RHK-254

RHK Technology

Imaging the Future of Nanoscience

INTRODUCING

PanScan Lumin-SLT

UHV Scanning Probe Microscope
With 72% optical light collection efficiency

Cryogen-free, LHe/LN2 flow and ambient temperature versions available

Ideal for:

Cathodeluminescence (CL)
Photoluminescence (PL)
STM Light Emission (STM-LE)
Raman Spectroscopy

WITH ALL THE ADVANTAGES OF THE ORIGINAL PANSCAN FREEDOM

Cryo-Free operation – 7K - 400K on the tip and sample
Atomic Resolution Imaging
Ultra-Low Noise & Drift
Superb Spectroscopy

PanScan Lumin-SLT is built and integrated at RHK's US factory in Michigan.
The system is available for purchase from RHK Technology, Inc. and its worldwide network of authorized distributors.

PanScan Lumin-SLT

RHK's Newest Innovation

UHV SPM with Unprecedented Light Capture enabling Cathodeluminescence, Photoluminescence, STM – Light Emission and Raman Spectroscopy

Cryogen-free, LHe/LN_2 flow and ambient temperature versions available.

RHK's new PanScan Freedom Lumin-SLT platform delivers ultra-stable SPM imaging and spectroscopic measurements as well as unmatched STM-LE light collection with up to 72% efficiency. This unique combination enables unrivaled exploration and fresh discoveries by providing highly efficient cathode-luminescence (CL), photoluminescence (PL), STM – Light Emission (STM-LE) and Raman spectroscopic measurements simultaneously with the full range of standard UHV LT SPM measurements. PanScan Freedom Lumin-SLT frees the researcher from trade-offs and technical constraints in performance that can interfere with insights and research progress.

Lumin-SLT arose from work between RHK Technology, Inc., and Unicamp, a Brazilian university active in Surface Science and Optical Spectroscopy of semiconductor nanostructures. Professor Luiz Zagonel, Applied Physics Department at Unicamp, selected an RHK PanScan for one of the Unicamp laboratories as a platform for optical spectroscopies linked to atomically resolved imaging. RHK customized Zagonel's system to enable integration of Unicamp-developed optical components, allowing optimized light collection and analysis for their research. Unicamp has already published its results in multiple technical journals. RHK licensed Unicamp technology and is now incorporating it into RHK's new PanScan Freedom Lumin-SLT.

RHK, not just remarkable...revolutionary

Lumin-SLT again positions RHK Technology as a proven first-to-market innovator of crucial enabling technology for exploring new frontiers of nanoscience. In fact, RHK's UHV LT Cryo-Free PanScan Freedom itself was an earlier ground-breaking, first-to-market enabling technology, now installed in dozens of laboratories around the world.

Enlighten yourself!

At the heart of Lumin-SLT is its unprecedented light collection efficiency. Previous commercial light collection systems were limited to a tiny fraction of the light emitted from the probe/sample interface. This inefficient light collection not only greatly lengthened acquisition times but frequently led to signal levels below the noise floor. Lumin-SLT's 72% light collection efficiency overcomes those limitations.

Features and applications

Lumin-SLT can collect light emitted by the sample upon excitation using the STM tunnel current, usually called induced light emission (STM-LE). When operating the STM in Field Emission mode, electrons of higher energy hit the sample surface causing light emission that can be captured. This emitted light is usually called Cathodeluminescence (CL). Lumin-SLT can also be used to inject light to perform Photoluminescence and Raman spectroscopy. The light coupling to the spectrometer is performed by use of optical fibers for greater flexibility and higher spectral resolution. The system uses sub-micrometer positioning to reach accurate alignment and safe use.

Light up your research with PanScan Lumin-SLT!

RHK Lumin-SLT is the most suitable tool to study the interplay between optical and electronic features with morphology of nanostructures. Such interplay is of paramount importance in semiconductors such as Transition Metal Dichalcogenides (TMDs), quantum confined systems (core-shell nanoparticles), and plasmonic nanoparticles, among many others.

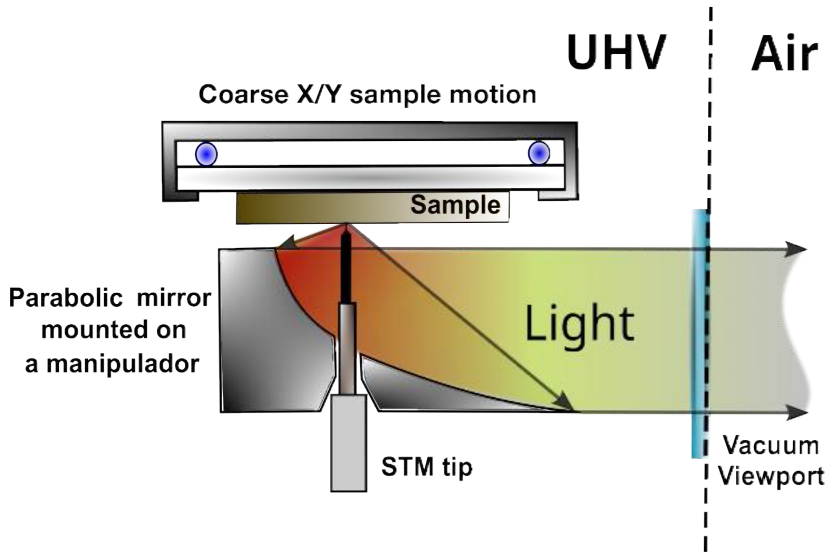
PanScan Lumin-SLT

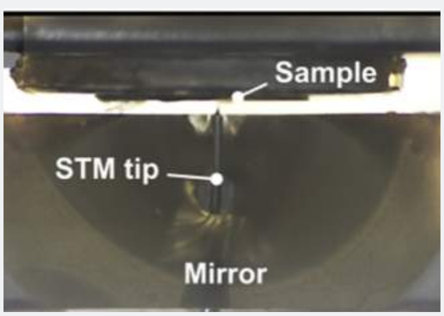
Optical Design

The in-situ reflective optics at the core of the Lumin-SLT operate efficiently over a wide optical range allowing investigations of light emissions from IR to UV wavelengths.

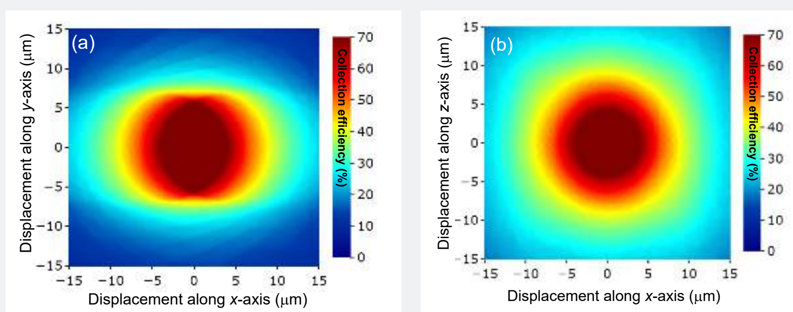
The parabolic mirror with an effective NA of 1.4 collects up to 72% of the light emitted from the surface. The unique design with no multi-surface lenses in vacuum minimizes the light loss along the entire optical path from the probe to the spectrometer and can reach a spectral resolution of 0.5 nm with an overall efficiency of 50% by careful NA matching of the collected light into the spectrometer.

The parabolic mirror is mounted on a three axis nano-positioning stage in UHV with integrated closed-loop position sensors providing nanometer resolution and micron repeatability to ease alignment. This configuration allows the mirror to be perfectly aligned to the STM tip for any sample thickness. The sample position can be independently adjusted over a 25mm^2 area of the sample while maintaining optical alignment, allowing the relevant feature of interest to be quickly positioned under the tip without the need for time consuming optical realignment.   Moreover, when not in use, the mirror can be fully retracted to outside the thermal shields.



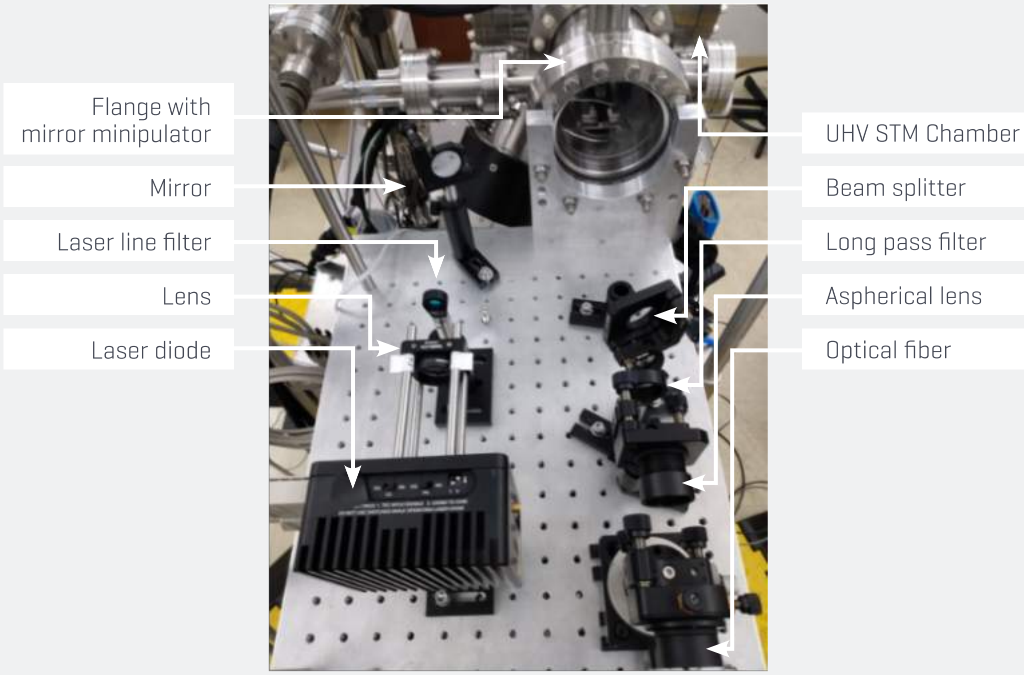


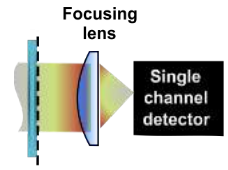
Orientation of the STM tip, sample and parabolic mirror viewed along the optical path from outside of the UHV chamber. Multiple CCD cameras with the mirror's encoded nano-positioners, provide a safe probe approach protocol.



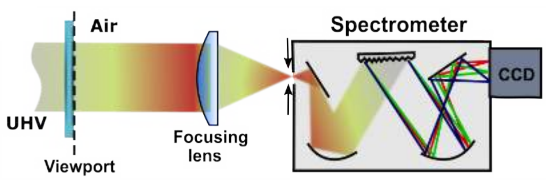
Heat map showing the collection efficiency (in %) of the Lumin SLT parabolic mirror as the STM tip is moved away from the focal point of the parabolic mirror. There is no loss of collection efficiency in the whole scan area even at room temperature.

Flexible Experimental Configurations



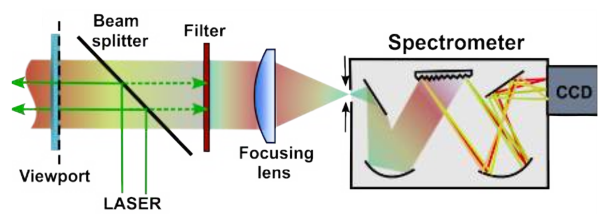


Light coupled directly to a PMT or APD. The system can directly count individual photons versus time, position, or varying stimuli such as tunnel current, bias voltage, etc.



Configuration for CL and STM-LE

Light coupled through free space or fiber into optical spectrometer. The optical design assures that virtually all collected photons are delivered to the spectrometer. Ex-situ STM preamp allows high voltage to be applied to the tip, enabling CL measurements.



Configuration for PL and Raman spectroscopy

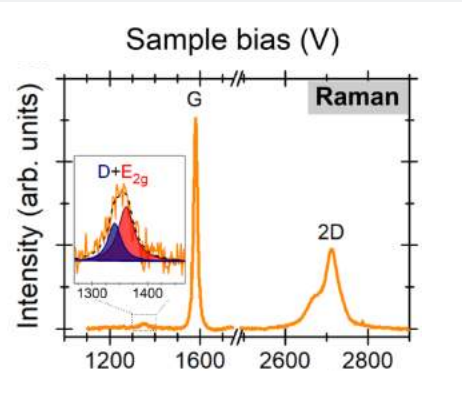
The optimized light path assures Raman Spectroscopy with high transmission and spectral resolution.

The Lumin-SLT can be configured for any type of optical measurement from deep UV to the far IR. The matched optical components on the optical table can be quickly arranged for the emitted light to be transmitted in free space, focused onto a fiber, delivered to a single channel detector (APD/PMT) or an optical spectrometer. These optical components can be used to couple laser light to the probe/sample for photoluminescence and Raman spectroscopy measurements as well as to efficiently collect most photons in electron-induced luminescence measurements.

Most optical experiments can be performed by only changing optical elements on the optical table without need of venting and system bakeout. The mirror and the vacuum viewport are the only elements that may require venting to be replaced.

Experimental results

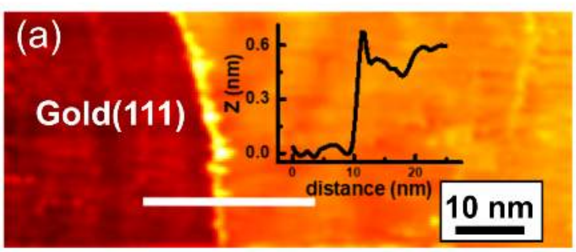
Raman Spectroscopy

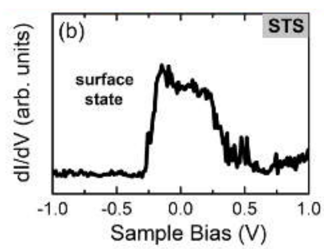


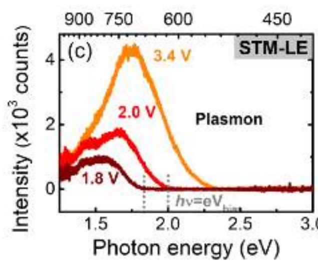
Raman spectrum of HOPG with a single layer (monolayer) of h-BN measured without the STM tip near the sample surface. The spectrum was acquired using a 532 nm laser. ‡

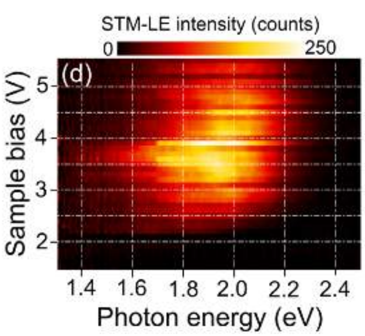
Experimental results

STM LE – Plasmon Emission on Au(111) surface







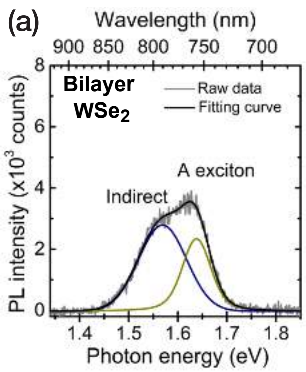


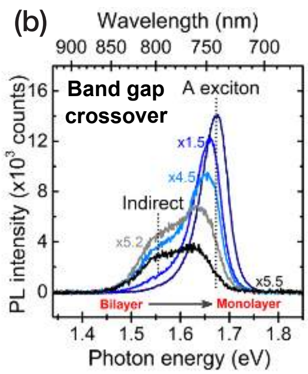
(a) STM image of the gold(111) surface (-1.5 nA, -210 mV), and the inset shows the height profile along the surface step. (b) STS curve (80 mV, 0.8 kHz). (a) and (b) were obtained at 80 K. (c) STM-LE obtained at three different bias values with a tunneling current of 10 nA and 30 s acquisition time. (d) Series of spectra as a function of the applied sample bias for a tunneling current of 10 nA and 5 s of exposure time. (c) and (d) were measured at 100 K.

Experimental results

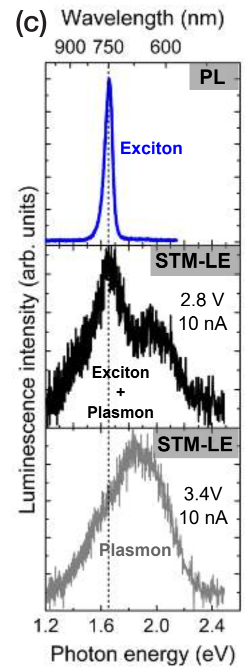
Comparing Photoluminescence (PL) and STM Light Emission (LE) results of WSe_2 on Au

[a] In-situ PL spectrum taken at room temperature on the bilayer, showing decomposition in two peaks.
[b] Bandgap crossover observed in the transition from the bilayer to the monolayer region.





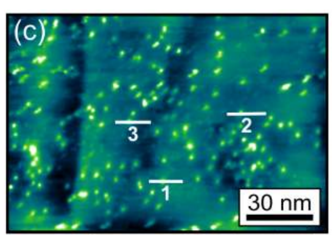
[c] Comparison of the PL and STM-LE spectra acquired at RT in UHV. The acquisition time for the STM-LE spectra was 1 s.‡

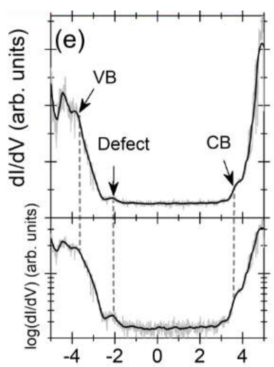


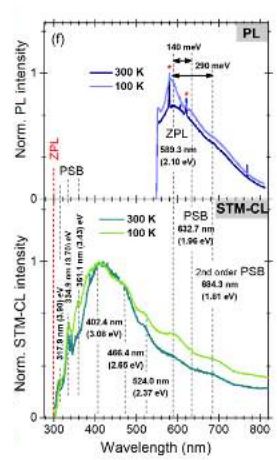
Experimental results

Comparing Cathodeluminescence (CL) and Photoluminescence (PL) and STS results on h-BN

[c] h-BN surface with point defects. [e] STS curves obtained in the region with point defects. [f] In situ PL and STM-CL spectra in which phonon sidebands [PSBs] are observed near the Zero-Phonon Line [ZPL] peaks.‡







The data in this brochure and the below publications utilized the PanScan Flow Lumin-SLT system:

[‡]Design and implementation of a device based on an off-axis parabolic mirror to perform luminescence experiments in a scanning tunneling microscope
Rev. Sci. Instrum. 93, 043704 (2022); doi: 10.1063/5.0078423

Tunneling-current-induced local excitonic luminescence in p-doped WSe 2 monolayers
Nanoscale · June 2020; doi: 10.1039/D0NR03400B

Band gap measurements of monolayer h-BN and insights into carbon-related point defects
2D Materials, Volume 8, Number 4; doi: 10.1088/2053-1583/ac0d9c

Epitaxial growth, electronic hybridization and stability under oxidation of monolayer MoS2 on Ag(1 1 1)
Applied Surface Science
Volume 538, 1 February 2021, 148138; doi: /10.1016/j.apsusc.2020.148138

Features

Measurement modes
CL, PL, STM-LE, Raman

Measurement environment
Ambient, UHV, Cryogenic

Optical collection system
Parabolic mirror connected with 3D closed-loop controlled nanopositioners with 1 micron position accuracy.

Optical system can be customized to customer requirements by selecting appropriate viewports, mirror, lens, optical coatings, etc.

Light injection
Coupled in free optics

Light collection
Coupled using fibers to the spectrometer

Cryogen-free, LHe/LN_2 flow and ambient temperature versions available

Locate and position probe over features of 2 μm size with optional high resolution optical positioning module

Specifications

Temperature range
7K – 400K (depending on model)

Scan Size
6μ x 6μ@ 300K
1.5μ x 1.5μ @ 10K

Light collection efficiency
72%

Optical NA
1.4 equivalent NA

Optical positioning Piezo motor
Nanometer resolution, micron repeatability

Usable optical wavelengths
Deep UV to far IR

STM resolution
Atomic

Making the Ideal Real

RHK delivers compelling value and proven quality to broaden the frontiers of atomic scale research. We stand ready to meet your specifications and exceed your expectations. In addition to industry leading Control systems, RHK supplies a wide range of SPMs and complete Surface Science research systems.

Explore with Confidence

Every day, in university and government labs around the globe, RHK research platforms lead to new discoveries. Founded in 1981, RHK brings over 40 years of experience to the design and manufacture of advanced Surface Science solutions. Our installed base now includes over 1,250 SPM tools.

RHK has sales and customer support offices worldwide.

RHK SPM SYSTEMS OPERATING IN OVER 40 COUNTRIES.

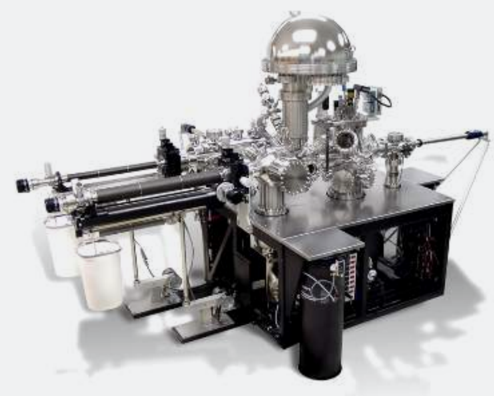
Also available from RHK

R10 SPM

10th Generation Controller

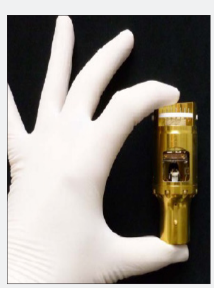
Beetle Family

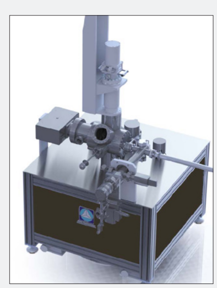
UHV Variable Temp AFM/STM



PanScan Family

PanScan Kit for homemade systems





PanScan Freedom Tesla with Cryo-free 5T magnet

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