

Near-IR System for Nanophotonics OSD-106

ELEMENTAL ANALYSIS
FLUORESCENCE
GRATINGS & OEM SPECTROMETERS
OPTICAL COMPONENTS
FORENSICS
PARTICLE CHARACTERIZATION
RAMAN
SPECTROSCOPIC ELLIPSOMETRY
SPR IMAGING

Observe fluorescence from nanopowders

Introduction

Nanophotonics is one of the most exciting new fields to come out of nanotechnology. The quantum-confinement effects observed in these very small (~10 nm) particles can lead to unique optical properties. Rare-earth (RE) doped materials are particularly of interest due to their fluorescence emissions in the visible and infrared regions of the spectrum. There is an interest in examining the effects of particle size on the fluorescence properties of RE-doped nanopowders, for the optical characteristics of RE ions are strongly influenced by their local bonding. Because most photonic devices require these powders be incorporated into a host matrix (i.e., polymer, glass, solvent), there is a need to investigate the emission properties in different host materials. A fully-integrated HORIBA Scientific spectroscopy system (sample chamber, TRIAX550 monochromator, detectors) was employed to study the effects of different solvents on RE-doped nanopowders

Experimental setup

Optically-active, RE-doped nanopowders containing the rare-earth ions (Er^{3+} , Yb^{3+}) were synthesized with several dopant concentrations. The powders were first analyzed out-of-solution in order to obtain the as-prepared fluorescence characteristics. This was done by placing a small amount of powder between two glass slides. Measurements were made in reflectance mode using the SampleMax Solid-State Sample Holder (600 gr/mm grating blazed at 1.5 μm) with the sample placed approximately 45° off the entrance-slit focal axis. Solid-state laser diodes or a Ti:Sapphire ring laser were used to pump the absorption bands of the RE-doped nanopowders. Fluorescence was measured using HORIBA Scientific thermoelectrically cooled InGaAs and PbS detectors, with the output sent directly to a Stanford Research SR850 lock-in amplifier (using the integrated optical chopper for beam modulation).

Subsequently, dilute solutions containing various solvents (methanol, ethanol, and cyclohexane) were prepared for in-solution measurements. The samples were placed in cuvettes, then placed into the SampleMax rotating turret for fluorescence measurement.

Results

The fluorescence emissions of the nanopowder/alcohol solutions, even in the most dilute samples, were accurately measured with the constructed system. The high resolution of the system allowed examination of the effects of the host matrix on the emission characteristics of the RE-doped nanopowders (refer to spectra on page 2). Small shifts in fluorescence peaks are normally

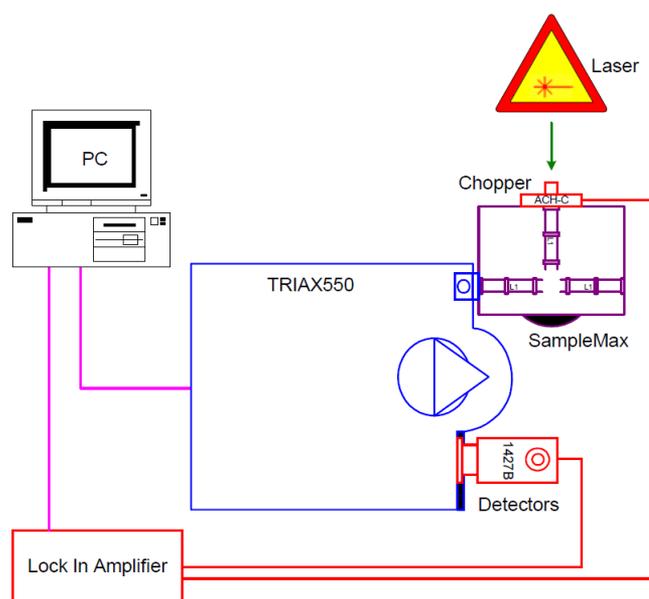


Figure 1. Experimental setup.



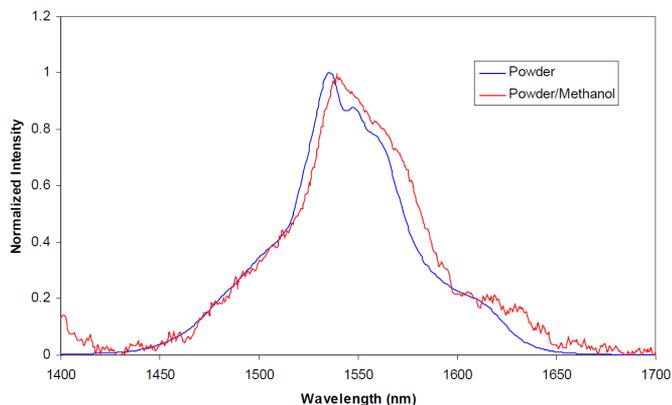


Figure 2. Spectra collected with HORIBA Scientific thermoelectrically cooled InGaAs detector.

very difficult to see with noisier (lower-intensity) signals like the dilute powder/methanol solution. However, given the sensitivity of the HORIBA Scientific system, small shifts were easily observed.

Conclusions

The HORIBA Scientific TRIAX550 coupled with the solid-state laser diodes proved valuable to the successful observation of the effects of solvents on RE-doped nanopowders. This high-resolution fluorescence system experienced minimal noise, allowing effective data collection and analysis. The ability to measure liquids, powders, bulk glasses, and thin films in a matter of minutes was found to dramatically increase productivity. The ability to quickly interchange detectors eliminated the need for lengthy alignment procedures when monitoring materials which have emissions across a broad range of wavelengths.

HORIBA Scientific components	Part number
TRIAX550 monochromator	TRIAX500
Solid-State Detector Interface	1427B
InGaAs detector, thermoelectrically cooled (800–1650 nm)	DSS-IGA020T
PbS detector, thermoelectrically cooled (1000–3000 nm)	DSS-PBS020T
Si detector, ambient temperature (200–1100 nm)	DSS-S025A
SampleMax, Visible	ASC-VIS
Sample Compartment Turret	ASC-STUR
SampleMax Optical Rail	ASC-ORAIL
SampleMax Solid-Sample Holder	ASC-SSOL
Chopper	ACH-C
Lock-in amplifier	SR850
Cable for silicon detector ± 15 V	CCA-LKDS

Acknowledgements

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