



## Bispectral Fluorescence Test Report

Test results reported for:

Sample #

# SAMPLE

CSA Group report:

LEDC001-010

# REPORT

Original issue date:

21-Mar-2016

# ONLY

Prepared for:

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Test report prepared by:

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Test and Measurement Services

Test report approved by:

Laboratory Manager,  
Test and Measurement Services

## 1.0 Description of test sample

CSA test sample identification: Sample name	Manufacturer specifications:
Manufacturer: Manufacturer name Part number: Sample # Serial Number: COMY000-# Description: Test sample description	Substrate: Clear plastic Absorption $\lambda_{MAX}$ (nm): 450 Fluorescence $\lambda_{MAX}$ (nm): 600 Description: LED remote phosphor

## 2.0 Scope of testing

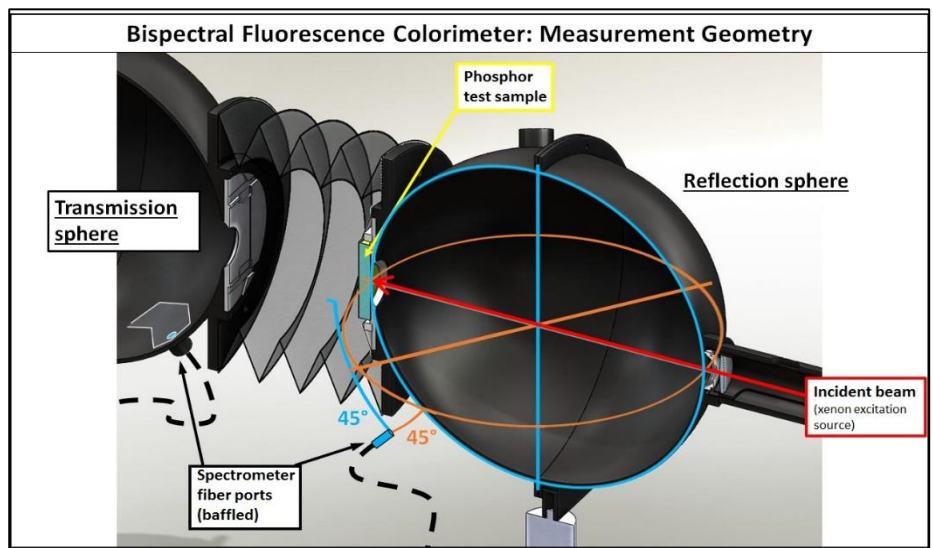
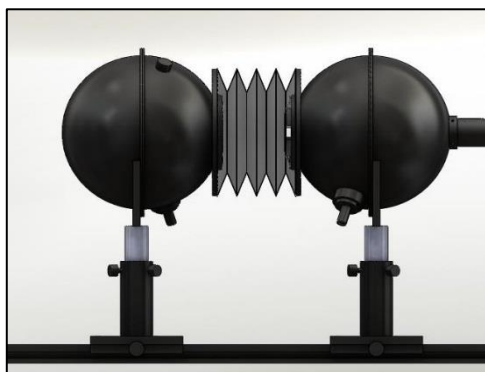
Bispectral fluorescence testing for reflection, transmission, and emission spectra using a two-sphere, reflection/transmission bispectral fluorescence colorimeter.

### 2.1 Test protocol and data reduction

Sample is irradiated with monochromatic, collimated light from 380 - 830nm, in 10nm steps. Average radiometric power incident upon the test sample at each 10nm step is on the order of  $1\mu W$ . Spectral bandwidth at each monochromator step (incident wavelength) is 5nm, FWHM. All viewing wavelengths are measured simultaneously for Rx and Tx at each 10nm excitation step.

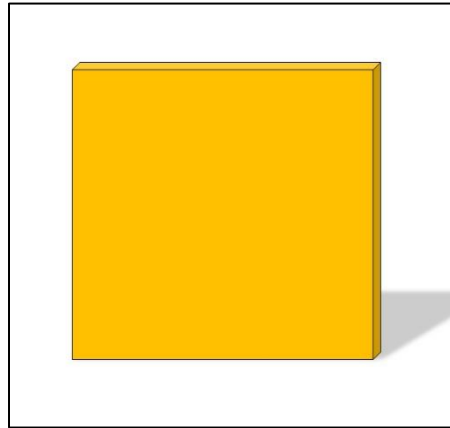
Data is generated in the form of a 46 x 46 entry matrix containing the Donaldson radiance factor for the relevant excited/measured wavelengths in each cell. Noise is removed from the measurement by manually isolating the measured spectra and removing the non-zero values found outside the measured spectrum. Spectral measurements at each excitation step are taken with a 1nm resolution prior to Donaldson factor calculation. The Donaldson calculation uses a wavelength bin of 10nm to calculate radiance factor.

### 2.2 Bispectral fluorescence colorimeter set-up



**ABOVE, LEFT:** Drawing of the BFC dual-sphere setup with the transmission sphere at left and the reflection sphere on the right, with incident beam collimator attachment partially in image. **ABOVE, RIGHT:** BFC measurement geometry. The "accordian"-style sample baffle is shown as extended - is contracted and transmission sphere moved-up to sample during testing to catch all transmitted light.

Sample Photo:



Above: Phosphor test sample

**3.0 Results - Bispectral Fluorescence Measurements**

**Test Conditions:**

Test Date: 20-Mar-16  
 Method: Bispectral fluorescence colorimetry  
 Sphere geometry:  $2\pi$   
 Correction factors applied: Radiant flux calibration  
 Thermal:  
 Ambient Temperature (°C): 25.0  
 Ambient Humidity (%RH): <60%

**Test Results:**

Rx:

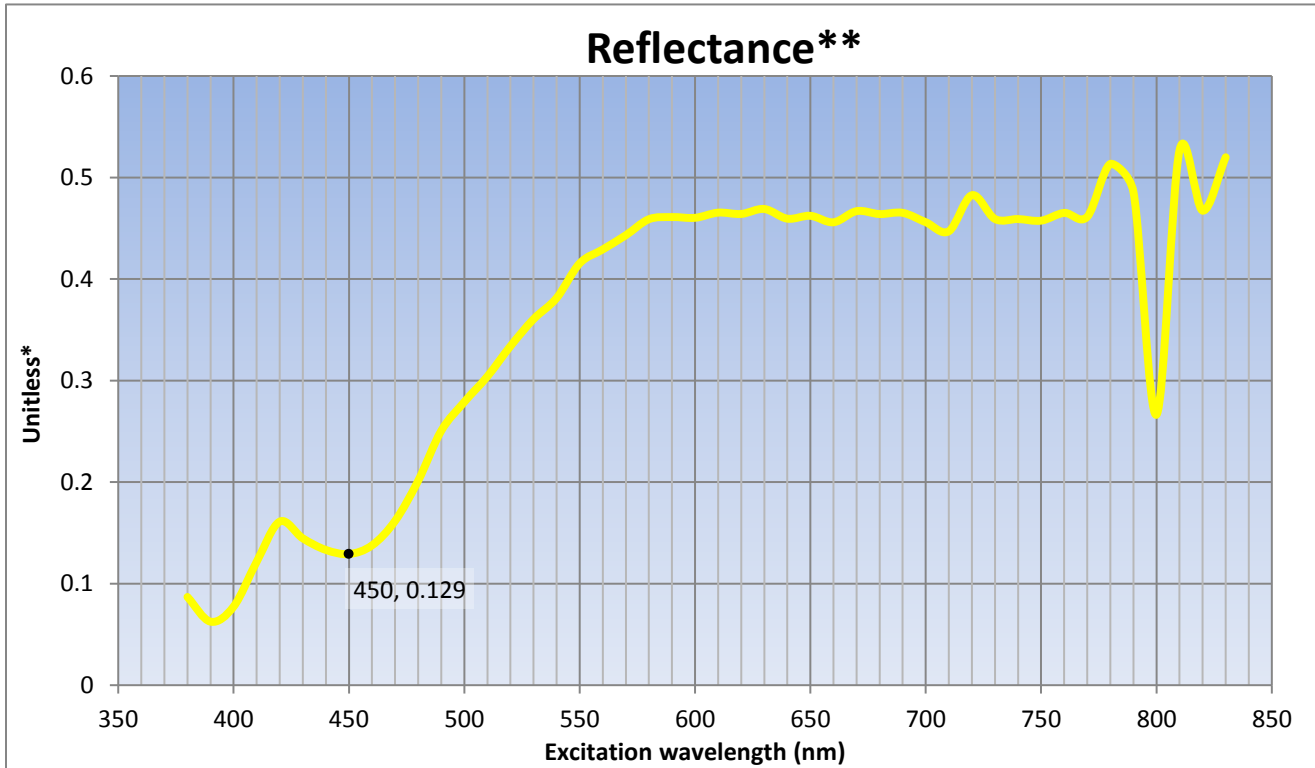
Absorption, peak (nm)	Emission, peak (nm)
450 (±5)	590 (±5)

Tx:

Absorption, peak (nm)	Emission, peak (nm)
450 (±5)	610 (±5)

**4.0 Charts & Tables - Bispectral Measurements - Donaldson Radiance Factor**

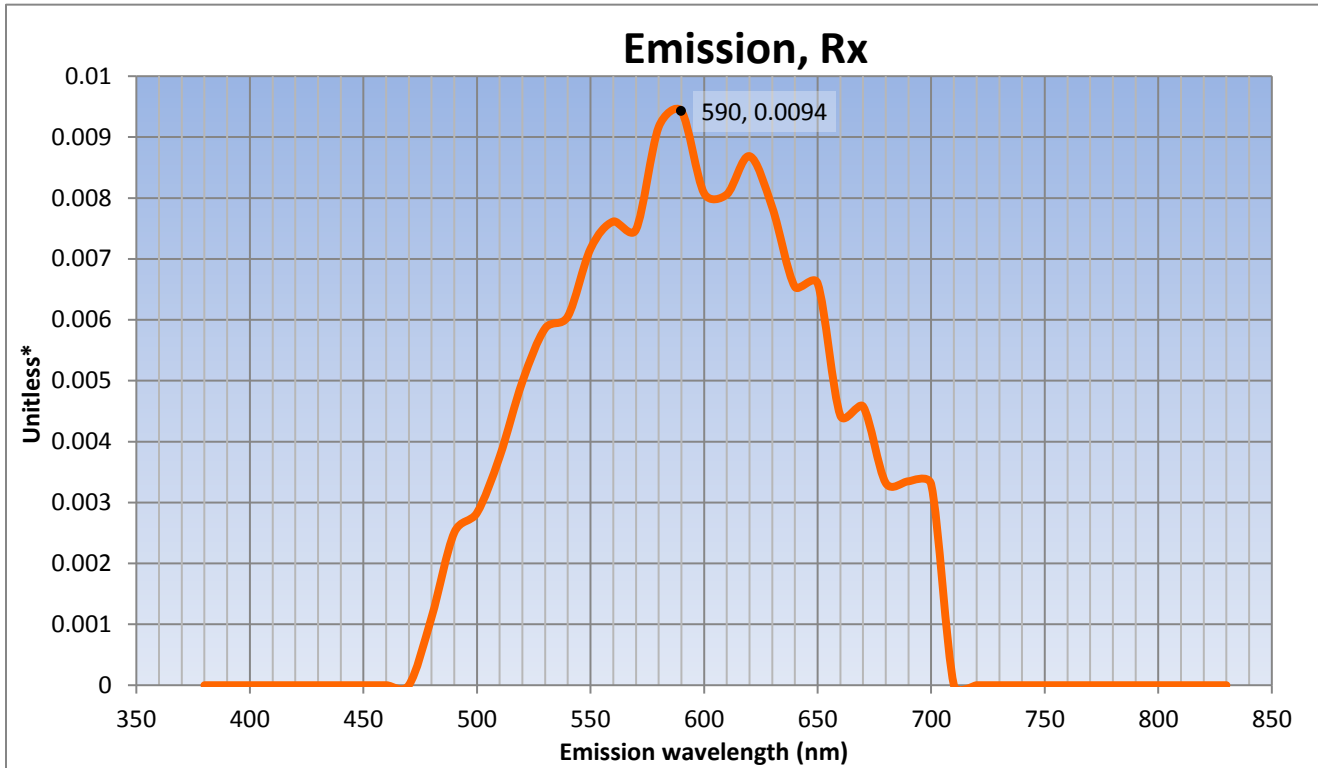
Reflectance Spectrum



Reflection Radiance Factor (unitless, wavelength in nm)

380	0.086879		540	0.381310		700	0.456000
390	0.062552		550	0.415460		710	0.447060
400	0.077418		560	0.429170		720	0.482620
410	0.121530		570	0.443180		730	0.459170
420	0.161140		580	0.458920		740	0.459120
430	0.144610		590	0.461070		750	0.457530
440	0.133210		600	0.460330		760	0.465150
450	0.129160		610	0.465410		770	0.461380
460	0.137700		620	0.464140		780	0.513460
470	0.161810		630	0.469010		790	0.486010
480	0.201370		640	0.459490		800	0.266370
490	0.250570		650	0.462300		810	0.526990
500	0.278940		660	0.455950		820	0.467350
510	0.304100		670	0.466900		830	0.520001
520	0.333940		680	0.464040			
530	0.360530		690	0.465200			

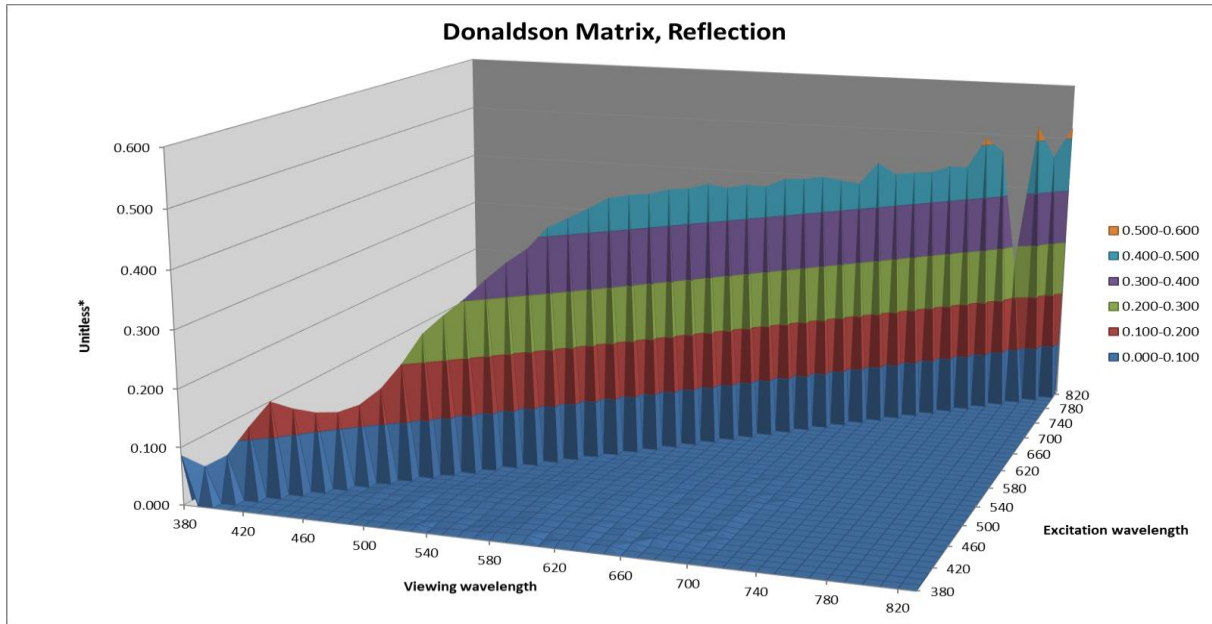
Emission Spectrum, Rx (at peak excitation wavelength)



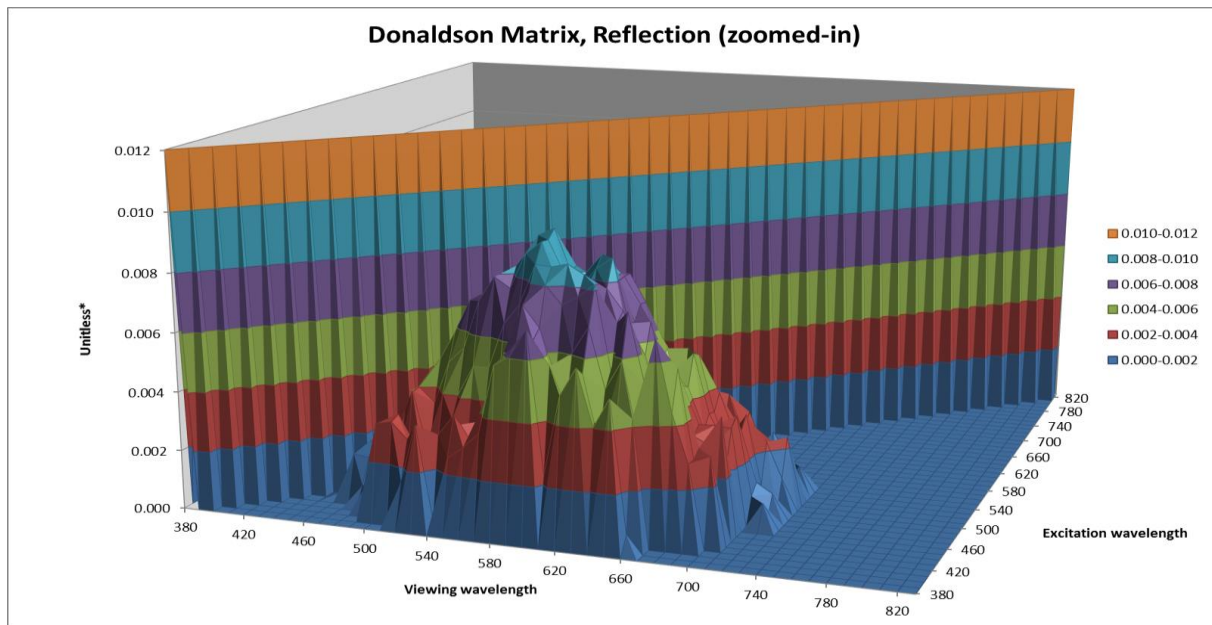
Rx Emission Radiance Factor (unitless, wavelength in nm)

380	0	540	0.006056	700	0.003296
390	0	550	0.007167	710	0
400	0	560	0.007614	720	0
410	0	570	0.007479	730	0
420	0	580	0.009165	740	0
430	0	590	0.009428	750	0
440	0	600	0.008078	760	0
450	0	610	0.008058	770	0
460	0	620	0.008687	780	0
470	0	630	0.007847	790	0
480	0.001115	640	0.006541	800	0
490	0.002506	650	0.006598	810	0
500	0.002830	660	0.004427	820	0
510	0.003754	670	0.004577	830	0
520	0.004985	680	0.003319		
530	0.005859	690	0.003348		

Donaldson Matrix for reflection



Donaldson Matrix for reflection, zoomed-in on amplitude axis

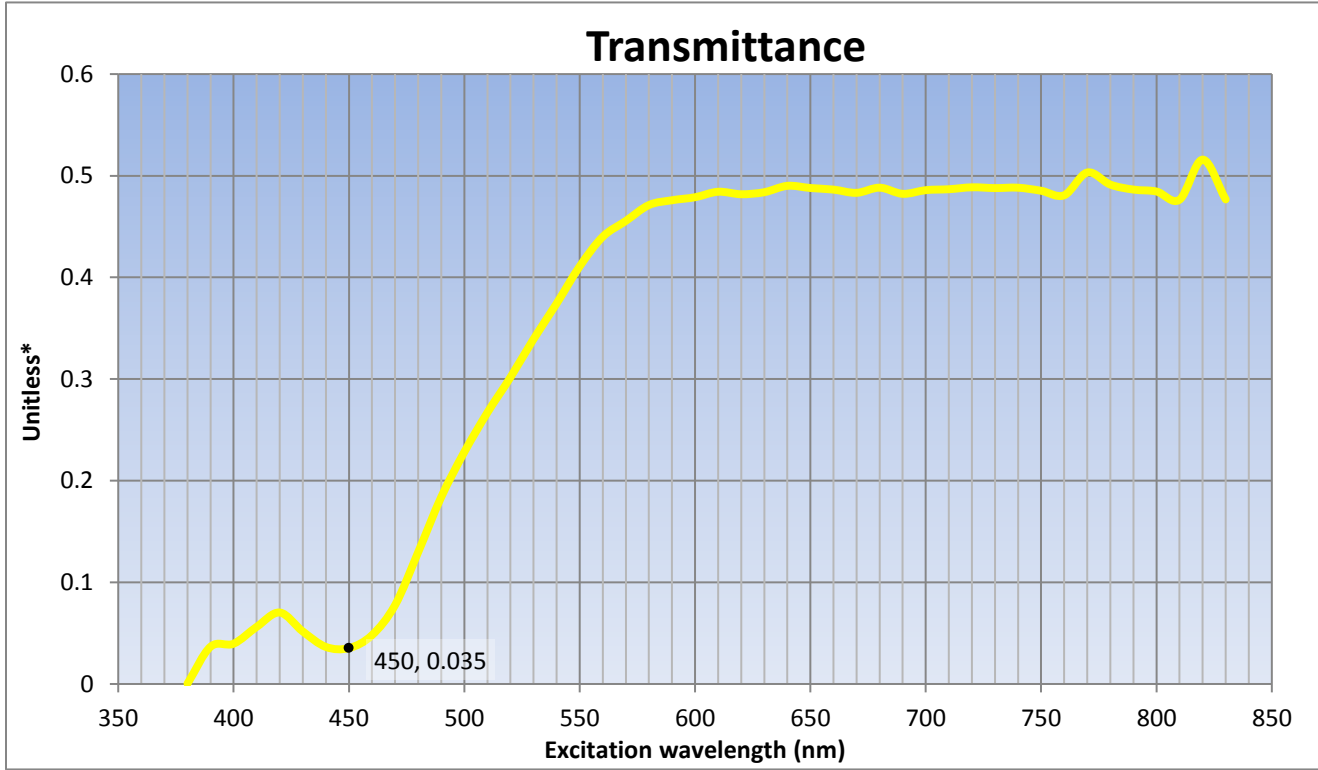


\*Spectrum amplitude is unitless, and normalized to the excitation source at each wavelength. Absolute amplitude of the reflected/transmitted/fluoresced light from a phosphor at any given time, and under any illumination conditions, will ultimately be relative to the optical density of the phosphor sample and the intensity of the excitation source which is incident upon the phosphor. Spectral data is truncated to remove the noise in the measurement apparatus.

\*\*Reflectance is measured for the sample and normalized to the reflectance of the perfect diffuse reflector (99% diffuse standard).

**4.0 Charts & Tables - Bispectral Measurements - Donaldson Radiance Factor**

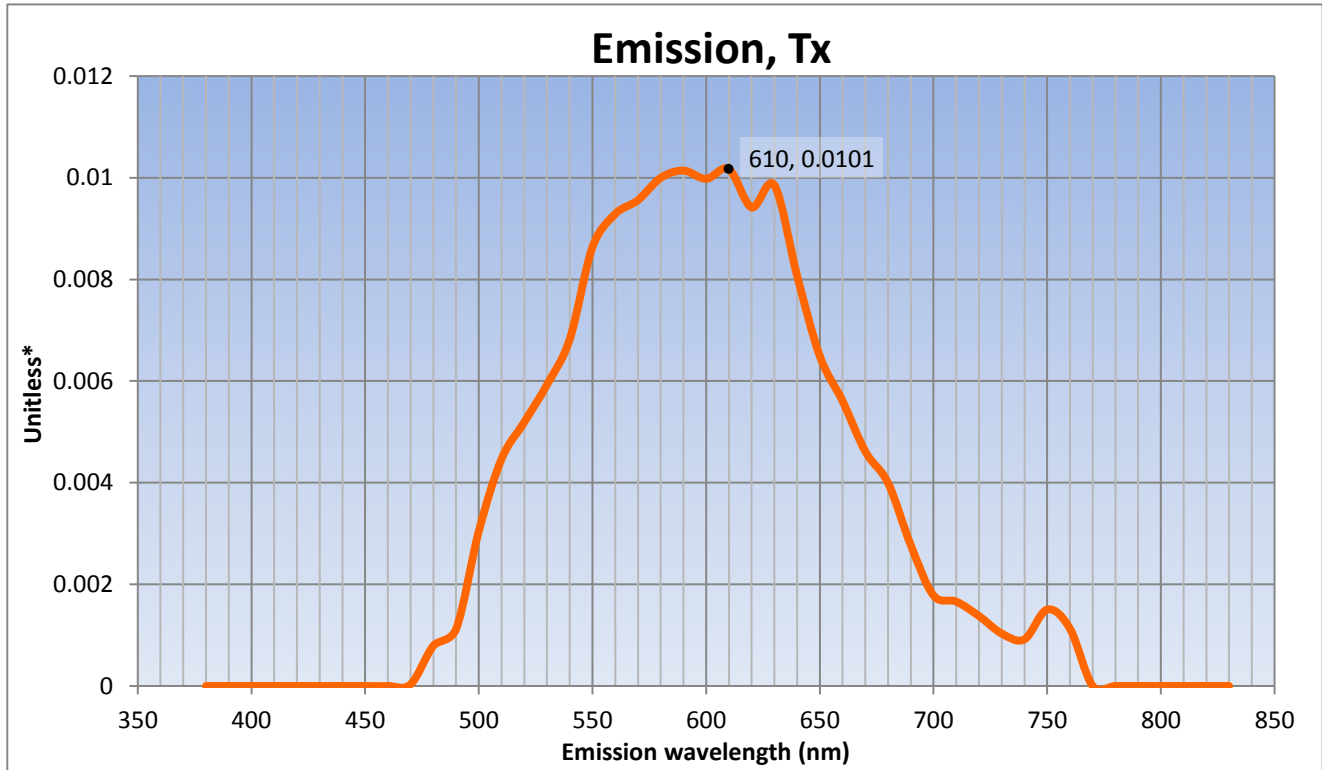
Transmittance Spectrum



Transmission Radiance Factor (unitless, wavelength in nm)

380	0.000349		540	0.374260		700	0.485810
390	0.036654		550	0.410820		710	0.486740
400	0.039660		560	0.439990		720	0.488610
410	0.056192		570	0.455530		730	0.487870
420	0.070309		580	0.471150		740	0.488220
430	0.051648		590	0.475900		750	0.485240
440	0.036451		600	0.478860		760	0.480790
450	0.035326		610	0.484250		770	0.503210
460	0.048061		620	0.481810		780	0.491290
470	0.077712		630	0.483800		790	0.486390
480	0.129680		640	0.490050		800	0.484470
490	0.183950		650	0.487930		810	0.476410
500	0.228210		660	0.486370		820	0.515870
510	0.266970		670	0.483180		830	0.476700
520	0.301720		680	0.488240			
530	0.339260		690	0.482230			

Emission Spectrum, Tx (at peak excitation wavelength)

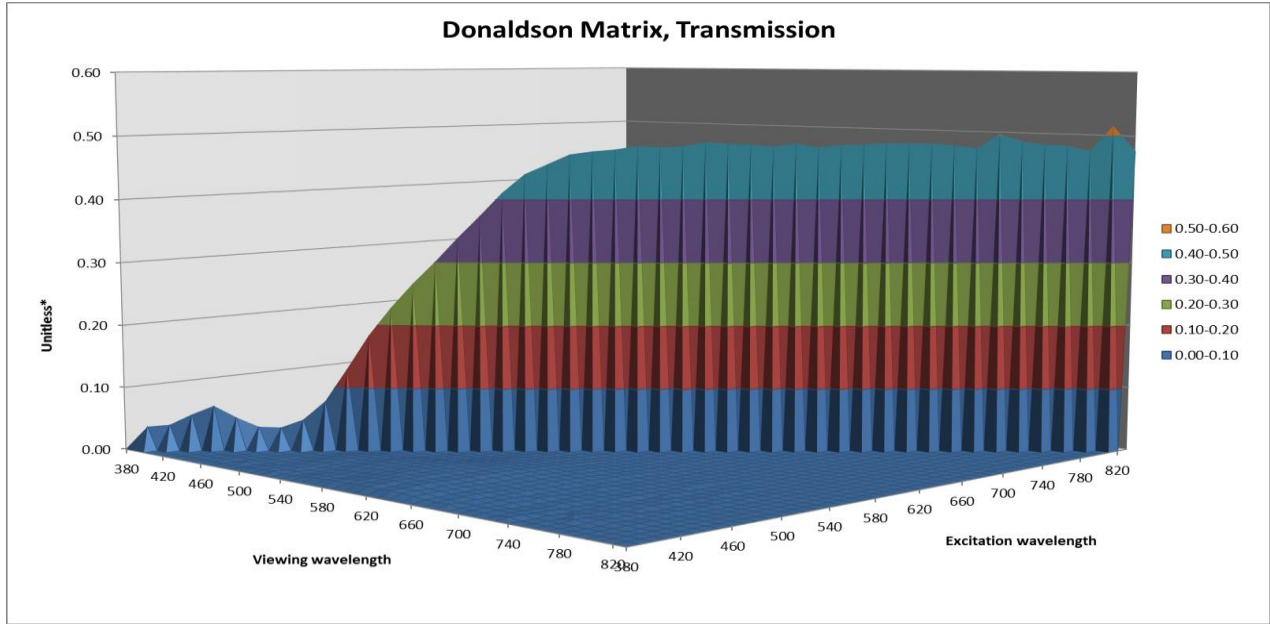


Tx Emission Radiance Factor (unitless, wavelength in nm)

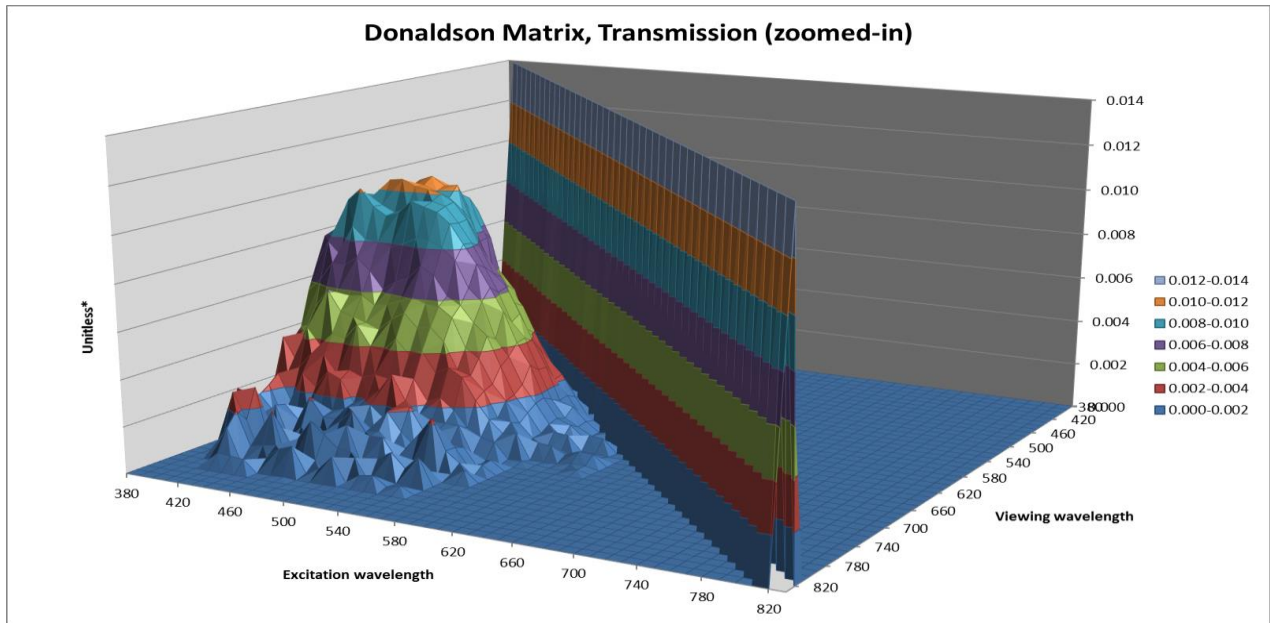
380	0	540	0.006824	700	0.001781
390	0	550	0.008636	710	0.001661
400	0	560	0.009288	720	0.001378
410	0	570	0.009558	730	0.001032
420	0	580	0.009998	740	0.000917
430	0	590	0.010141	750	0.001504
440	0	600	0.009978	760	0.001131
450	0	610	0.010168	770	0
460	0	620	0.009417	780	0
470	0.000033	630	0.009853	790	0
480	0.000791	640	0.008072	800	0
490	0.001120	650	0.006489	810	0
500	0.003045	660	0.005608	820	0
510	0.004467	670	0.004615	830	0
520	0.005190	680	0.003995		
530	0.005928	690	0.002772		



Donaldson Matrix for Transmission



Donaldson Matrix for Transmission, zoomed-in on amplitude axis



\*Spectrum amplitude is unitless, and normalized to the excitation source at each wavelength. Absolute amplitude of the reflected/transmitted/fluoresced light from a phosphor at any given time, and under any illumination conditions, will ultimately be relative to the optical density of the phosphor sample and the intensity of the excitation source which is incident upon the phosphor. Spectral data is truncated to remove the noise in the measurement apparatus.

## 5.0 Description of Reference Standards and Test Equipment

### Bispectral fluorescence colorimeter instrumentation specifics

Item	Description /use	Manufacturer	Model	Calibration due
Integrating sphere	8" diameter	Gamma Scientific	GS-IS8	at use
Spectroradiometer	optical measurements	Gamma Scientific	RadOMA GS-1290-3	at use
Monochromator	optical filtering	Princeton Instruments	SP-2150i	at use
Radiometer	calibration	Gamma Scientific	Flex Optometer S480	at use
99% diffuse reflector plaque	calibration	Avian Technologies	FWS-99-01c	at make

## 6.0 Additional Information

None

END OF REPORT