Study of Stimulated Raman Spectroscopy for chiral molecules

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The shift in Raman frequency provides chemical and structural information. However, Raman scattering is relatively weak, leading to low detection sensitivity. As a consequence, it is difficult to measure the vibration spectra of molecules of low concentration, and weak Raman scatterers. This can be overcome using resonance Raman technique, wherein the wavelength of the exciting photon lies within the electronic absorption of the molecular system. Under this condition, the Raman signals can be enhanced by a factor of 10^4-10^6. But, in the case of some fluorescent molecules, the strong fluorescence signal masks the resonance Raman signals. Thus, the sensitivity of Raman spectroscopy is limited to the study of non-fluorescent and strong Raman scattering molecules.

Advanced Raman spectroscopic techniques, such as coherent anti-stokes Raman scattering (CARS), stimulated Raman scattering (SRS), etc. have been reported in recent times to overcome the problem. Both CARS and SRS involve a four-wave mixing process providing the signal. While stimulated Raman spectroscopy, a nonlinear phenomenon, is used as a gate for the detection of the instantaneous Raman scattering signals before being overwhelmed by the fluorescence signal. This method provides a Raman spectrum with a good signal-to-noise ratio and relatively efficient fluorescence rejection compared to conventional Raman spectroscopy.

To gain Raman spectrum for Raman active molecules, we employ stimulate Raman spectroscopy. In our experiment, a spectrally narrow pump (1030nm) beam is generated by a Yb:KGW laser (Pharos, Light Conversion) and a broad anti-Stokes (centered at 900 nm) beams are used for Raman probe. Raman probe is produced by NOPA (ORPHEUS-N, Light conversion). These two beams are focused into the sample using a 100 mm convex lens. The energy differences between Raman pump and probe beam are from 400cm^{-1} to 1800cm^{-1}. It can cover the spectral window for Raman active vibration modes. Spectral resolution is determined by band-width of Raman pump, our fundamental Raman pump pulse band-width was around 20cm^{-1}. So, we used narrow band-pass filter which is centered at 1030nm (LL01-1030, Semrock) is used for making narrow pulse and we can control the center of pump pulse by tilting angle of narrow band-pass filters. The Raman pump used was centered at 1024 nm, with a bandwidth of 21 cm^{-1}.

The ratio of the probe spectrum with and without the Raman pump gives the gain or loss spectrum. SRS occurs only when both beams are present. The loss is given by: Loss = (Raman probe with Raman pump on)/(Raman probe with Raman pump off).

Figures 1 depicts the change in Stimulated Raman Loss (SRL) measurement intensities of the 1003 cm^{-1} peak of toluene against pulse energies.

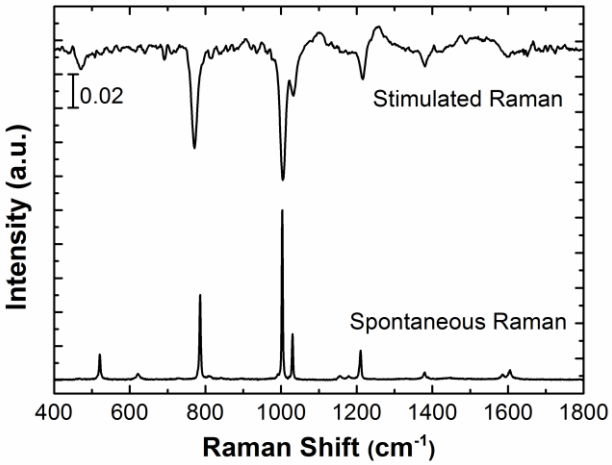

Figure.1. stimulated Raman spectrum of toluene (upper), spontaneous Raman spectrum of toluene (lower).

This studies were carried out using stimulated Raman spectroscopy, benzene, toluene and α-pinene. The our results indicate that molecules which has Raman active modes are well matched with spontaneous Raman spectrum. And our stimulated Raman loss measurement system will be improved to get better signal-to-noise level.

참고문헌

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