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HORIBA spectrometers are used to characterize doped glasses for photonics

Luminescence of Glasses Doped with Rare Earths for Photonic Materials

Introduction

Upconversion luminescence occurs via a multiphoton absorption process where a material absorbs several lower-energy photons, and subsequently higher-energy photons are emitted from the material. Upconversion can occur efficiently in glasses doped with rare-earth trivalent ions such as Er^{3+}, Nd^{3+}, Ho^{3+}, and Yb^{3+}. Rare-earth-doped upconversion phosphors find use in photonics because of their low cost, high stability, low toxicity, and size-independent optical properties. Applications of these phosphors may be found in fields such as solid-state lasers, fiber-optic amplifiers, medical imaging, security, and solar cells.[1,2]

Experiment

A typical photoluminescence (PL) experiment requires a high-resolution optical spectrometer with photodetectors to cover the required spectral range. In this note, we describe two different set-ups. The first uses a HORIBA 1250M spectrometer with a long focal length for spectral resolution of 0.006 nm. This unique feature affords fine wavelength separation of samples exhibiting multiple emission bands. The second uses a HORIBA iHR550 imaging spectrometer, which can be fitted with three detectors in order to cover a wide spectral range from UV to mid-IR.

PL of Oxysulfide Phosphor

At the University of Texas–San Antonio[1] a rare-earth oxysulfide phosphor, $Y_2O_2S{:}Yb^{3+}Er^{3+}$, was analyzed. A HORIBA 1250M spectrometer was set up with two detectors: an R928 photomultiplier tube for visible measurements from 200–860 nm, and a DSS-IGA020L InGaAs photodiode for IR measurements

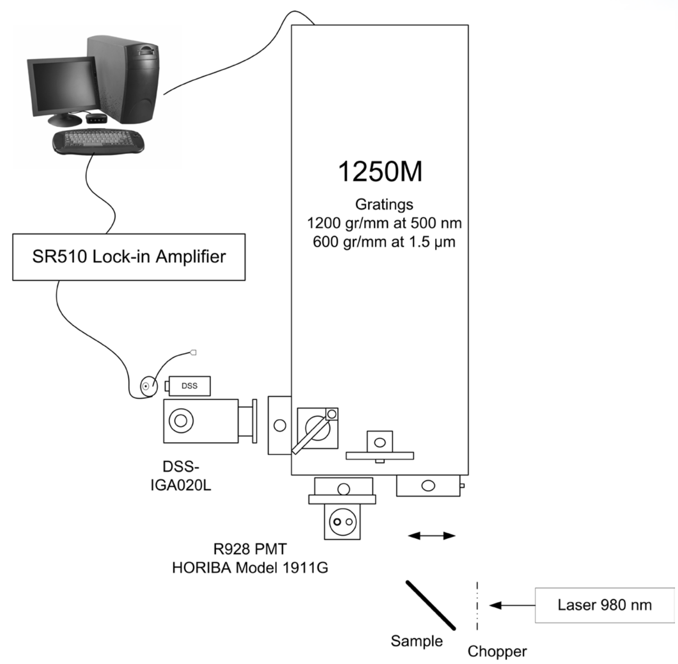

Figure 1. Typical experiment setup. A 980 nm laser excites the sample. A HORIBA 1250M spectrometer is configured with a photomultiplier tube and DSS-IGA020L InGaAs photodiode. A chopper and lock-in amplifier are used for the IR measurements.

up to 1.6 µm (Fig. 1). The system was controlled by SynerJY® software. The samples were excited at 980 nm with a 20 mW laser. Fig. 2 shows the IR emission spectrum, and Fig. 3 shows the visible (upconversion) emission spectrum. Simplified energy-level diagrams are shown in both Figures.

PL of Erbium-Doped Glass

The State Key Laboratory of Advanced Optical Communication Systems and Networks at Peking University[3] used a HORIBA iHR550 spectrometer to characterize Er-doped

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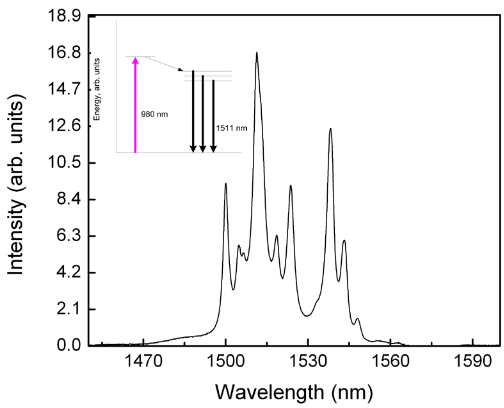

Fig. 2. Infrared emission spectrum of $Y_2O_2S{:}Yb^{3+}Er^{3+}$ phosphor under 980 nm laser excitation. Left inset shows simplified energy-level diagram.

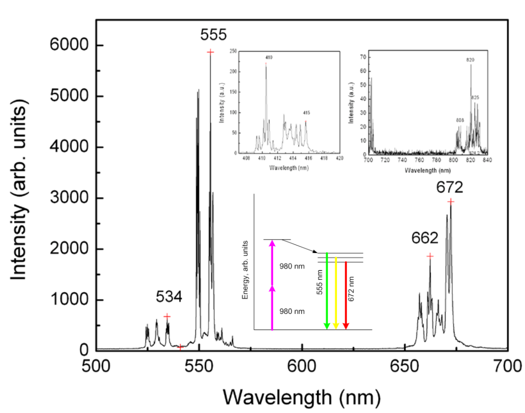

Fig. 3. Upconversion emission spectrum of $Y_2O_2S{:}Yb^{3+}Er^{3+}$ phosphor under 980 nm laser excitation. Center inset shows a simplified energy level diagram.

waveguide amplifiers (EDWAs). EDWAs are made of silicate glass doped with combinations of Er^{3+} and other rare-earth ions. The goal was to find another rare-earth dopant for silicate glass to favor red upconversion luminescence and suppress green upconversion luminescence in the EDWA. A 1480 nm laser was used for excitation.

Both Y and Yb were tested as potential dopants. In the IR luminescence spectrum, there were small differences between the spectra of the Er/Y and Er/Yb materials. In the upconversion spectrum the comparison between the two materials is much more pronounced. Both green and red peaks appear in the spectrum of the Er/Y material, but in the spectrum of the Er/Yb material, the green emission near 550 nm is almost totally suppressed while the red upconversion centered near 660 nm is favored (Table 1). A model was developed to explain these results.

Peak	Er/Y	Er/Yb
410 nm	+	–
524 nm	+	–
550 nm	+	–
660 nm	+	+

Table 1. Upconversion spectra for Er/Y and Er/Yb silicate glass. Excitation is with a 274 mW 1480 nm laser.

Conclusions

Selection of appropriate rare-earth dopants for optical glass can optimize the optical emission properties according to the specific application requirement. HORIBA photoluminescence systems are ideal candidates to characterize accurately materials doped with rare earths, because of their optimal optical design, high sensitivity, spectral resolution, and broad spectral range.

References

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3. R. Guo, B. Wang, X. Wang, L. Wang, L. Jiang, and Z. Zhou, *Opt. Mat.* **35**(5) 2013, 935–939.

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