Ocean Insight

Microspectrometer Measures Fluorescence of Rare Earth Salts

Application Note

KEYWORDS

- Microspectrometer
- Europium chloride
- Terbium chloride

TECHNIQUES

- Fluorescence

APPLICATIONS

- QC for EV battery production
- Feasibility testing of phosphors
- Fluorescence of solutions

The Ocean ST microspectrometer provides application flexibility without the trade-offs typical of comparable spectrometers. In this application note, we put this versatility to the test by evaluating the effectiveness of Ocean ST for measuring the fluorescence of rare earth salts.

Ocean ST is a powerful microspectrometer that provides excellent UV response, high-speed spectral acquisition, and high signal to noise ratio (SNR) performance in an ultra-compact footprint. Unlike comparable microspectrometers, Ocean ST is versatile enough for applications ranging from absorbance of DNA/RNA samples and color measurement to fluorescence of chemical compounds and plasma monitoring.

About Rare Earth Salts

Rare earth salts including Europium chloride ($EuCl_3$), Terbium chloride ($TbCl_3$) and Samarium chloride ($SmCl_3$) are chemical compounds with myriad uses in research and industry, including in the manufacture of batteries for electric vehicles, in lighting products, and in portable electronic devices such as cell phones.

Rare earth metals and salts often are measured using expensive techniques like mass spectrometry, which may be inaccessible to some users or too complex to manage easily. In these instances, a powerful yet simple device like the Ocean ST microspectrometer provides an appealing and viable alternative.

Fluorescence of Europium Chloride ($EuCl_3$)

$EuCl_3$ is an inorganic compound used primarily in research, and its reddish glow when stimulated to fluorescence makes it attractive for use in certain lighting products.

To measure the fluorescence response of a 78 mM concentration $EuCl_3$ solution, we used an Ocean ST-VIS microspectrometer (350-810 nm) with Ocean Insight LSM LEDs (365 nm and 385 nm) and LDC-1 controller. The solution was sampled in a 1 cm quartz cuvette placed in a holder, with the LED beam positioned at 90° to the sample. Optical fibers were 400 µm diameter on the excitation side and 200 µm diameter on the collection side. With a liquid sample in a cuvette holder, a bifurcated fiber also could have been used.

An advantage of a modular spectroscopy setup is that one can easily swap out components to optimize measurements. For example, in these measurements we tested both 365 nm and 385 nm excitation wavelengths to compare the emission response for each, and then applied boxcar averaging at different averages to the results. Because we did not use a blocking filter in our setup, there is some bleed-over of the excitation band in our results, but it's far enough away from the analytical peaks to not be a factor **(Figure 1)**.

Boxcar smoothing is a technique that averages a group of adjacent detector elements across spectral data. The greater the boxcar width value, the smoother the data and the higher the SNR. If the value entered is too high, a loss in spectral resolution will result and peaks will become flattened. The SNR will improve by the square root of the number of pixels averaged.

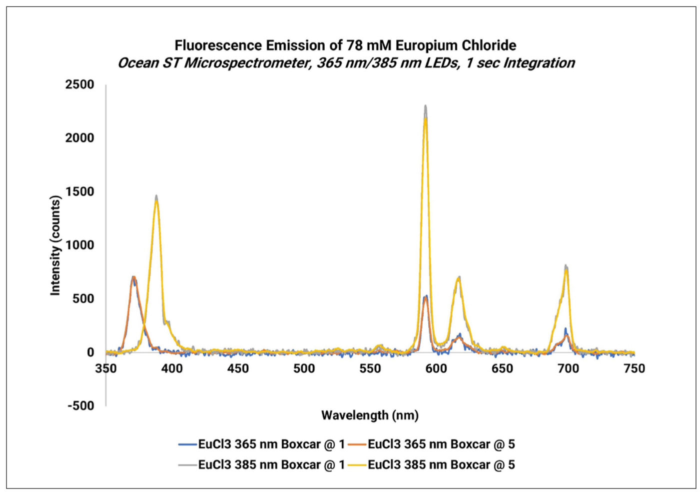

Figure 1. An Ocean ST microspectrometer measures the fluorescence response of Europium chloride. System flexibility allowed us to optimize excitation wavelengths and boxcar averaging.

Fluorescence of Terbium Chloride ($TbCl_3$)

$TbCl_3$ is a chemical compound. Its bright fluorescence (a greenish glow) makes $TbCl_3$ a desirable component of green phosphors for lighting and LCDs. Using a similar setup as described earlier, we measured the fluorescence of a 78 mM concentration $TbCl_3$ solution in a 1 cm quartz cuvette, with our focus on 365 nm LED excitation. Ocean ST-VIS integration time was set for 1 second (integration times can be set from 3.8 ms-6 s) and boxcar smoothing was applied at 1 and 5 averages. Results are shown in **Figure 2**.

Upon closer examination of the $EuCl_3$ and $TbCl_3$ spectra, you'll notice both compounds have peaks just below and above 600 nm but differ across other peaks. This is where the color differences between them come from. $EuCl_3$ has strong response at 700 nm, which produces its reddish glow, while $TbCl_3$ has two peaks in the green part of the spectrum **(Figure 3)**.

Additional Ocean ST Applications

The Ocean ST microspectrometer is an all-purpose option for various measurements. In addition to the fluorescence measurements demonstrated here, the Ocean ST is an especially good choice for these applications:

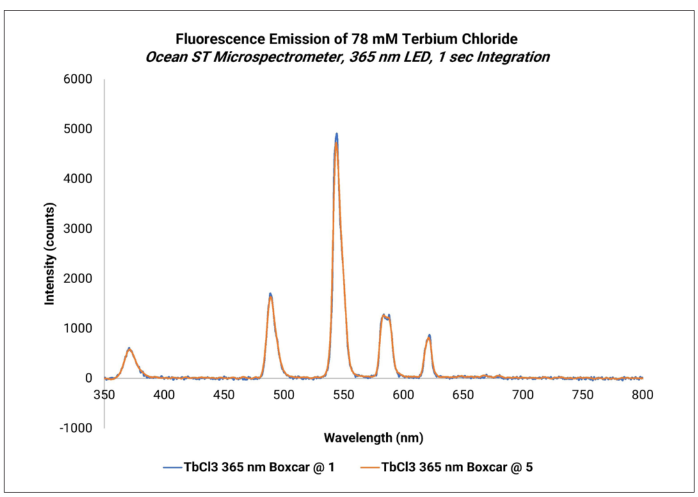

Figure 2. When excited with a 365 nm LED, the Terbium chloride solution revealed a strong fluorescence peak near 550 nm.

• Absorbance and irradiance at UV wavelengths. The Ocean ST-UV has excellent UV response (<300 nm).

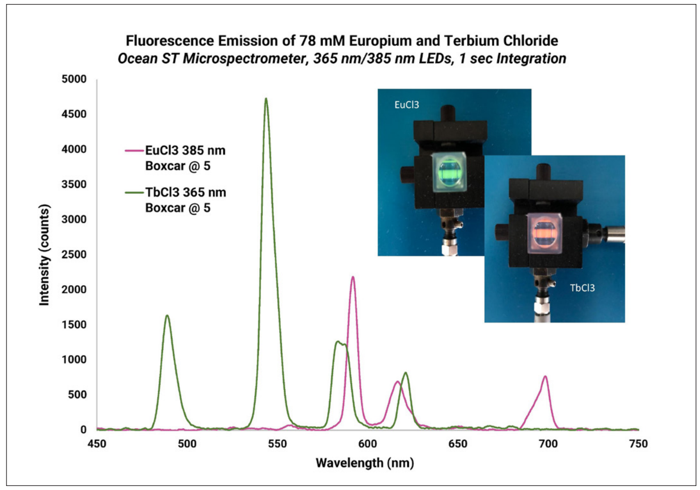

Figure 3. Differences in Europium chloride and Terbium chloride fluorescence peaks correlate to the color of each compound's emissive glow.

• Plasma monitoring. The Ocean ST-VIS has demonstrated superior response to comparable microspectrometers in a simulated plasma monitoring setup using a neon gas-discharge emission source.

• Reflection in the shortwave NIR (645-1085 nm). The Ocean ST-NIR is a convenient option for measuring the reflectance of plastics and other solid surfaces.

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