

## Using the Frontier to Characterize the Spectral Output of a NIR Diode Laser

Characterizing the spectral output of a diode laser requires more than simply measuring the center wavelength with a wavemeter. The distribution of energy between different modes will be affected by temperature and current and may change randomly. FT-IR instruments are well suited to studying this, combining high resolution and rapid measurement with their extremely precise wavenumber scale derived from the internal HeNe laser. Their high sensitivity allows weak sidebands

to be observed. This note illustrates the use of the Frontier™ FT-IR Spectrometer to characterize the spectral output of a NIR diode laser operating nominally at 785 nm with a peak width of 0.26 nm.

### Experimental

The measurements use a standard NIR Frontier with  $\text{CaF}_2$  beamsplitter and room temperature NIR DTGS detector. The laser output enters through the emission port at the back of the spectrometer, replacing the normal source. There are two significant practical considerations because of the nature of the laser output. The first is to ensure that the wavenumber scale is accurate, which requires that the IR beam fills the Jacquinot stop. This cannot be taken for granted with a collimated laser beam as the source. It can be ensured by aligning the laser beam to maximize the detector signal and reducing the Jacquinot stop diameter until it limits the detector signal. In this case, the J-stop diameter used was about 35% of the maximum. The second issue concerns phase correction. The very narrow spectral range of the output means that the interferograms do not have a large centerburst, which affects subsequent processing. Those phase correction methods based on transforming a short central region of the interferogram are unsatisfactory in this situation. With the Frontier, there are two ways of handling this. At resolutions of  $2\text{ cm}^{-1}$  and lower, full double-sided interferograms are generated, allowing calculation of a magnitude spectrum which avoids the problem. This is not possible at higher resolutions which have single-sided interferograms. Instead, a broadband source is used to generate a phase correction which is stored and applied to the laser spectrum.

## Results

Although the supplier suggests that this laser diode is suitable for Raman spectroscopy, the output is distributed between numerous modes. Figure 1 shows typical lineshapes as the current was increased from 60 mA to the typical operating value of 150 mA. The spectra were measured at  $2\text{ cm}^{-1}$  resolution, equivalent to  $0.12\text{ nm}$ . As the current is increased, the output increases and becomes more concentrated in a single mode. However, the

output is not stable. Figure 2 shows the output with a 150 mA current measured over 5 minutes. The peak output varies by over 30%. When the peak amplitude drops there is a corresponding increase in the intensity of the sidebands across a wide wave-number range. At the same time, the center wavenumber shifts by up to  $3\text{ cm}^{-1}$ . This performance indicates that this laser would be suitable for low performance Raman spectroscopy only.

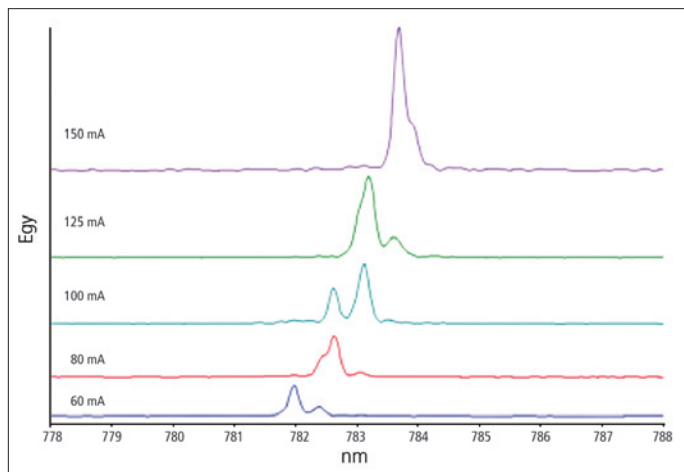


Figure 1. Typical spectral profiles at different operating currents.

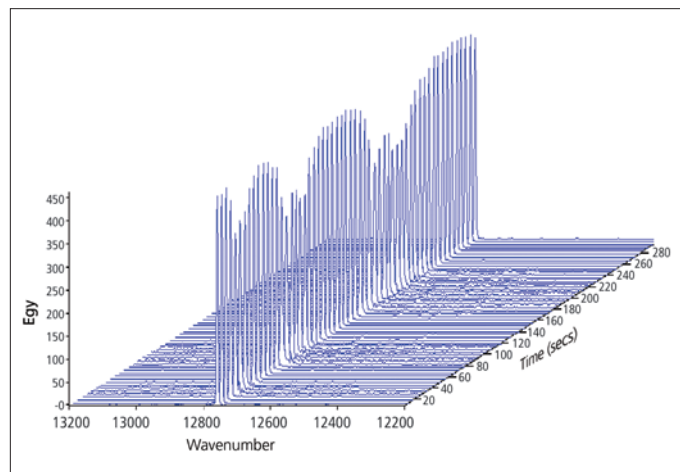


Figure 2. Variation in spectral profile over five minutes.

Pictures below show correlation between shift and amplitude.

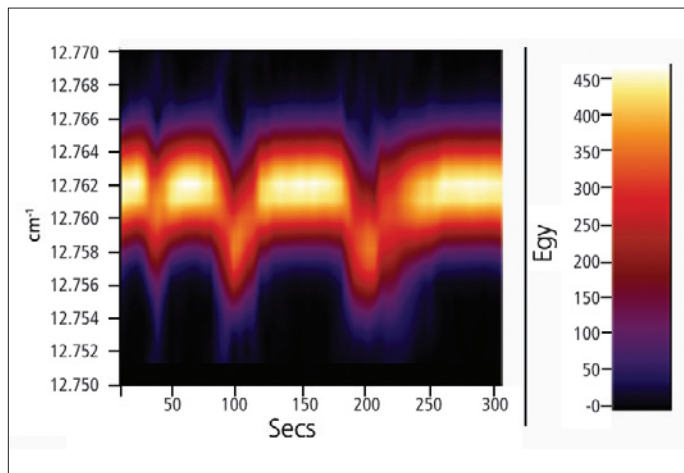


Figure 3. False color plot showing the frequency shift over time.

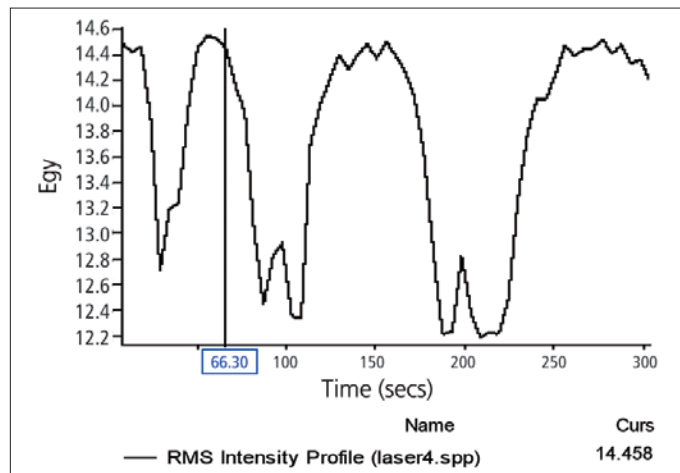


Figure 4. RMS intensity variation of output.