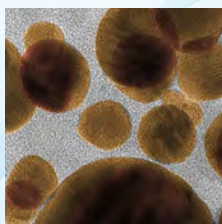
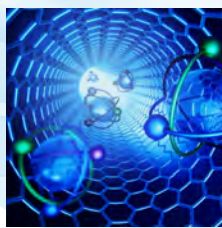
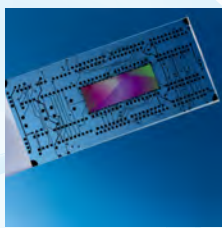
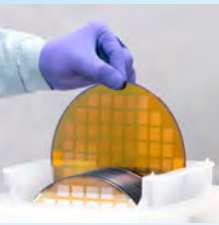


## SMS Systems

Standard Microscope Spectroscopy Systems



Modular and flexible  
performance  
without compromises

# Unique modular microspectroscopy solution

## From the Leader in Spectroscopy

The SMS series of microspectroscopy configurable solutions is the result of decades of HORIBA's experience in building microspectroscopy solutions. The SMS systems pack high performance on a modular platform, providing the ultimate flexibility in configuring microspectroscopy solutions that are uniquely suited to your needs. Their flexibility and versatility enables the affordable combination of multiple spectroscopic techniques such as Raman, Photoluminescence and Lifetime, etc., on one platform.

The SMS is built on a standard microscope! It offers the best of microscopy and spectroscopy without compromising performance for either. Its unique design decouples the spectroscopic functions from those of microscopy, enabling optimal performance for both.

The SMS comes either as a complete system including the microscope, or as an upgrade to a user's existing microscope. As an upgrade, the SMS system is compatible with any upright microscope from major microscope manufacturers, such as Olympus®, Nikon®, Zeiss® and Leica®.

Whether getting a complete system, or an upgrade to your existing microscope, you get a turnkey microspectroscopy solution that works right out of the box! Start collecting data from the first day, rather than spending months building a DIY solution.

### Key Features

- Modular, configurable microspectroscopy solutions
- Multimodal: Affordably combine multiple spectroscopies on one platform
  - Raman
  - Photoluminescence (Fluorescence)
  - Time-resolved Photoluminescence (Lifetime)
  - Absorbance & Reflectance
  - Electroluminescence
  - Darkfield Scattering Spectroscopy
  - Photocurrent
- High-end performance with no compromises!
- Industry-leading instrument control, data acquisition and processing software
- Advanced functionality, such as high speed mapping and automated XYZ stage
- Low temperature measurements down to 4K

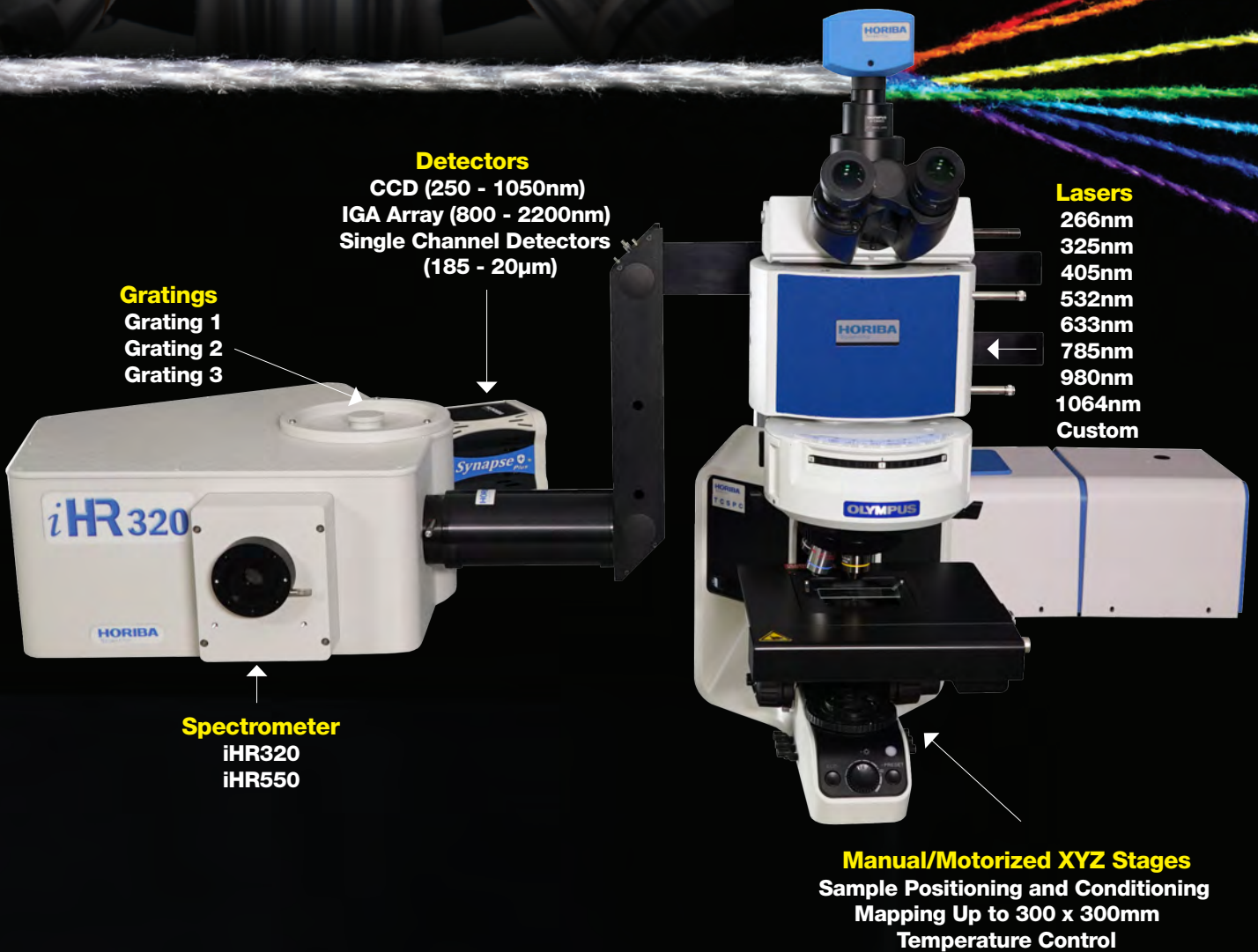
# Modular and Flexible Microspectroscopy Solution

Configure the SMS to suit your particular needs and budget.

Regardless of configuration, get a **complete turnkey solution** and start collecting data from day one!

### Turnkey options:

- Complete solution including microscope
- Upgrade to your existing microscope



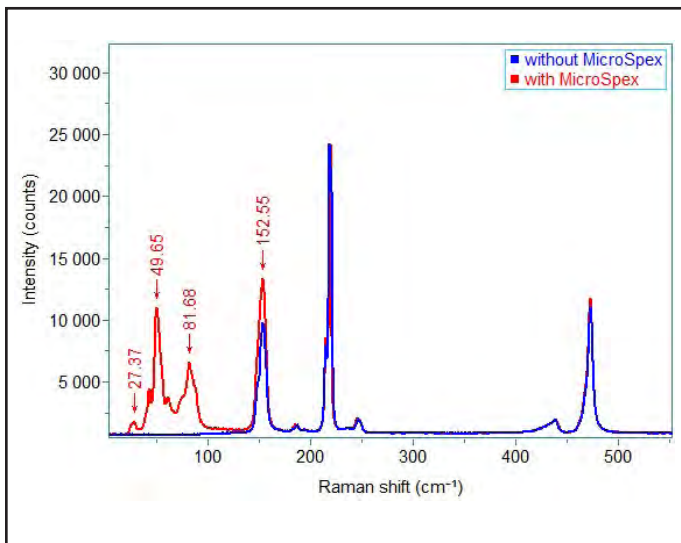
# Multiple spectroscopies on one platform

The SMS system is a multimodal platform capable of multiplexing different spectroscopic techniques on one platform.

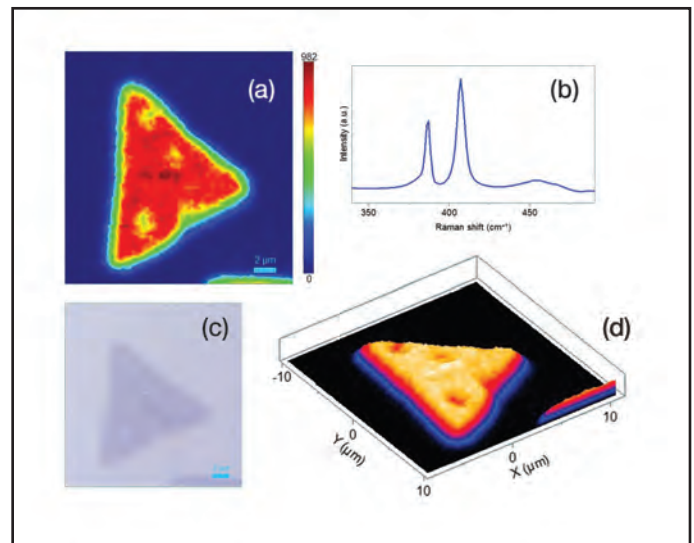
## Raman

The SMS offers high performance Raman microspectroscopy with specifications comparable to high-end benchtop systems, but with unrivaled flexibility.

- Unique design with sharp filter cut-on offers access to low wave number modes (better than  $80\text{ cm}^{-1}$  guaranteed)
- Advanced functionality, such as mapping



Raman spectra of sulfur (red) measured on SMS system.



Raman characterization of a monolayer  $\text{MoS}_2$  using 532 nm laser line (objective = 100x, spatial resolution =  $0.3\ \mu\text{m}$ ). (a) 2D image of Raman map of  $A_{1g}$  peak intensity. (b) A Raman spectrum showing sharp and intense  $E^1$  and  $A_{1g}$  peaks of  $\text{MoS}_2$  sample. (c) Optical image of the  $\text{MoS}_2$  flake. (d) 3D image of Raman map of  $A_{1g}$  peak intensity.

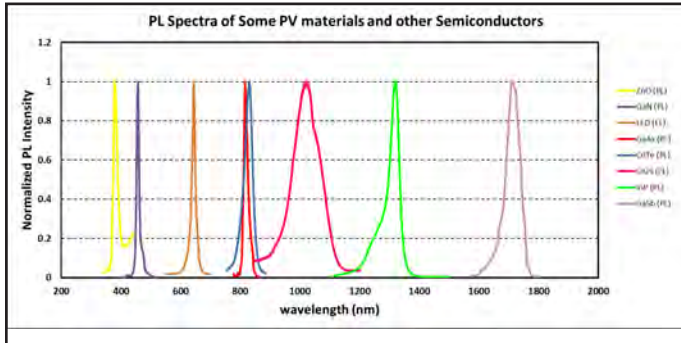
### Raman Specifications

Spectrometer and Detectors				
Spectrometers		MicroHR	iHR320	iHR550
Excitation Lasers		532 nm, 633 nm, 785 nm		
Spectral Range ( $\text{cm}^{-1}$ ) – Free space		80 – 9500 (532 nm), 80 – 6500 (633 nm), 80 – 3400 (785 nm)		
Spectral Range ( $\text{cm}^{-1}$ ) – Fiber		150 – 9500 (532 nm), 150 – 6500 (633 nm), 150 – 3400 (785 nm)		
Recommended Gratings		1800 g/mm, 1200 g/mm, 600 g/mm		
Spectral Resolution <sup>1</sup> ( $\text{cm}^{-1}$ / pixel)	405 nm	5.12	2.34	1.37
	532 nm	2.53	1.22	0.73
	633 nm	1.54	0.78	0.48
	785 nm	0.70	0.40	0.26
Microscope				
Microscope Objectives	Magnification	10X	50X	100X
	Spot Size (fiber-coupled)	< 50 $\mu\text{m}$	< 12 $\mu\text{m}$	< 6 $\mu\text{m}$
	Spot Size (free space-coupled)	< 10 $\mu\text{m}$	< 5 $\mu\text{m}$	< 2 $\mu\text{m}$
Sample Stage	XYZ (Manual and motorized options available) – 75 x 50 mm; 100 x 100 mm; 150 x 150 mm; 300 x 300 mm			
Vision Camera	Software controlled vision camera included			

<sup>1</sup> For 1800 g/mm grating and 26  $\mu\text{m}$  pixel CCD

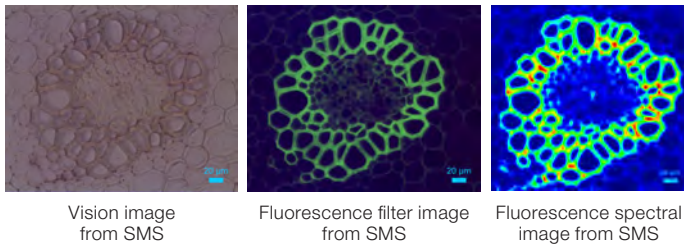
# Photoluminescence

- The SMS system uses mainly reflective optics in its design, offering a wide spectral range for both excitation (266 nm – 1064 nm) and emission (250 nm – 2200 nm)

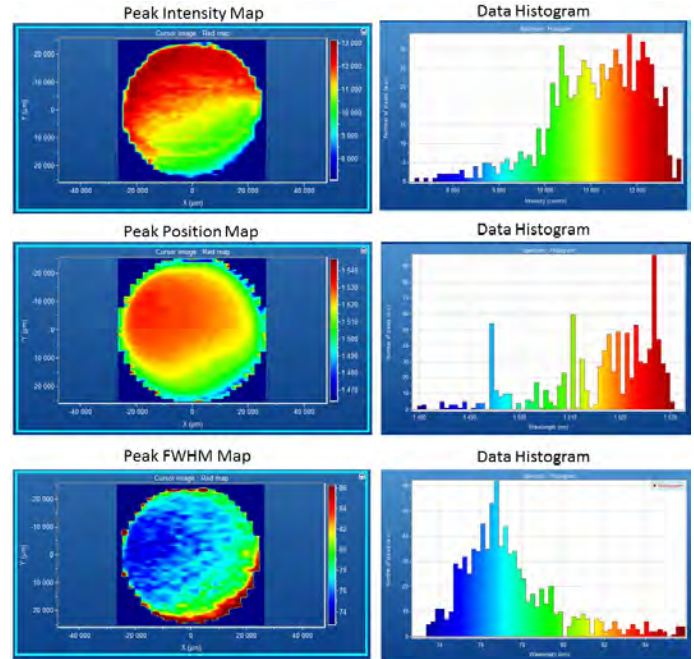


Different semiconductor materials, such as ZnO, GaN, GaAs, CdTe, CIGS, InP and GaSb characterized with an SMS system emitting photoluminescence from 200 nm to 2000 nm.

- Multiplex different techniques on one system, such as filter-based fluorescence imaging and full hyperspectral photoluminescence imaging



- Map up to 300 mm wafers



PL mapping performed on a fabricated InP device showing PL peak intensity, peak position and FWHM of the emission and its attributed histogram of the data.

## Photoluminescence Specifications

Spectrometer and Detectors				
Spectrometers	MicroHR	iHR320	iHR550	
Excitation Lasers <sup>1</sup>	266 nm, 325 nm, 405 nm, 532 nm, 633 nm, 785 nm, 980 nm, 1064 nm			
Spectral Range (nm) <sup>2</sup>	250 nm – 2200 nm			
Recommended Gratings <sup>3</sup>	1800 g/mm, 600 g/mm, 300 g/mm			
Spectral Resolution <sup>4</sup> (nm)	0.39	0.18	0.1	
Microscope				
Microscope Objectives <sup>5</sup>	Magnification	10X	50X	100X
	Spot Size (fiber coupled)	< 50 μm	< 12 μm	< 6 μm
	Spot Size (free space coupled)	< 10 μm	< 5 μm	< 2 μm
Sample Stage	XYZ (Manual and motorized options available) – 75 x 50 mm; 100 x 100 mm; 150 x 150 mm; 300 x 300 mm			
Vision Camera	Software controlled vision camera included			

<sup>1</sup> Other laser wavelengths available on request

<sup>2</sup> Extension into mid IR available on request

<sup>3</sup> Other gratings available on request

<sup>4</sup> Based on 1200 g/mm grating at 500 nm and a 26 μm pixel CCD

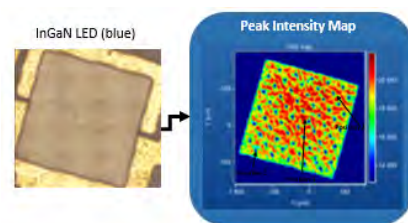
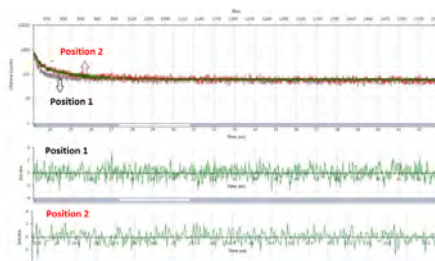
<sup>5</sup> Reflective objectives may be recommended if working in the UV or using multiple sources that cover a broad spectral range

# Time-resolved Photoluminescence (Lifetime)

Add Time-resolved Photoluminescence or lifetime point and imaging measurement to any SMS system with the Time Correlated Single Photon Counting (TCSPC) option.

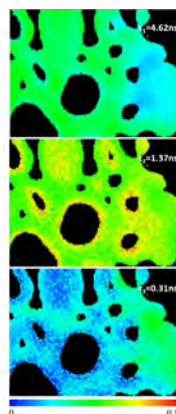
Working in the time domain removes the confounding influences of concentration and photobleaching, as well as offering insights into temporal phenomena, such as carrier dynamics in photovoltaics and defects in semiconductors.

With its industry-leading true 100 MHz system operation, the SMS TCSPC option has fast acquisition rates, with decays acquired in mere milliseconds, allowing for TCSPC lifetime dynamic measurements. Select from our current catalog of over 70 compact pulsed light sources, with more being added all the time.



## Time-resolved (Lifetime) Imaging - FLIM

With its latest FiPho TCSPC electronics, the SMS offers spatially-resolved lifetime or time-resolved photoluminescence characterization, enabling enhancement and complementary insights to steady state photoluminescence measurements, especially for semiconductor characterization.



## Unique TCSPC Benefits

- 40 years of experience in TCSPC innovation
- Industry-leading true 100 MHz system operation
- Lifetimes from 25 ps to seconds
- True plug and play sources do not require recalibration switching from one to the other
- Unique SpectraLED LED series for highest efficiency phosphorescence measurements

## Time-resolved Photoluminescence (Lifetime) Specifications

Spectrometer and Detectors				
Spectrometers	MicroHR	iHR320	iHR550	
Excitation Lasers	Discrete pulsed sources available from 260 nm to 1060 nm			
	Tunable pulsed white laser from 400 nm			
Spectral Range (nm)	250 nm – 1700 nm			
Recommended Gratings <sup>1</sup>	1200 g/mm, 600 g/mm, 300 g/mm			
Spectral Resolution <sup>2</sup> (nm)	0.39	0.18	0.1	
Measurable Lifetime Range <sup>3</sup>	25 ps to seconds			
Microscope				
Microscope Objectives <sup>4</sup>	Magnification	10X	50X	100X
	Spot Size (fiber-coupled)	< 50 μm	< 12 μm	< 6 μm
	Spot Size (free space-coupled)	< 10 μm	< 5 μm	< 2 μm
Sample Stage	XYZ (Manual and motorized options available) – 75 x 50 mm; 100 x 100 mm; 150 x 150 mm; 300 x 300 mm			
Vision Camera	Software controlled vision camera included			
Additional software <sup>5</sup>	EzTime (or EzTime Image, if doing FLIM)			

<sup>1</sup> Other gratings available on request

<sup>2</sup> Based on 1200 g/mm grating at 500 nm and a 26 μm pixel CCD

<sup>3</sup> Electronics and detectors for lifetimes shorter than 25 ps available on request

<sup>4</sup> Reflective objectives may be recommended if working in the UV or using multiple sources that cover a broad spectral range

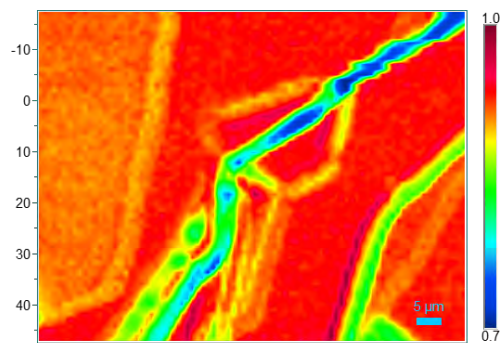
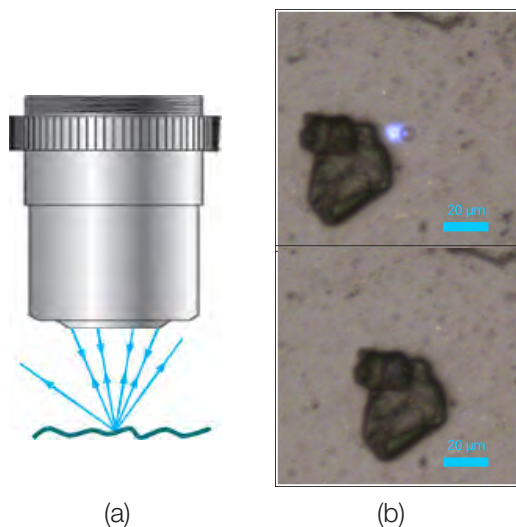
<sup>5</sup> Both EzTime and EzTime Image can be installed on the same computer as LabSpec 6

# Reflectance and Transmittance

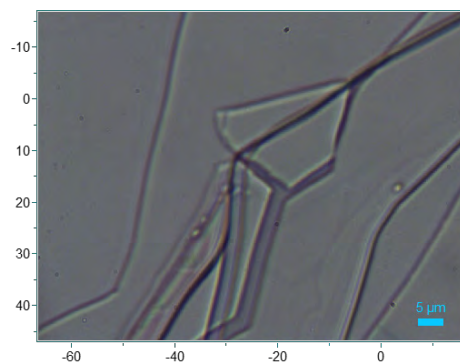
Perform broad-spectrum reflectance and transmittance measurements from UV to NIR with high spatial resolution.



White light spot focusing on specular surface by various objectives.



(a)



(b)

(a)  $\mu$ -T map of a mica sample, obtained by 50x objective around the wavelength of 695 nm. (b) Optical image of the mapping area of the mica sample.

Micro-reflectance measurement using an objective. (a) Reflection captured by an objective, (b) Images of a white light spot focused by 10x objective, on the specular substrate (top), and on a scattering surface of MoS<sub>2</sub> flake (bottom).

## Reflectance and Transmittance Specifications

Spectrometer and Detectors				
Spectrometers	MicroHR	iHR320	iHR550	
Excitation Sources	Xenon Lamp (200 nm – 2200 nm)			
	Tungsten Halogen Lamp (> 350 nm)			
	Supercontinuum Laser (> 400 nm)			
Spectral Range (nm) <sup>1</sup>	250 nm – 2200 nm			
Recommended Gratings <sup>2</sup>	1200 g/mm, 600 g/mm, 150 g/mm			
Spectral Resolution <sup>3</sup> (nm)	0.39	0.18	0.1	
Microscope				
Microscope Objectives <sup>4</sup>	Magnification	10X	50X	100X
	Spot Size (fiber-coupled)	< 50 $\mu$ m	< 12 $\mu$ m	< 6 $\mu$ m
	Spot Size (free space-coupled)	< 10 $\mu$ m	< 6 $\mu$ m	< 2 $\mu$ m
Sample Stage	XYZ (Manual and motorized options available) – 75 x 50 mm; 100 x 100 mm; 150 x 150 mm; 300 x 300 mm			
Vision Camera	Software controlled vision camera included			

<sup>1</sup> Extension into mid-IR available on request

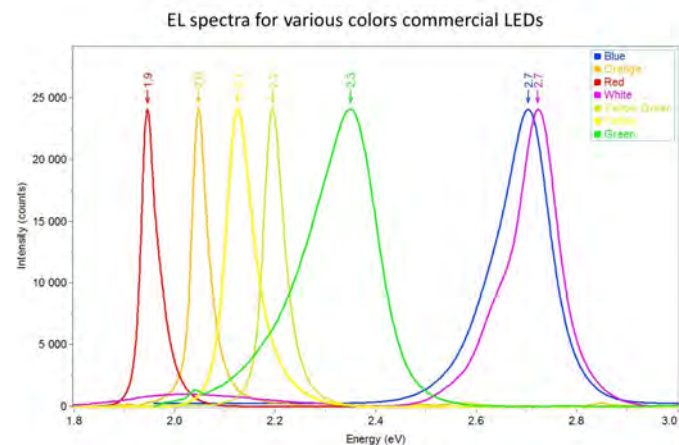
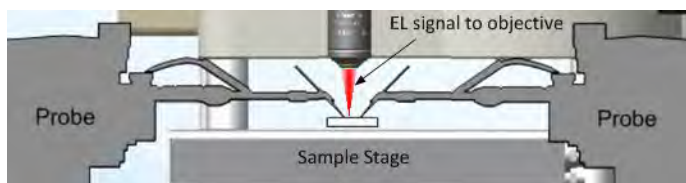
<sup>2</sup> Other gratings available on request

<sup>3</sup> Based on 1200 g/mm grating at 500nm and a 26  $\mu$ m pixel CCD

<sup>4</sup> Reflective objectives may be recommended if working in the UV or using multiple sources that cover a broad spectral range

# Electroluminescence and Photocurrent

With its open microscope frame design, the SMS system can accommodate micro-probes to enable electroluminescent measurements on LEDs, photovoltaic and other semiconductor materials.



Electroluminescence spectra for different colors of LEDs measured by an SMS system, plotted based on energy.

## Electroluminescence Specifications

Spectrometer and Detectors				
Spectrometers	MicroHR	iHR320	iHR550	
Excitation Source <sup>1</sup>	Keithley Source Meter (2400 series)			
Spectral Range (nm)	250 nm – 14 μm			
Recommended Gratings <sup>2</sup>	1200 g/mm, 600 g/mm, 150 g/mm			
Spectral Resolution <sup>3</sup> (nm)	0.39	0.18	0.1	
Microscope				
Microscope Objectives <sup>4</sup>	Magnification	10X	50X	100X
Sample Stage	XYZ (Manual and motorized options available) – 75 x 50 mm; 100 x 100 mm; 150 x 150 mm			
Vision Camera	Software controlled vision camera included			

<sup>1</sup> Other current voltage sources available on request

<sup>2</sup> Other gratings available on request

<sup>3</sup> Based on 1200 g/mm grating at 500 nm and a 26 μm pixel CCD

<sup>4</sup> Reflective objectives may be recommended if working in the UV, or using multiple sources that cover a broad spectral range

## Photocurrent Specifications

Spectrometer and Detectors				
Spectrometers	MicroHR	iHR320	iHR550	
Excitation Sources	Lasers: 266 nm – 1064 nm			
	Xenon Lamp (200 nm – 2200 nm) – Tunable option available			
	Tungsten Halogen Lamp (> 350 nm) – Tunable option available			
	Supercontinuum Laser (> 400 nm) – Tunable option available			
Photocurrent Measurement <sup>1</sup>	Keithley Source Meter (2400 series)			
Recommended Gratings <sup>2</sup>	1200 g/mm, 600 g/mm, 150 g/mm			
Spectral Resolution <sup>3</sup> (nm)	0.39	0.18	0.1	
Microscope				
Microscope Objectives <sup>4</sup>	Magnification	10X	50X	100X
Sample Stage	XYZ (Manual and motorized options available) – 75 x 50 mm; 100 x 100 mm; 150 x 150 mm; 300 x 300 mm			
Vision Camera	Software controlled vision camera included			

<sup>1</sup> Extension into mid-IR available on request

<sup>2</sup> Other gratings available on request

<sup>3</sup> Based on 1200 g/mm grating at 500 nm and a 26 μm pixel CCD

<sup>4</sup> Other objectives may be recommended if working in the UV, or using multiple sources that cover a broad spectral range



# Darkfield Scattering

## Nanospectroscopy with Darkfield Scattering Technique

Take advantage of darkfield functionality on the microscope to perform nanospectroscopy on the SMS. Enable characterization of nanomaterials by measuring the light scattering spectrum in darkfield mode.

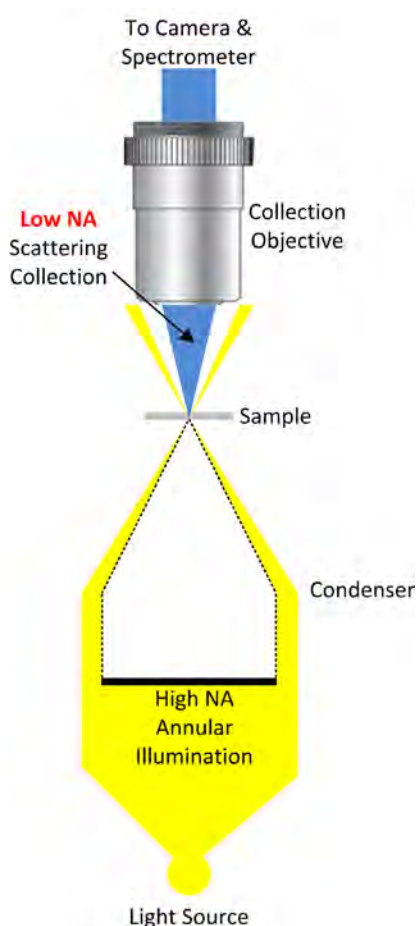
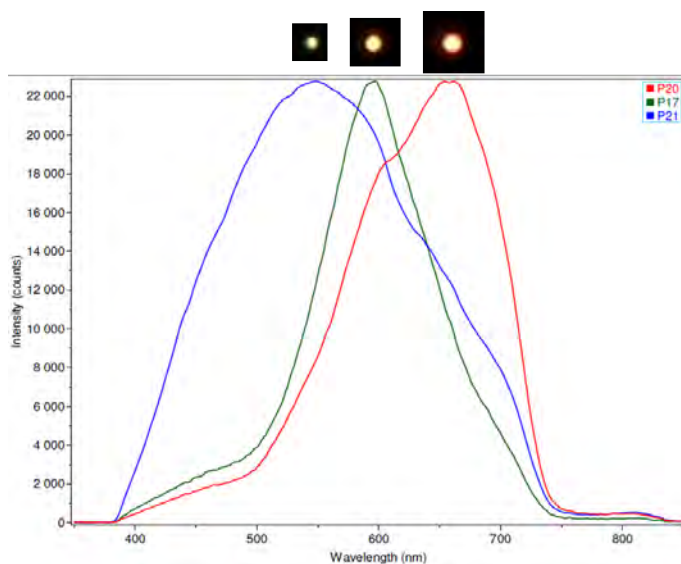


Image of gold nanoparticles on the darkfield microscope vision camera.



Spectra of individual gold nanoparticles. As the particle size increases, the spectrum shifts to the longer wavelengths.

Image showing illumination method in darkfield microscopy

## Darkfield Scattering Specifications

Spectrometer and Detectors				
Spectrometers	MicroHR	iHR320	iHR550	
Excitation Sources	Xenon Lamp (200 nm – 2200 nm)			
	Tungsten Halogen Lamp (> 350 nm)			
	Supercontinuum Laser (> 400 nm)			
Spectral Range (nm) <sup>1</sup>	200 nm – 2200 nm			
Recommended Gratings <sup>2</sup>	1200 g/mm, 600 g/mm, 150 g/mm			
Spectral Resolution <sup>3</sup> (nm)	0.39	0.18	0.1	
Microscope				
Microscope Objectives <sup>4</sup>	Magnification	10X	50X	100X
Sample Stage	XYZ (Manual and motorized options available) – 75 x 50 mm; 100 x 100 mm; 150 x 150 mm; 300 x 300 mm			
Vision Camera	Software controlled vision camera included			

<sup>1</sup> Extension into mid-IR available on request

<sup>2</sup> Other gratings available on request

<sup>3</sup> Based on 1200 g/mm grating at 500 nm and a 26 µm pixel CCD

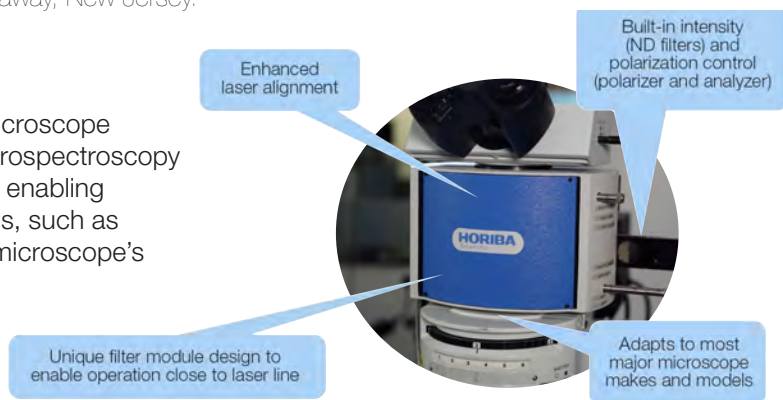
<sup>4</sup> Other objectives available on request

# High-end performance with no compromises

HORIBA is not simply a system integrator buying components from third party vendors and integrating them. As an original equipment manufacturer, HORIBA designs and manufactures most of the key components relevant to spectroscopic performance of the SMS system in their state-of-the-art facility in Piscataway, New Jersey.

## The Universal Microscope Adapter (UMA)

A key enabler for the SMS system is the Universal Microscope Adapter (UMA). The UMA is a uniquely designed microspectroscopy accessory that adapts to most upright microscopes, enabling high-end performance for challenging spectroscopies, such as Raman, PL and lifetimes without compromising the microscope's native functionality.



## Gratings, Spectrometers and Detectors

HORIBA has long history in high performance optical instrumentation design and manufacturing, from high quality gratings to the triple grating imaging spectrometer, and an assortment of deep-cooled scientific array detectors used in SMS systems. This means that we back our instruments with deep knowledge of the underlying components, and industry leading applications support.

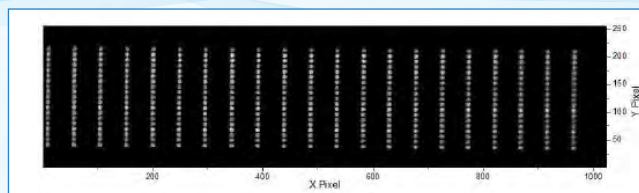
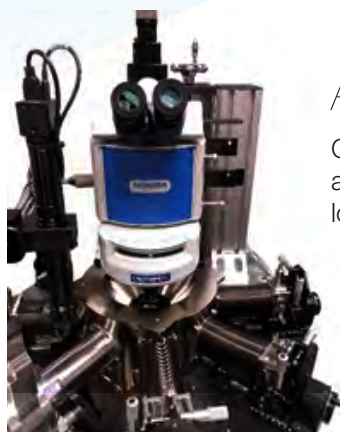


Image of a 633 nm laser moved across the focal plane through nineteen 200  $\mu\text{m}$  fibers. The 1x imaging adapter was used with an iHR550 spectrometer, 1200 gr/mm grating blazed at 500 nm, and 1024x256 open-electrode CCD.



## Accessories

Customize your SMS system to address different sample handling and conditioning needs, from unusually sized samples to low temperature measurements.

- Up to 300 mm wafer mapping stage
- Low temperature measurements down to 4 Kelvin (4K) using most commonly available cryostats.



# Software

Benefit from our industry-leading LabSpec 6 software. With a simple and intuitive user interface, LabSpec 6 offers advanced features for instrument control, automated data collection and analysis, as well as user account management.



**Instant processing**  
Advanced on-the-fly custom processing gives data ready for immediate analysis, without further time-consuming treatment



**OneCheck**  
Automated alignment and calibration tools ensure that valid and optimized data are obtained time and time again



**Video overlay**  
Overlay Raman images onto optical microscope images for hybrid sample viewing



**Image analysis and display**  
Fast conversion of hyperspectral map data into meaningful chemical images, with full display control



**Database searching**  
Identify material composition with large spectral databases using the KnowItAll® informatics platform



**Customized reporting**  
Create customized multi-data, multi-page templates for fast reporting of results



**Batch processing**  
Fast batch processing of multiple data files, for efficient high throughput data treatment



**Templates and methods**  
Instant recall of hardware settings, and fast, easy customization and automation of data acquisition and analysis functions



**VBS / ActiveX**  
Integrated VBS script editor for in-software programming, and external hardware control via ActiveX



**User accounts**  
Secure password protected user access control with optimized user level based interfaces

# Applications



The SMS systems are manufactured at HORIBA's brand new, state-of-the-art 132,000 square foot facility in Piscataway, New Jersey, featuring the highest quality manufacturing processes and efficiencies.



Made in the USA



HORIBA Instruments has a policy of continuous product development, and reserves the right to amend part numbers, descriptions and specifications without prior notice.

# HORIBA

Scientific

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