Depending on the instrumental setup, spectral resolutions of $\sim 0.05 \text{ cm}^{-1}$, depth resolutions of about 2 μm and effective lateral resolutions of 1 – 1.5 μm can be reached. Raman microspectroscopy often takes advantage of a **confocal** setup to increase the spectral resolution, where two apertures (behind the light source and before the spectrometer) reduce stray light and eliminate out-of focus information and only information from the focal plane reaches the detector.

Raman vs. IR spectroscopy

1. other selection rules, i.e., partially complementary information
2. lower sensitivity, because scattering effect is weaker
3. well-suited for aqueous solutions
4. visible excitation, fluorescence of the sample or contaminations may overlap with the signal
5. no sample preparation necessary
6. bands below 400 cm^{-1} are measurable

Source:

https://serc.carleton.edu/NAGTWorkshops/mineralogy/mineral_physics/raman_ir.html