application note

Analysis of ZnO, GaN and AlGaN with MiniPL/Raman Instrument

Presented here are the spectra collected using the MiniPL/Raman instrument supplied by Photon Systems, Inc.. The system is configured with the following specifications:

Dual Gratings,

1200ln/mm resolution of ~ 1nm

3600ln/mm resolution of ~ 34cm^{-1}

Laser 248.6nm and or 224nm

Slits operated at either 125um or 300um

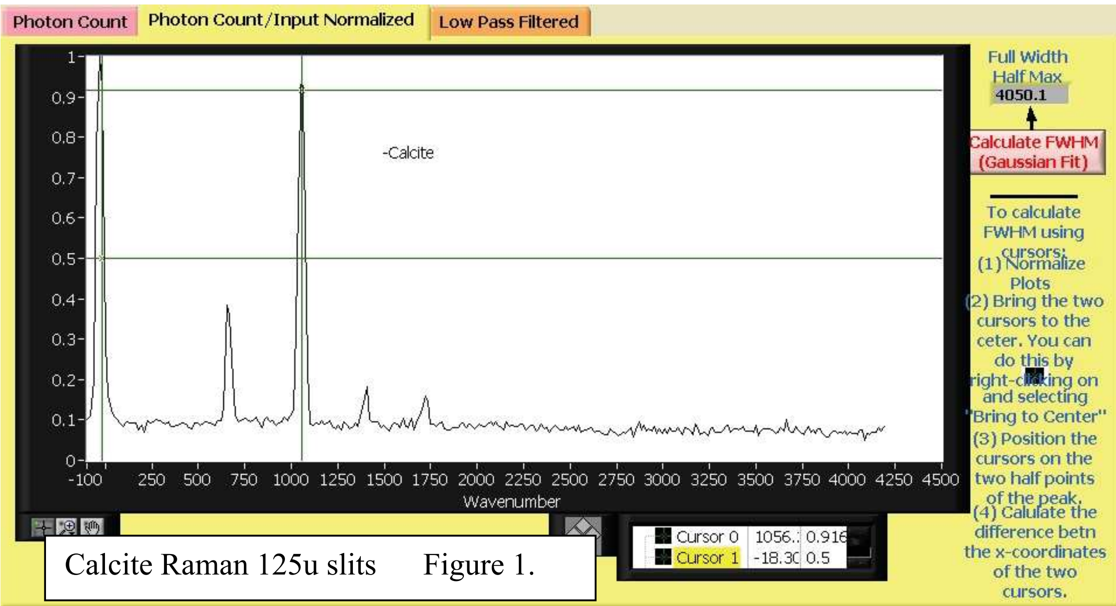
Custom software including spectral analysis module

Internal energy meter used to normalize PL or Raman signal

For more detailed specification please see our data sheet on www.Photonsystems.com

Raman spectra:

The first two figures show typical Raman spectra taken just prior to the material analysis that follows.



Calcite Raman 125u slits Figure 1.

Figure 1 shows Calcite Raman Spectra taken with the 125um Slit and the 3600ln/mm Grating. Note the Raleigh line is actually shifted (calibration issue) by about 18cm^{-1}, should be at zero(0 cm^{-1}). You can see the 4 major calcite peaks normalized with the highest peak at 1. The spectra can be displayed in wavelength (nm or A) as well as eV or cm^{-1}. In addition the system has internal software to recalibrate to known spectra.

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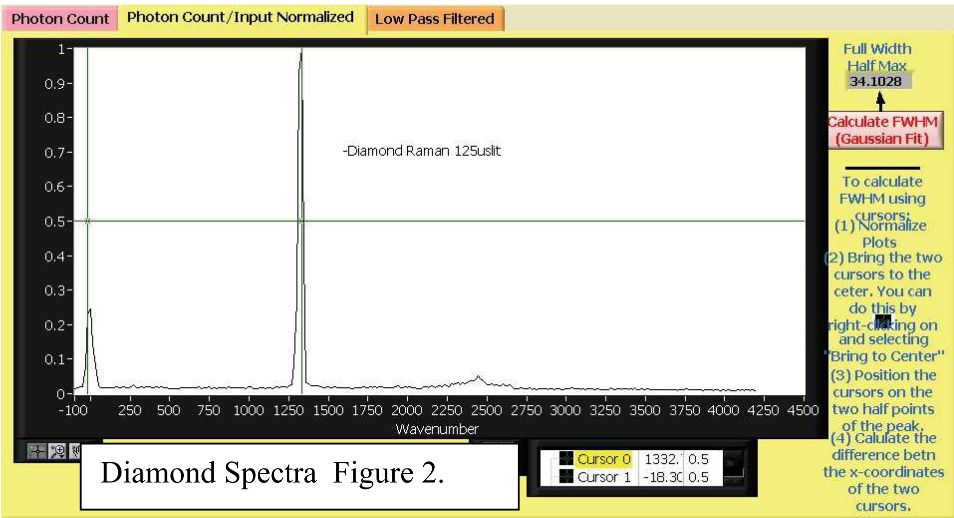
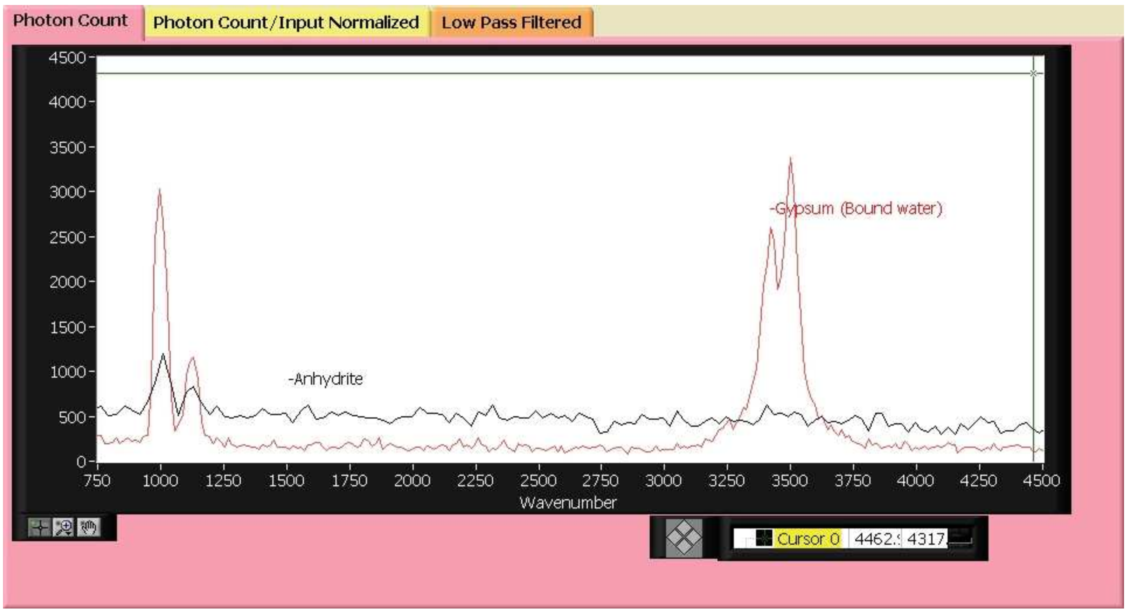
Figure 2 shows Diamond spectra also taken with the same conditions as above on the same instrument.



Diamond Spectra Figure 2.

Again you can see the principal diamond peak but also note the peak around 2500cm^{-1}, this represents DLC (Diamond Like Carbon). The ration of these peaks can be expressed in the hardness of the diamond film or tool.

In addition this instrument is capable of seeing bound and free water Raman spectra in materials. See the following plot for this.



It is important to note that if you are looking for H20 on a thin film or in a bound material Raman is one technique for detection.

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Photoluminescence Data

This PL data was taken with the 3600ln grating but with the 300um slit setting.

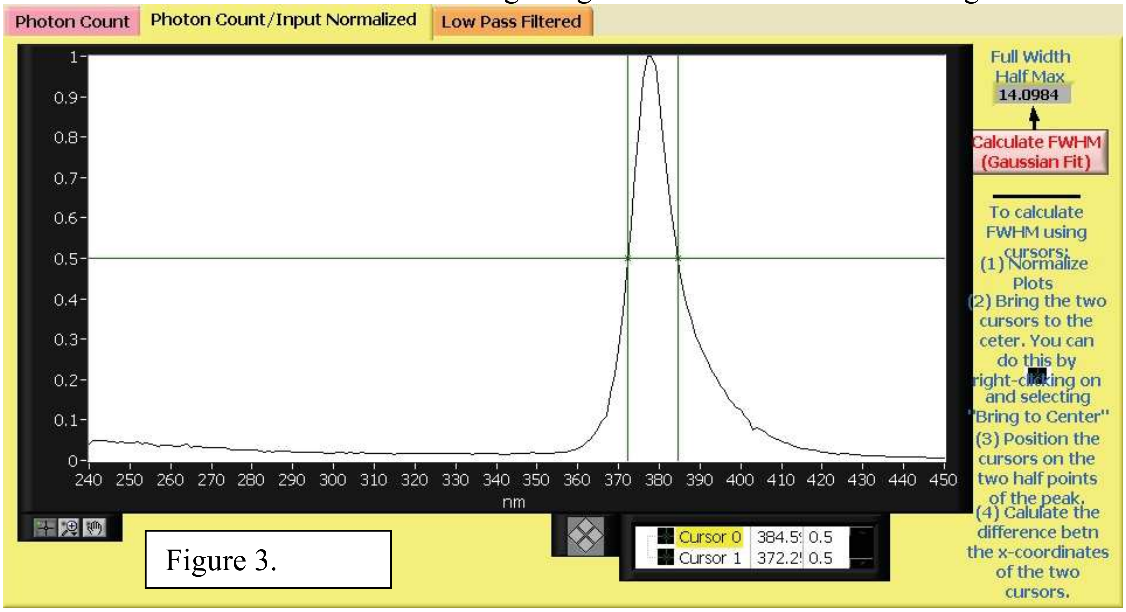

Figure 3.

Figure 3 shows the PL spectral for ZnO 173 material. Note the FWHM of ~14nm and the peak is round 280nm. Again we have normalized the output in order to calculate the FWHM which is curve fit using a Gaussian simulation.

Figure 4 shows the ZnO 177 material.

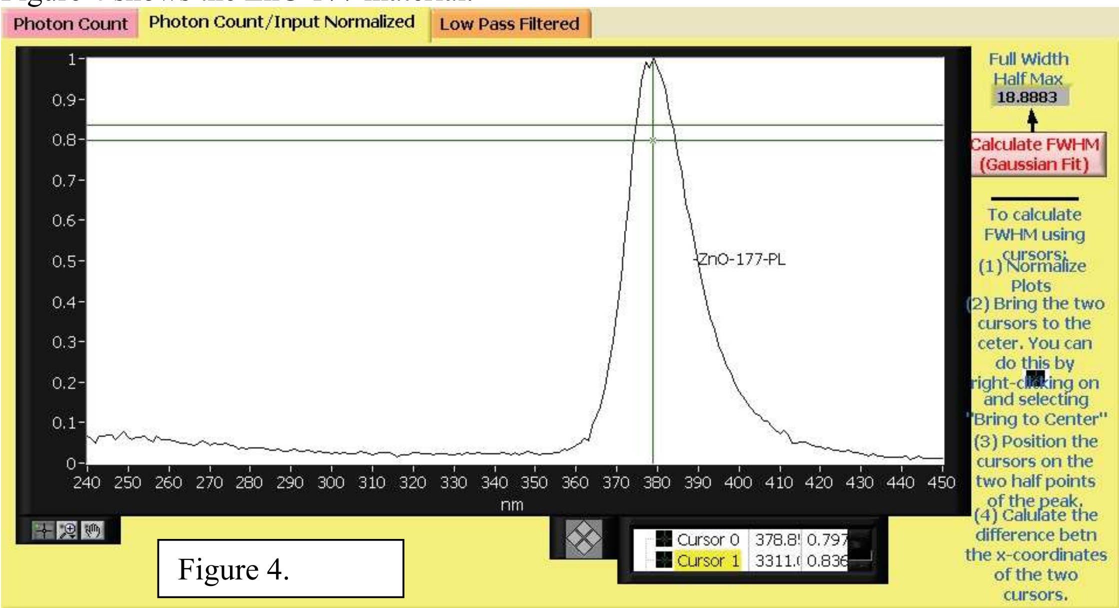

Figure 4.

Note the FWHM is calculated to be 18.8nm and a peak at 378nm. Note a significant Red tail on the spectra.

Figure 5 shows the M19428 material. Note we have taken the spectra with the slits at 300um (red) and at 125um (Black), normalized the spectra and plotted both using the standard analysis software included with the MiniPL system. Note that the spectra are identical.

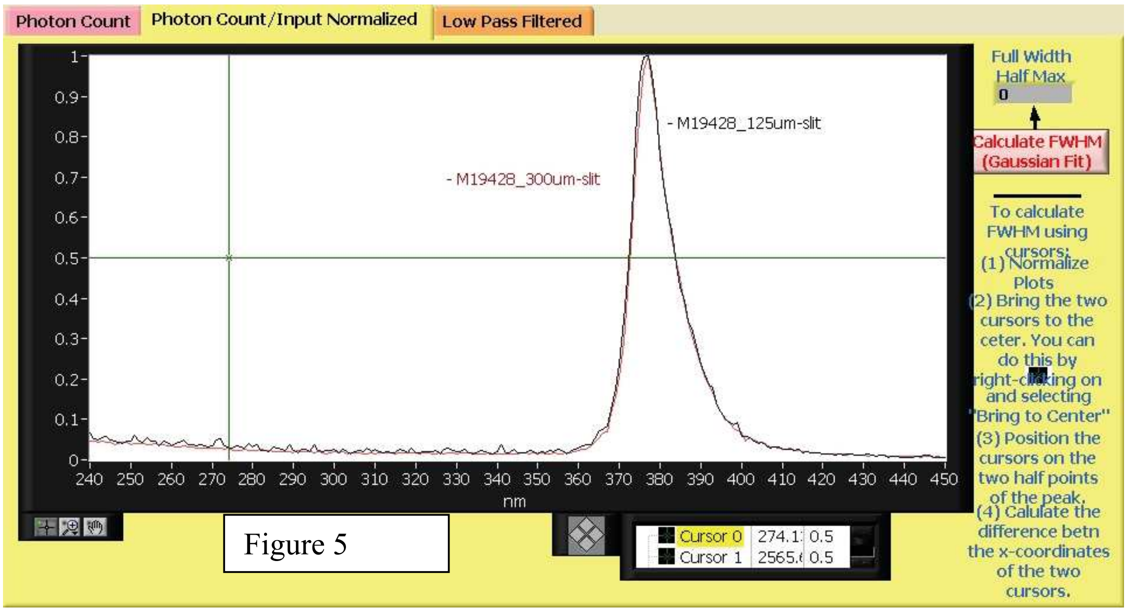

Figure 5

Figure 7 shows a variety of GaN, ZnO and AlGaN plots using a 248nm laser.

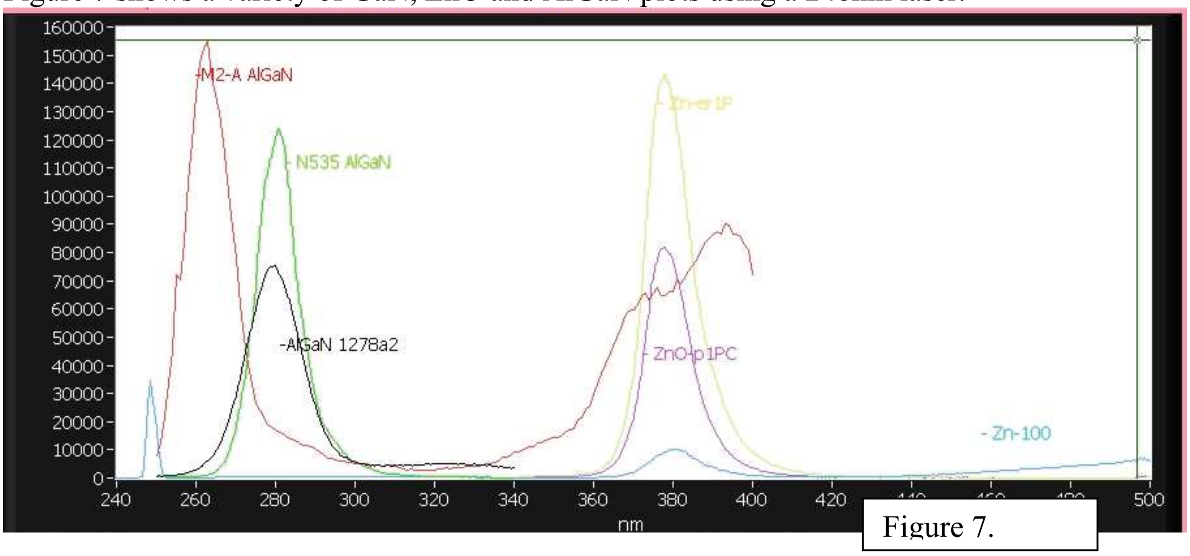

Figure 7.

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Here are some PL plots using the 224nm laser.

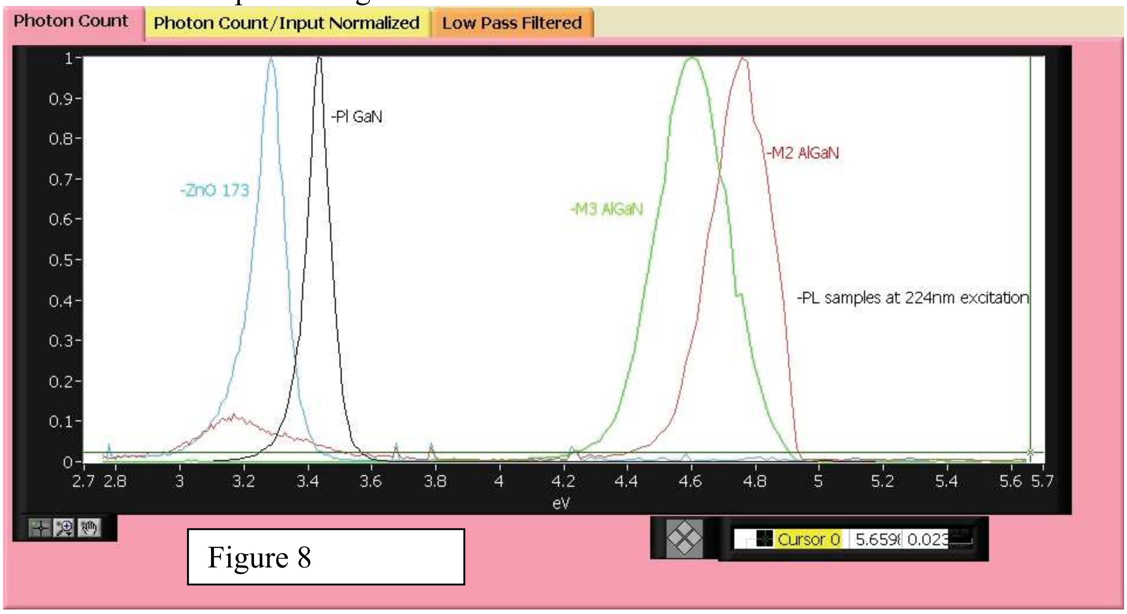

Figure 8

Note the spectra in independent of excitation wavelength other than the ability test samples at a bandgap near the excitation. Figure 8 shows AlGaN, ZnO and GaN samples all normalized to their peak spectra.

This provides a basic summary of the use of the Deep UV Lasers, Detection systems combined with a 1/8meter monochrometer to provide a high quality Photoluminescence instrument. This and similar data can be obtained using these components independently with a different monochrometer if desired.

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