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To Whom It May Concern

An Upconversion Kit with 980 CW Laser [1 No, Includes CW 980 nm laser (0-2W) with modulation option mounted to front of Fluoromax sample compartment, includes hot mirror] will be procured under Board of Research in Nuclear Sciences (BRNS), Govt of India sponsored research project entitled “**Exploration of soft chemistry to tune phosphors for energy applications**” sanctioned to **Dr. Pushpal Ghosh**, Department of Chemistry. This upconversion Laser will be mounted or work as an attachment to the already existing Spectrofluorometer (Fluoromax-4 Spectrofluorometer) installed at Principal Investigator’s (PI) laboratory in the Department of Chemistry of Dr Harisingh Gour Vishwavidyalaya (A Central University), Sagar, M.P. (Picture is attached). This spectrofluorometer is manufactured by HORIBA Instruments Incorporated, 20 Knightsbridge Road, Piscataway, NJ 08854-3913, United States of America (USA).



The interested vendors/suppliers of the above said 980 Laser system are requested to send the quotation along with detailed specifications and proprietary certificate (if any) to the PI either by email (pghosh@dhsgsu.edu.in) or by post latest by **14/10/2023**. A technical note of the intended Laser System is also attached here with. Maximum fund could be available for purchasing, installation and Customs duty, etc. of the intended Laser system is ~Rs.1000000/- (~Ten Lakhs Only) from the “Equipment” Head of the BRNS sponsored project.

Dr. Pushpal Ghosh, Assistant Professor, [Recipient of **Alexander von Humboldt Fellowship**]
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Dr Harisingh Gour Vishwavidyalaya (A Central University), Sagar, M.P.

Measuring PL Upconversion Spectra and Lifetimes of Lanthanide-Doped Nanoparticles

ELEMENTAL ANALYSIS

FLUORESCENCE

GRATINGS & OEM SPECTROMETERS

OPTICAL COMPONENTS

FORENSICS

PARTICLE CHARACTERIZATION

R A M A N

SPECTROSCOPIC ELLIPSOMETRY

SPR IMAGING

Fluorescence Upconversion Laser Accessories:

FL-LAS-980 and QM-LAS-980

FL-40

Introduction

Upconverting lanthanide-based nanomaterials exhibit a unique fluorescence anti-Stokes shift, which enables them to convert NIR wavelength excitation into visible shorter wavelength emissions (NIR to UV-Vis). Applications utilizing these light energy upconverters have been growing rapidly and include bioimaging, biosensing, solid-state lasers, photo-controlled delivery, photodynamic therapy, to name a few. Among various rare earth ions, trivalent erbium seems to be one of the most attractive choices due to its rich energy level structure which provides several potential emission channels in the short-wavelength part of the spectrum, including the most demanded green and blue regions.

Experiment and Results

The Er^{3+} doped nanoparticles in hexane were excited using a cw DPSS laser with 980 nm output set at 1W (user adjustable). The laser was mounted to the front of a plug-in sample drawer assembly for the Fluorolog-3 spectrofluorometer with an electronic laser safety interlock, replacing the standard Fluorolog-3 sample compartment.

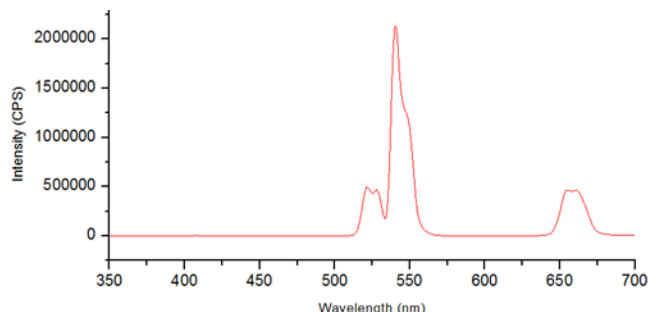


Figure 1: Steady state upconversion emission spectrum of Er^{3+} doped nanoparticles exhibiting 3 prominent peaks at 522, 540 and 661 nm.

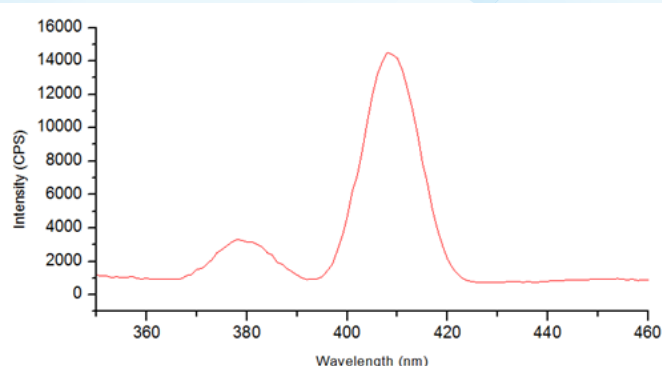


Figure 2: Shows two weak PL upconversion peaks of Er^{3+} doped nanoparticles in hexane with maxima at 378 and 408 nm recorded in the weak UV-blue spectral region measured with 10 nm slits.

The same DPSS laser can be conveniently used to measure PL upconversion lifetimes. By using a TTL trigger from the DeltaHub TCSPC electronic module, operating in the MCS mode, the laser can be set to a pulsed operation with the pulse position, duration and repetition rate under software control.

Figures 3, 4 and 5 show upconversion decays measured with the use of the DeltaTime kit for the 980 nm laser at three upconversion bands. The decays at 522 and 540 nm were fitted with a 3-exponential function resulting in one risetime and two lifetimes, while the decay at 657 nm was fitted with a 2-exponential function yielding one risetime and one lifetime (Table 1). The presence of the risetimes indicates that the emitting states are not directly populated by the excitation pulse, but are reached by a nonradiative relaxation from a higher excited state.

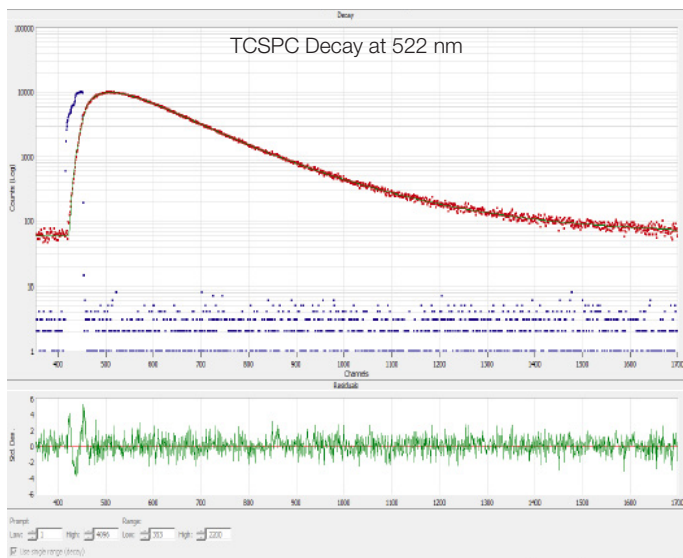


Figure 3: Upconversion PL decay at $\text{em} = 522 \text{ nm}$ excited with the 980nm laser operating in the pulse mode. The decay analysis required a 3-exponential fitting function resulting in 2 lifetimes and 1 risetime (see Table 1 below). The negative pre-exponential factor represents the risetime.

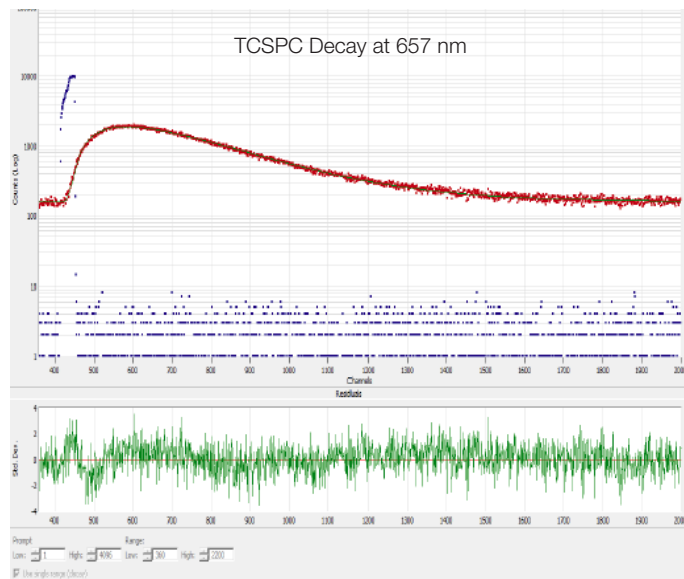


Figure 5: Upconversion PL decay at $\text{em} = 657 \text{ nm}$ excited with the 980nm laser operating in the pulse mode. The decay analysis required a 2-exponential fitting function resulting in 1 lifetime and 1 risetime (see Table 1 below). The negative pre-exponential factor represents the risetime.

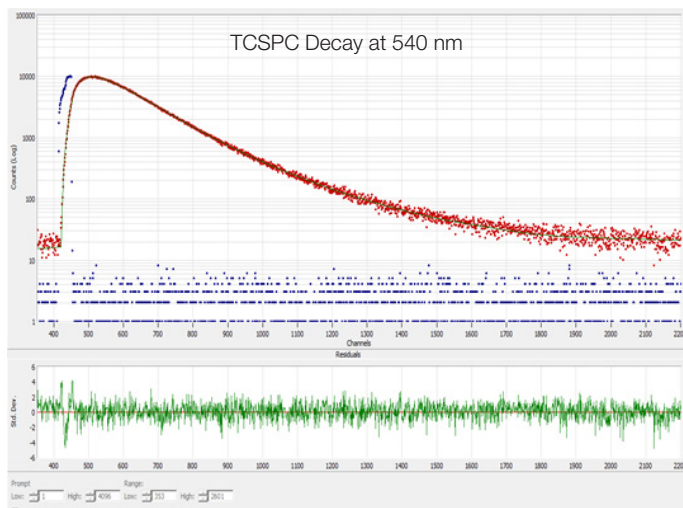


Figure 4: Upconversion PL decay at $\text{em} = 540 \text{ nm}$ excited with the 980nm laser operating in the pulse mode. The decay analysis required a 3-exponential fitting function resulting in 2 lifetimes and 1 risetime (see Table 1). The negative pre-exponential factor represents the risetime.

Table 1: Lifetimes and pre-exponential factors

$\lambda_{\text{em}}/\text{nm}$	T1/ μs	T2/ μs	T3/ μs	B1	B2	B3	Chi-square
522	124.1	265.1	64.7	0.45	0.07	-0.48	1.21
540	130.3	283.7	64.00	0.46	0.06	-0.48	1.19
657	260.9	136.9	-	0.50	-0.50	-	1.20

Conclusion

The Fluorolog-3 equipped with the 980 nm DPSS laser upconversion accessory is a powerful and convenient tool to study photoluminescence of upconverting nanomaterials. It can provide complementary spectral and lifetime information which is critical to fully characterize the photophysical mechanism and efficiency of these materials.

Instrument: Fluorolog 3-22
Accessories: DT-980L-FL; DeltaTime kit for 980 nm laser
 FL-LAS-980 – upconversion nm laser accessory
Experimental Conditions:
 Ex = 980 nm
 Em = 350–700 nm
 Solvent: n-hexane
Experiment Type: Upconversion emission spectra
 Upconversion lifetimes

These experiments can also be performed with the PTI QuantaMaster 8000 Series fluorometer equipped with the QM-LAS-980 upconversion accessory.



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