HORIBA
Scientific

NIR System for Nanophotonics

OSD-AN-106

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

Examine effects of particle size on RE-doped nanopowders

Introduction

Nanophotonics is one of the most exciting new fields to come out of nanotechnology. The quantum confinement effects implicit 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 as the optical characteristics of RE ions are strongly influenced by their local bonding. Since 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 spectroscopy system (sample chamber, iHR550 monochromator and detectors) was employed to study the effects of different solvents.

Experimental Setup

Optically-active nanopowders containing the rare-earth ions Er^{3+} and 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 done in reflectance mode using the SampleMax Solid State Sample Holder with the sample approximately 45° off the entrance slit focal axis. A 600g/mm grating was used on the iHR550. Solid-state laser diodes or a Ti:Sapphire ring laser were used to pump the absorption bands of the RE-doped nanoparticles. Fluorescence was measured using HORIBA TE-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 measurements. The experimental setup is shown in Figure 1.

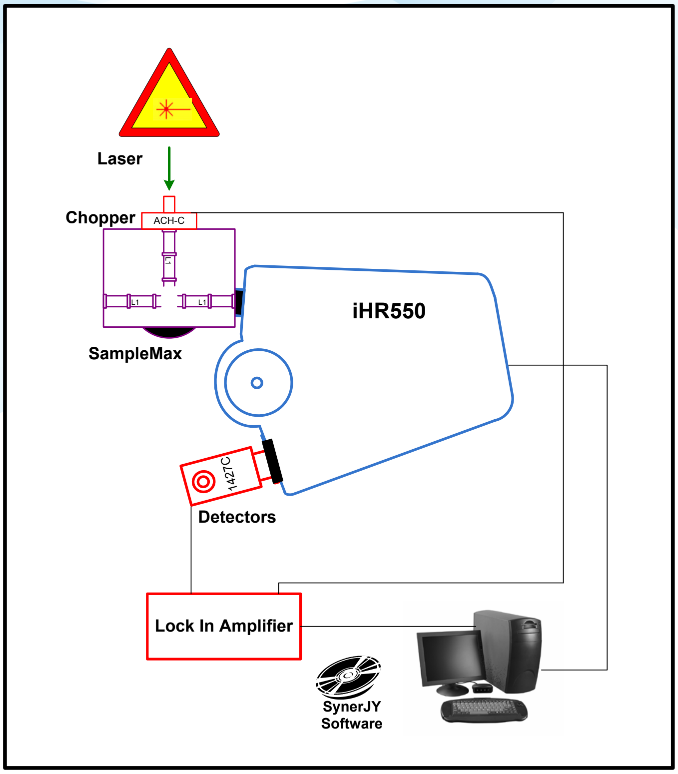

Figure 1. HORIBA Spectroscopy system with iHR550 spectrometer, SampleMax sample compartment and detectors.

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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 for examination of the effects of the host matrix on the emission characteristics of the RE-doped nanopowders (see Figure 2). Small shifts in fluorescence peaks are normally very difficult to see with noisier (lower intensity) signals like the dilute powder/methanol solution. However, due to the sensitivity of the HORIBA system, small shifts were easily observed.

Conclusions

The HORIBA iHR550 system with 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 for effective data collection and analysis. The ability to measure liquids, powders, bulk glasses, and thin films in a matter of minutes was found to drastically increase productivity. The ability to quickly interchange detectors eliminated the need for lengthy alignment procedures while monitoring materials with emissions across a broad range of wavelengths.

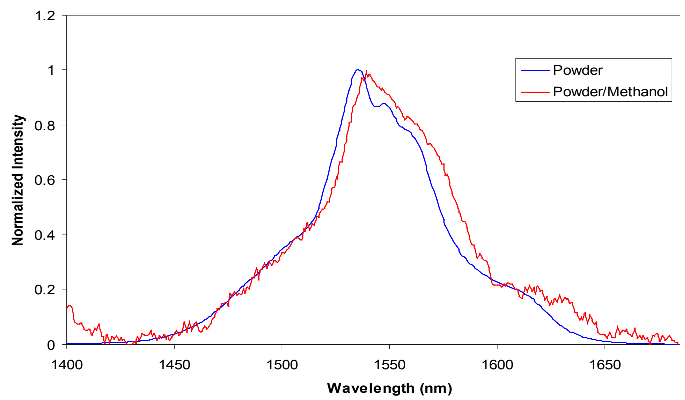

Figure 2. Fluorescence spectra of powder and powder in methanol solution collected with Horiba TE cooled InGaAs detector.

HORIBA Components	Gratings	HORIBA Part Number
iHR 550 Imaging Spectrometer		iHR550
	1200 gr/mm x 500 mn	510-07-141
	900 gr/mm x 850 mn	530-66-141
	600 gr/mm x 1.5 mn	510-16-141
Solid State Detector Interface		1427C
Detector, InGaAs, TE-Cooled (800 - 1650 nm)		DSS-IGA020T
Detector, PbS, TE-Cooled (1000 - 3000 nm)		DSS-PBS020T
Detector, Silicon, Ambient (200 - 1100 nm)		DSS-S025A
SampleMax, Visible		ASC-VIS
SampleMax, Turret		ASC-STUR
SampleMax Optical Rail		ASC-ORAIL
SampleMax Solid Sample Holder		ASC-SSOL
Optical Chopper		ACH-C
Lock-in Amplifier		SR850
Software		SynerJY

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