RTS2-Omni-Imager

Raman-Hyperspectral Integrated Microscopic Spectroscopy System

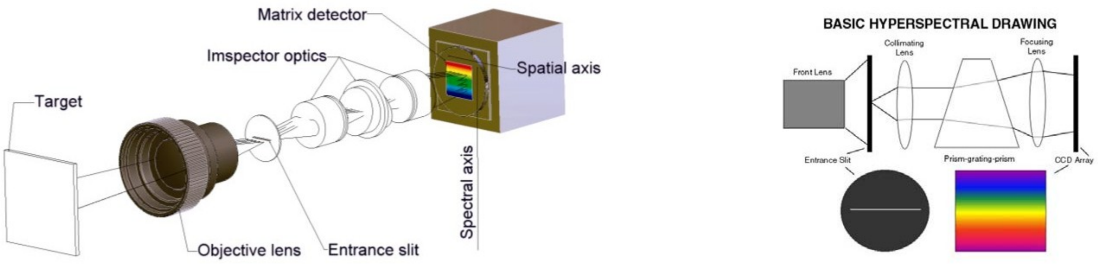
Dark-Field Microscopy Technology

Dark-field microscopy combines an optical microscope with a specialised illumination and observation geometry so that only light scattered by the sample enters the objective and is detected. This makes it possible to visualise particles below the diffraction limit. Compared with conventional bright-field microscopy, dark-field microscopy overcomes insufficient transmission or reflection contrast when imaging small structures in uniform samples. Fine structures stand out clearly against the background, making the technique especially suitable for particles, fibres and small-scale interfaces.

Hyperspectral imaging (HSI) is an imaging-spectroscopy technology with high spectral resolution. Using an imaging spectrograph, it acquires many narrow, contiguous spectral bands in the ultraviolet, visible, near-infrared and mid-infrared regions. Each pixel contains tens to hundreds of narrow spectral bands (typically less than 10 nm wide), producing a complete and continuous spectrum.

An imaging spectrograph captures one line of the target at a time and disperses the light so that each wavelength component maps to one pixel of a linear array. Each frame therefore contains line pixels along one dimension (the spatial axis) and spectral distribution along the other (the spectral axis, representing intensity at each spectral element), combining image and spectrum in a single dataset.

The system uses Zolix's patented focal-plane scanning technology. A built-in precision motorised platform separately controls image acquisition and focus/depth-of-field adjustment.



Principle of hyperspectral imaging and basic optical layout

The dark-field microscopic hyperspectral imaging system can integrate dark-field scattering, time-resolved fluorescence and Raman spectroscopy. Its fast push-broom acquisition typically records a data cube in 10 seconds to 1 minute, depending on camera resolution, exposure time, frame rate and signal strength. This enables unstable samples to be measured and analysed rapidly, supports trajectory tracking of nanomaterials, and allows real-time analysis of motion and changes in physical properties.

For large samples, an optional Zolix-developed precision motorised XY stage can be combined with beam-splitting and detection modules for mapping. The software automatically stitches and corrects each scan strip to generate a large-area single-layer image. With the built-in motorised autofocus axis, in-situ imaging or mapping can also be performed at different depth layers, supporting large-area, multidimensional, in-situ and tomographic imaging applications.

Product Introduction

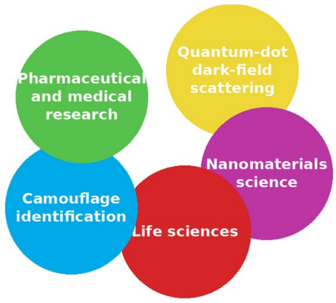
RTS2-Omni-Imager dark-field scattering microscopic hyperspectral imager

The RTS2-Omni-Imager is a newly developed system from Beijing Zolix Instruments Co., Ltd. Centred on dark-field scattering hyperspectral imaging, it can integrate steady-state and time-resolved fluorescence as well as Raman spectroscopy. It overcomes the limitations of single-purpose spectroscopic instruments and provides advanced research users with a fast, comprehensive, in-situ and correlative system for spectral measurement and identification.

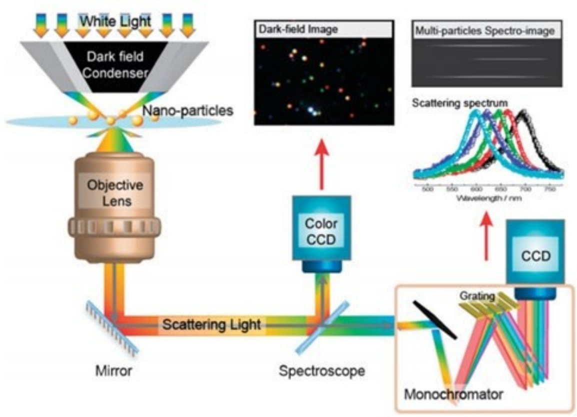
Its modular design provides excellent expandability for different application scenarios. Linear push-broom imaging replaces conventional point-scanning hyperspectral imaging, delivering high scan speeds. Within minutes, the system can hyperspectrally scan reflected-light, fluorescence and dark-field scattering signals across the microscope field of view, obtaining both image and spectral information with high sensitivity and accuracy.

Typical Applications

- Quantum-dot dark-field scattering
- Nanomaterials science
- Life sciences
- Camouflage identification
- Pharmaceutical and medical research



System Configuration and Key Components



Typical dark-field scattering spectroscopy arrangement

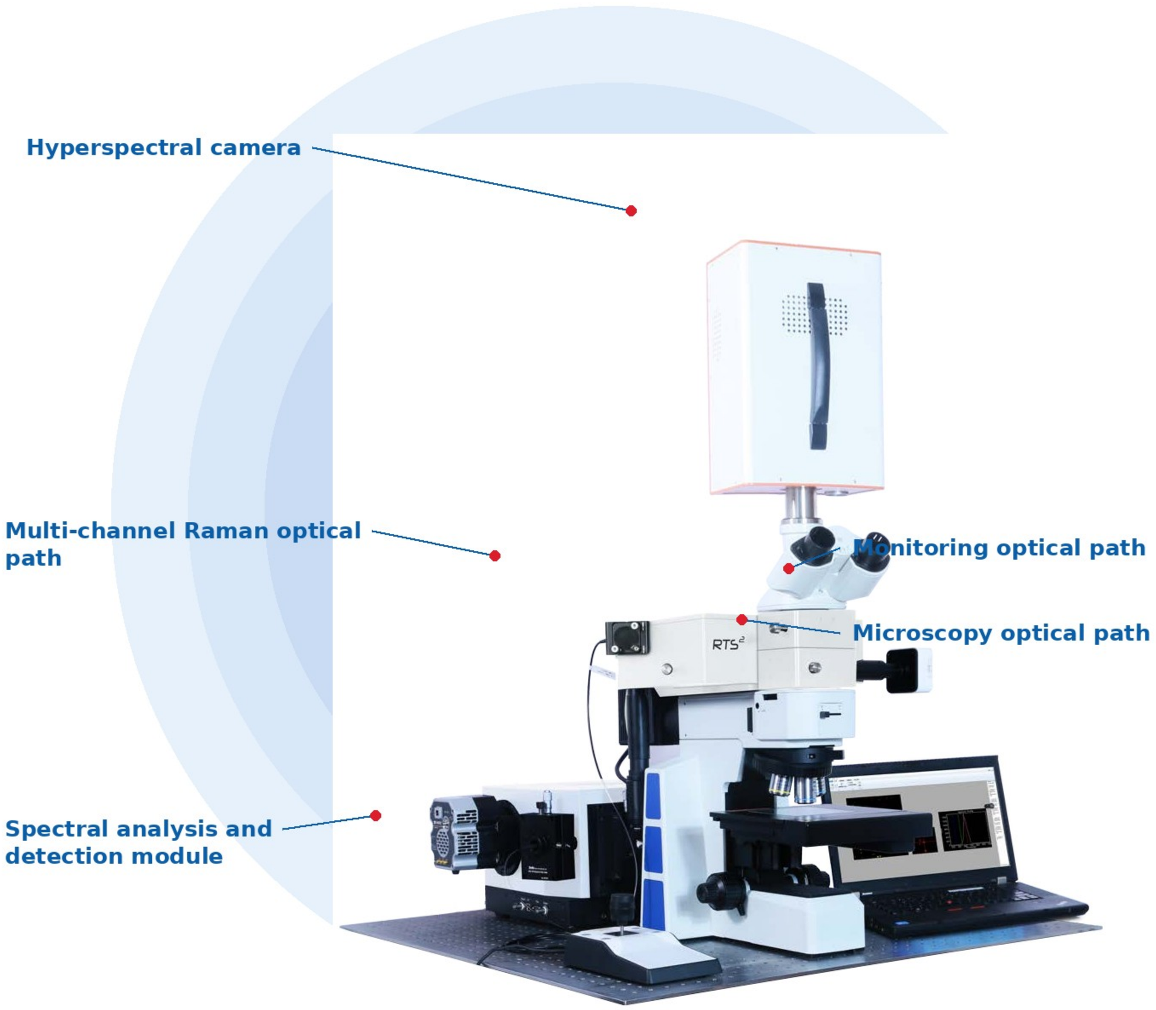
A dark-field scattering spectroscopy setup can consist of a dark-field microscope (a dark-field condenser for transmitted illumination, or bright/dark-field objectives and an epi-dark-field illuminator for reflected illumination), an imaging grating spectrograph, and a high-sensitivity scientific CCD detector.

In a traditional configuration, the grating spectrograph is coupled to the image output of the microscope, with the microscope image focused onto the spectrograph entrance. With the slit opened wide and a mirror selected instead of the grating (or the grating set to zero order), the dark-field image is viewed on the CCD. A particle of interest is centred, the slit is narrowed and the grating is moved to the appropriate wavelength to acquire its spectrum.

The new hyperspectral configuration uses a hyperspectral camera in place of the microscope colour camera, acquiring both a sample image and a hyperspectral image containing a spectrum at every point without moving the sample. It can coexist with a conventional grating spectrograph, while laser excitation and a confocal optical path can be added for fluorescence or Raman spectroscopy.

Typical Configurations

RTS2-Omni-Imager
Dark-Field Scattering Microscopic Hyperspectral Imager



RTS2-Omni-Imager system structure (labels translated into English)

Software and Spectral Database

Modular acquisition, processing and spectral-identification tools

The spectral image-processing software has a modular architecture comprising image-processing and spectral-identification modules. Functions include unsupervised classification, spectral-angle matching, waveform-similarity matching, spectral linear unmixing, spectral divergence analysis, combined spectral-angle/divergence analysis, band arithmetic and principal component analysis. The spectral database provides database management and maintenance, data preprocessing, query and analysis, and graphical display.

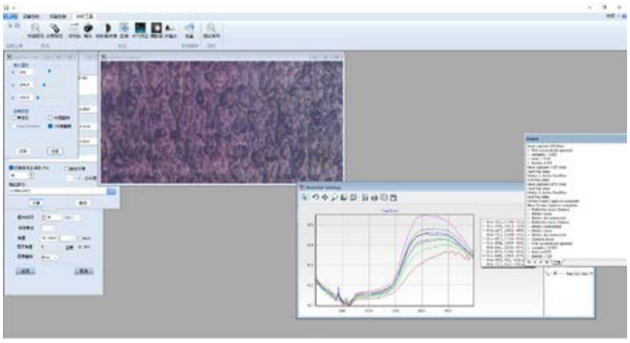
Band Selection / Extraction / Frame Extraction

- User-defined wavelength range of interest
- Selectable number of spectral channels
- Custom channel count within any wavelength range
- Higher acquisition frame rates by reducing the number of bands
- Visible-NIR cameras only

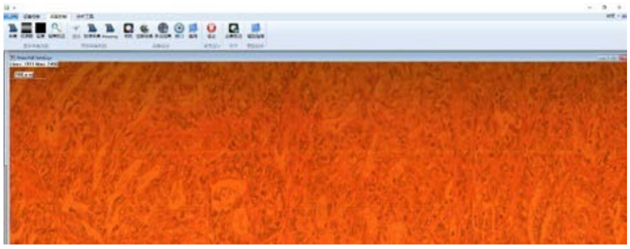
Calibration / Inversion

- Independent storage of each dataset
- One-click reflectance calibration in software
- Individual and batch data processing
- Real-time inversion results using a user-supplied model

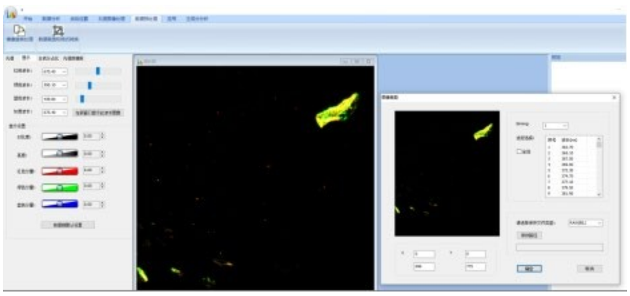
Acquisition and Preprocessing



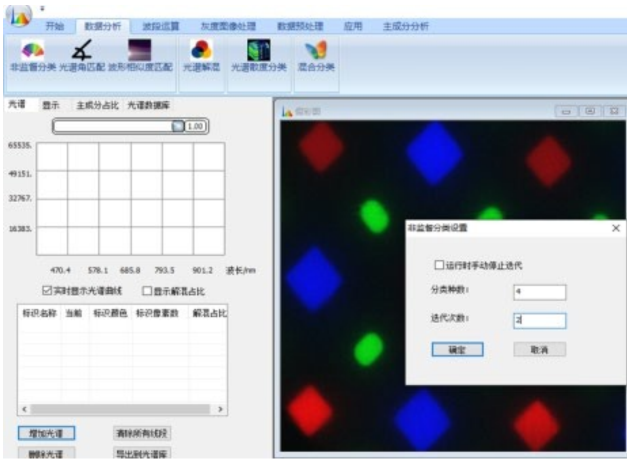
Data acquisition software



Data image



Unsupervised classification

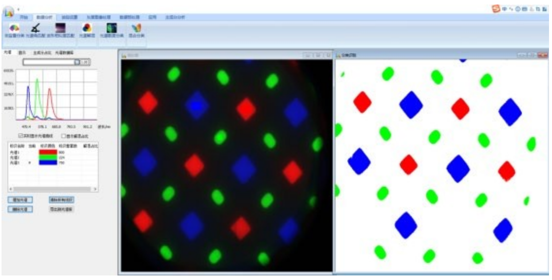


Spectral-angle and waveform-similarity matching

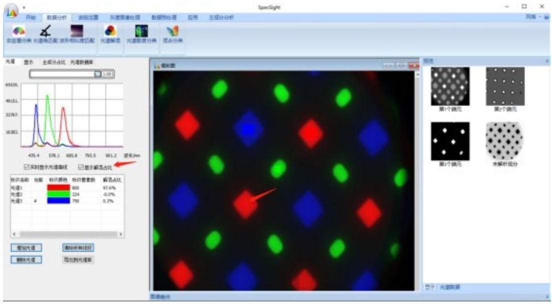
The acquisition software supports a built-in motorised mechanical shutter and data-preprocessing windows for binning, band cropping, image cropping and format conversion.

Advanced Software Functions

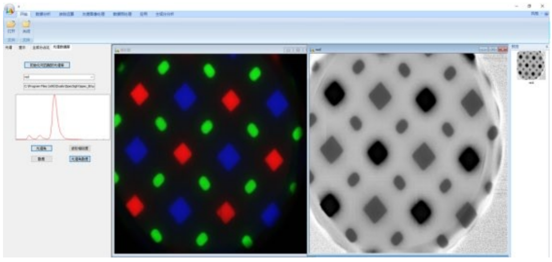
Spectral unmixing, band arithmetic, NDVI and principal component analysis



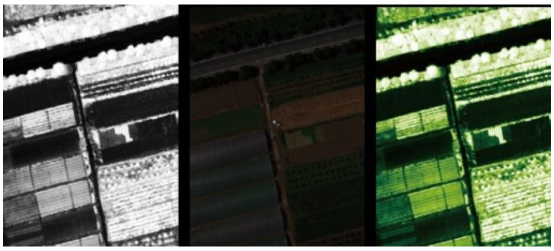
Spectral linear unmixing



Combined spectral-angle and divergence analysis

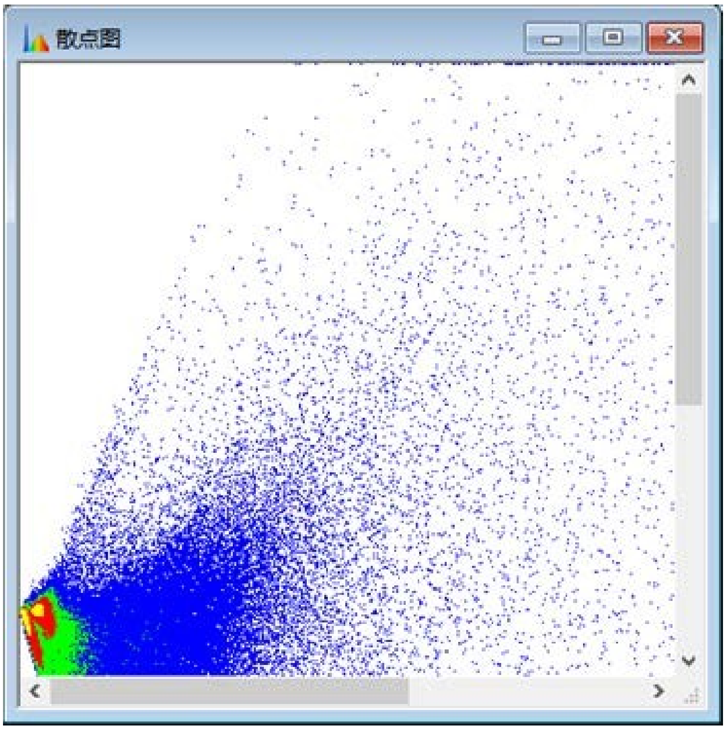


Band arithmetic



NDVI: original, result and density-sliced images

Principal Component Analysis



Principal-component greyscale images and scatter plot

These tools support dimensionality reduction, material discrimination, feature extraction and quantitative analysis across hyperspectral data cubes.

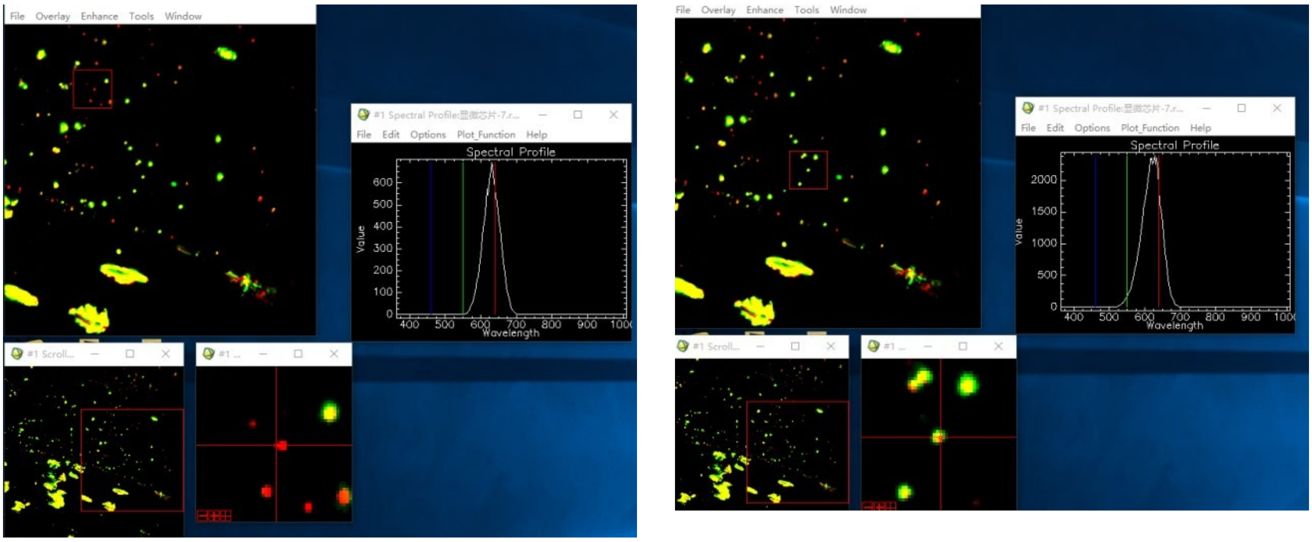
Applications and Measured Data

Examples for nanomaterials and fluorescence measurements

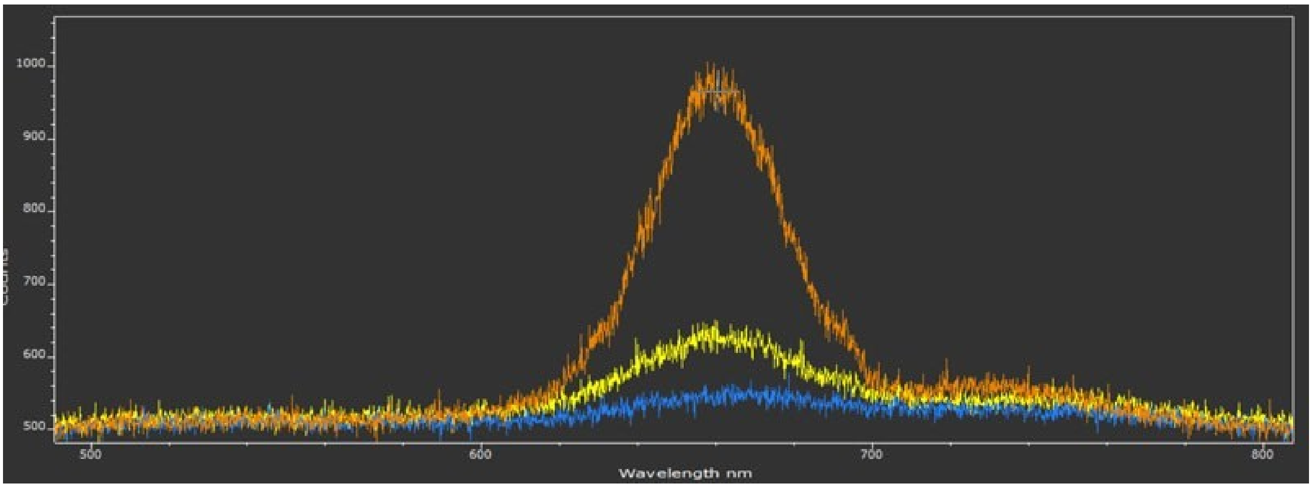
The RTS2-Omni-Imager overcomes the application limitations of single-purpose spectroscopic instruments. It can be used for quantum-dot dark-field scattering, nanomaterials science, life sciences, camouflage identification, and pharmaceutical and medical research. The system supports analysis of nanoscale physical, chemical and biological processes.

Nanoparticles

- Dark-field scattering spectra of different nanoparticles within the same field of view
- Polarised dark-field scattering spectrum of a single gold nanorod at 0 degrees, 30 degrees and 90 degrees



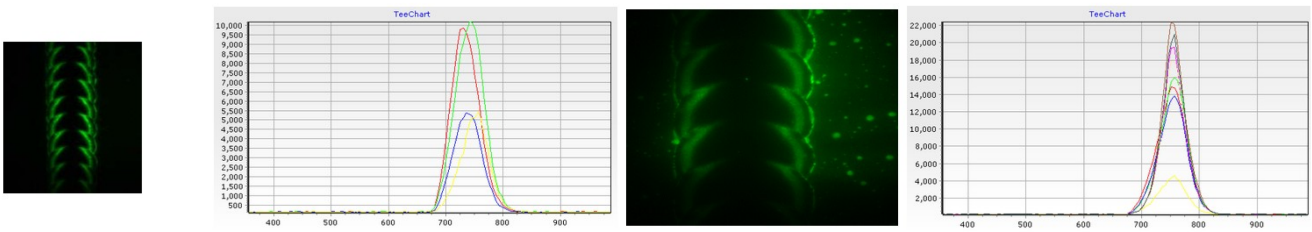
Dark-field hyperspectral measurements of different nanoparticles in one field of view



Polarisation-dependent dark-field scattering spectra of a single gold nanorod

Perovskite Fluorescence

Perovskite material was excited with a 532 nm LED source, and a fluorescence peak was detected at 750 nm.



Perovskite material fluorescence test

Technical Specifications

Performance and hardware configuration

Hyperspectral Imaging Performance

Parameter	Specification
Scanning method	Built-in push-broom scan
Focusing method	Motorised focus
Spectral range	400-1000 nm
Spectral resolution	2.8 nm
Spectral sampling interval	0.6 nm
Detector	sCMOS
Cooling	Cooled; air or water cooling
Pixel count	2048 x 2048
Effective spectral channels	User configurable
Dynamic range	16 bit
Spatial image resolution	2048 x 1024
Scan speed	9 s per data cube

Typical Dark-Field / Fluorescence Performance

Parameter	Specification
Spectral range	400-1000 nm
Spectral resolution	Less than 3 nm
Imaging speed	Less than 1 minute at 640 x 512
Spatial resolution	Less than 2 micrometres

Typical Raman Performance (Optional)

Parameter	Specification
Raman shift range	90-5000 cm-1
Spectral resolution	2.0 cm-1 or better with 1800 g/mm grating
Third-order Si peak SNR	Greater than 30:1

Hardware Configuration

Parameter	Specification
Microscope	Standard upright microscope with 100x, 50x and 10x dark-field objectives; inverted microscope optional
Hyperspectral camera	Omni-Imager, F/2.4, 400-1000 nm
Computer	Lenovo all-in-one computer
Spectrograph (optional)	320 mm or 500 mm focal-length spectrograph; three gratings: 1800 g/mm blazed at 500 nm, 1200 g/mm blazed at 750 nm, and 150 g/mm blazed at 500 nm; motorised shutter; TE deep-cooled back-illuminated detector; active pixels at least 2000 x 256
Excitation sources (optional)	Raman excitation lasers at different wavelengths; continuous or pulsed fluorescence excitation sources such as picosecond lasers, femtosecond lasers and supercontinuum sources
Power supply	220 V
Operating environment	Temperature 20 +/- 5 deg C; relative humidity no more than 85%; keep away from high-power electrical equipment and vibration sources

Source: Zolix Chinese catalogue, pages 53-59. Translation prepared for commercial review; confirm final product terminology and specifications with Zolix before publication.