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Characterizing Fluorescence and Phosphorescence from Plastic Samples Using the Lumina Fluorescence Spectrometer

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Key Words

- Lumina
- Fluorescence
- Glow-in-the-dark
- Luminous
- Phosphorescence

Introduction

Although many of the samples analyzed with a fluorescence spectrometer are liquids placed in a traditional 10 mm cuvette, a flexible research-grade instrument can do much more. Interest in solid materials is increasing across all disciplines of research and development, both in industry and academia. To illustrate the capabilities of the Thermo Scientific Lumina fluorescence spectrometer for solid measurements, we describe the fluorescence and phosphorescence analysis of glow-in-the-dark plastic star samples in this technical note. We demonstrate some of the features available in the Lumina™ spectrometer and the Thermo Scientific Luminous software to characterize these materials. The samples are mounted in the solid sample holder of the Lumina spectrometer.

Fluorescence Excitation and Emission Spectra

In the first experiment, the fluorescence emission and excitation spectra were obtained using the WaveScan application of the Luminous™ software. An excitation wavelength of 366 nm and an emission wavelength of 460 nm provided the best results for the blue-colored sample. The emission and excitation slits were both set to 5 nm and a 20 ms exposure was acquired at 1 nm data point intervals. The fluorescence spectra for the blue plastic star are shown in Figure 1. The fluorescence emission and excitation spectra from the green star were quite different and consisted of a main excitation peak at 462 nm and a strong emission peak at 507 nm (data not shown).

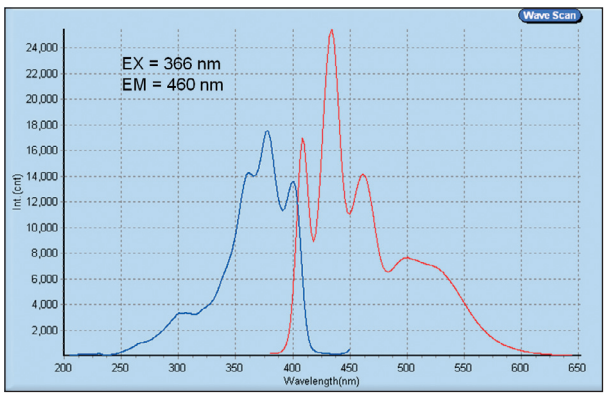

Figure 1

Phosphorescence and Luminescence Spectra

The WaveScan software application can also be used measure the phosphorescence emission spectrum of the samples. In phosphorescent materials, excitation causes the molecule to enter an excited state which then undergoes intersystem crossing to a symmetry-disallowed triplet state. Although this transition is forbidden, the molecule can eventually return to the ground state, often by emitting a photon of light. For materials that "glow-in-the-dark", the lifetime of the triplet state can be several minutes to hours. In this experiment, the sample is exposed to the excitation light, the shutter is closed and the phosphorescence intensity measured. This is repeated for each point in the spectrum. Figure 2 shows the phosphorescence spectra from the green and blue samples.

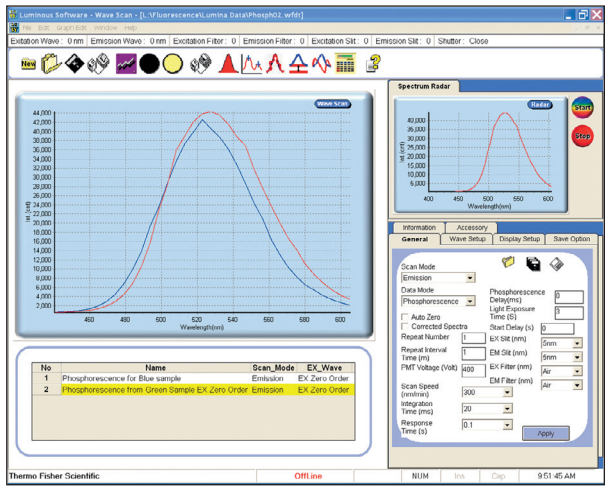

Figure 2

In this example, the excitation grating was set to the zero order position allowing broadband light from the xenon source to excite the sample for 3 seconds. Even though the fluorescence spectra described earlier were quite different for the two samples, the phosphorescence spectra are quite similar; suggesting that the same compound was used in both plastics to generate the phosphorescence effect.

A third data mode available with the Lumina spectrometer is Luminescence. This mode provided an easy way to measure the spectrum of light emitted by the sample after being left under bright room lights for several minutes. Figure 3 shows two repeat luminescence spectra acquired immediately after placing the sample in the spectrometer. A phosphorescence spectrum is shown for comparison.

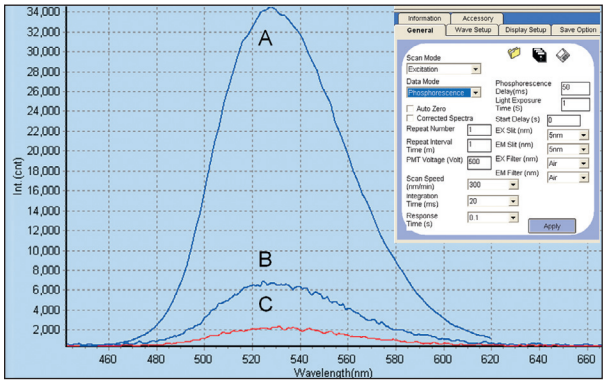

Figure 3: A) Phosphorescence spectrum from green plastic, B) Luminescence spectrum after exposure to bright room light, and C) repeat luminescence spectrum showing loss of intensity after acquiring the first spectrum

Measuring Phosphorescence Decay

The difference in the luminescence spectrum indicates that the phosphorescence signal decreases at a rapid rate after exposure to light. To study this effect we used the TimeScan application in the Luminous software. A kinetics measurement or time scan was used to measure the intensity of the phosphorescence at 527 nm. Data was collected every 200 milliseconds for a 30-second total measurement time. The excitation and emission slits were set to 10 nm and 342 nm excitation light was used. The results for the two samples are shown in Figure 4.

The phosphorescence decay is very similar for the two samples even though the fluorescence spectra are different. This again indicates the same compound was added to the plastic. The final experiment in the analysis is to measure the decay curves for different light exposure times. Figure 5 shows the decay curves when the initial light exposure is reduced from 10 seconds to 0.2 seconds.

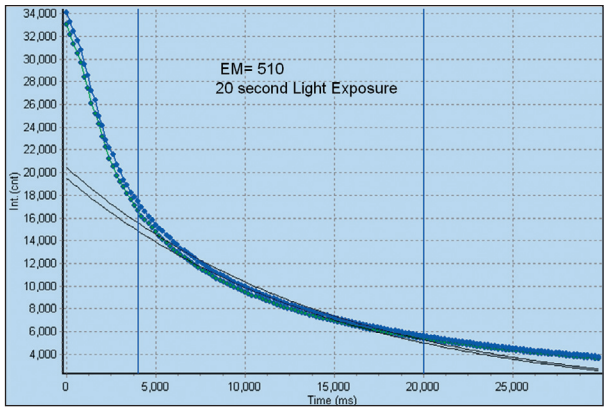

Figure 4

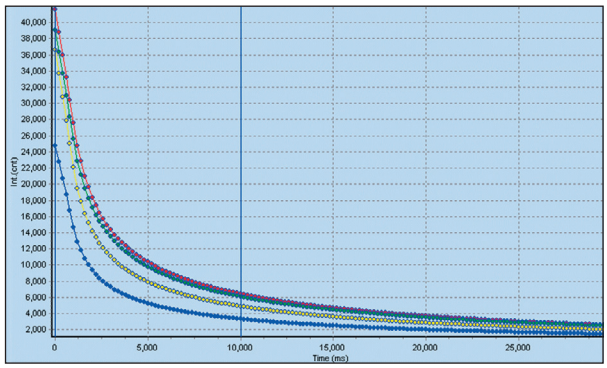

Figure 5: Phosphorescence decay with light exposure time set to 10 s, 5 s, 1 s and 0.2 s

The decay rate is similar when the sample is exposed to the source excitation the 10 second and 5 second before closing the shutter and measuring the intensity decay. Even with an exposure time of 0.2 seconds, a significant number of molecules are excited before the phosphorescence decay is measured.

Conclusions

In this study, we have employed several features of the Lumina fluorescence spectrometer and the Luminous software to characterize fluorescence and phosphorescence from solid samples. We also used the luminescence capability of the instrument to verify that the spectrum for room light excitation was similar to the spectrum acquired with the Phosphorescence data collection mode. This series of experiments provides an excellent example of the powerful hardware and software tools included with the Lumina fluorescence spectrometer.

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