Institute of Solid State Physics, University of Latvia

Introduction to
“Nanofinder-S”

3D Scanning Confocal Microscope with Spectrometer

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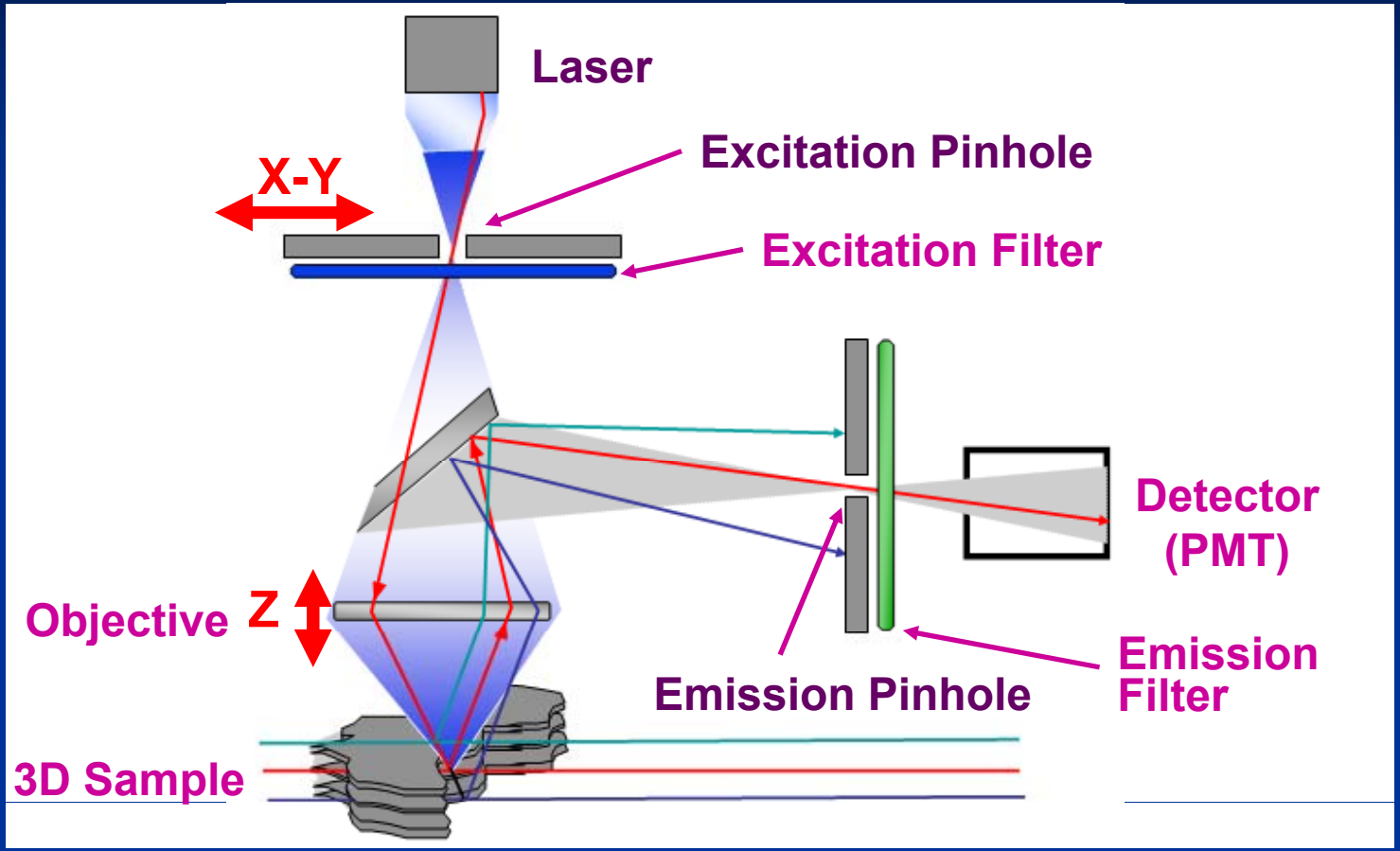
Principle of Confocal Microscopy



A type of light microscopy in which a point of illumination is projected or rastered over a specimen, and the reflected illumination is screened through an exit aperture in order to eliminate light from out-of-focus planes.

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Nanofinder-S

Before

Now

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Nanofinder-S

www.solartii.com

SOLAR TII

Simultaneous / Multifunctional Analysis:

- Optical and Confocal Microscopy
- Raman Measurements
- Luminescence Measurements
- 0D, 1D, 2D & 3D High-speed Imaging and Spectroscopy

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Main components:

1. Inverted microscope (bandpass 400-850 nm)
2. CCD for microscope
3. Laser confocal microscope unit with photomultiplier tube (PMT)
4. Scanning unit with galvanometer mirror scanners (X and Y)
5. Opticomechanical unit
6. Monochromator-spectrograph
7. CCD for spectrograph
8. PMT for spectrograph
9. Reference PMT
10. Laser He-Cd: 441.6 nm, 70 mW (up to 3 lasers possible)
11. Computer and electronics

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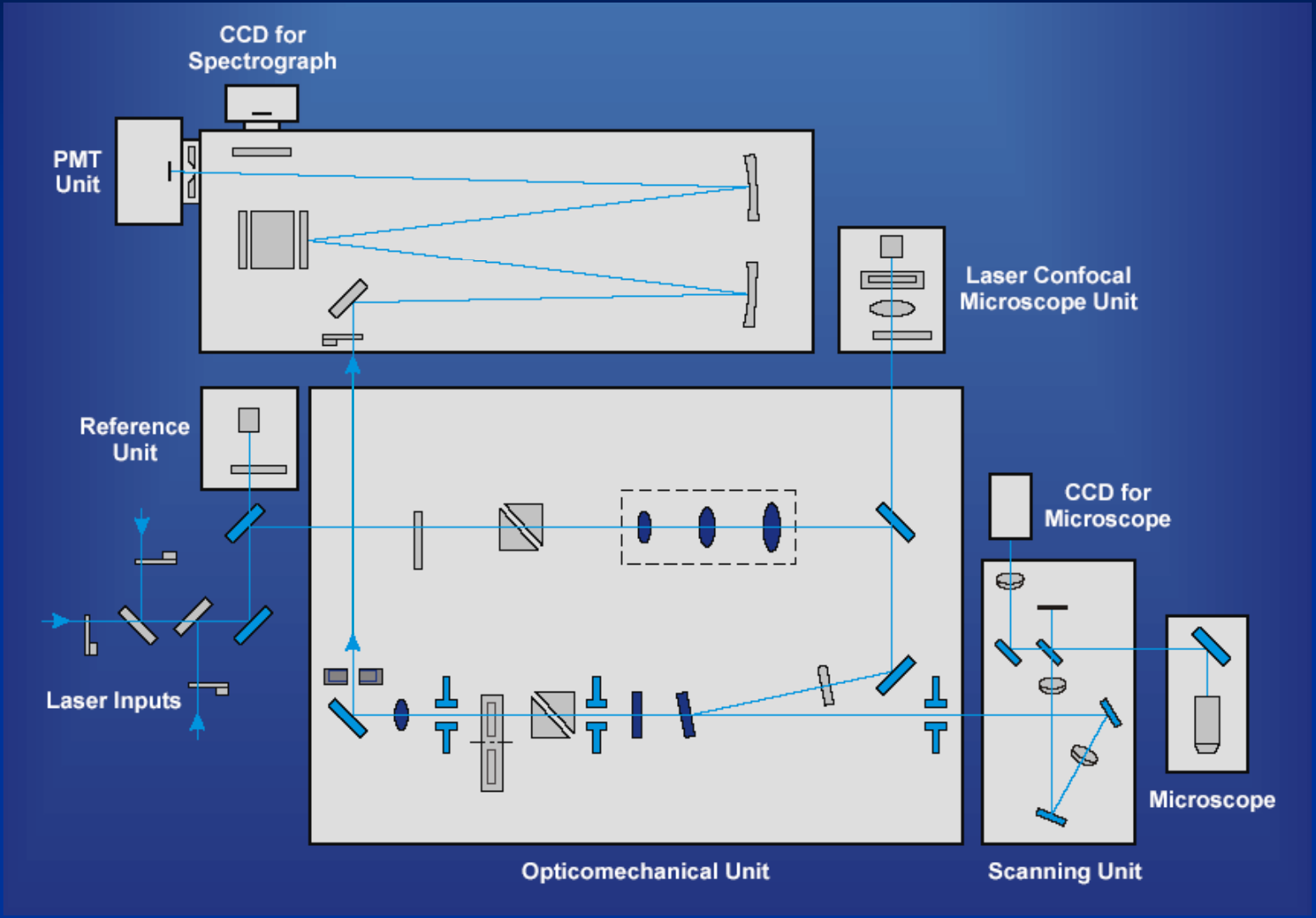
Nanofinder-S modular optical layout



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Inverted Nikon ECLIPSE TE2000-S microscope

- Works in Reflection & Transmission
- High-performance Objectives
  - Plan Fluor 10X/0.30
  - Plan Fluor 40X/0.75
  - CF Plan Apo 100X/0.95
- Coupled with color CCD camera Kappa DX 20 H
  - · SONY ICX 285 CCD Sensor
  - · 2/3" Interline, Progressive Scan
  - · 1384 x 1032 pixel
  - · 0.0016 Lux at 10 sec integration
  - · 12 bit digital
  - · Signal-to-noise ratio 63 dB

	10x	40x	100x
Video Image size (μm)	890 × 660	222 × 165	89 × 66
Confocal Image size (μm)	1100 × 1320	275 × 330	110 × 132

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SCANNING UNITS

1. Scanning unit with galvanometer mirror scanners (X and Y)

110 μm × 132 μm (*with 100x objective*)

spacial optical resolution 200 nm

2. Piezo-scanner (Z)

0 - 80 μm (*with 100x objective*)

spacial optical resolution 500 nm

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OPTICOMECHANICAL UNIT (OMU)

- **Optimized optics:** 400-850 nm
- **Polarizers:** Glan-Taylor prism (excitation and detection channels)
- **Zoom beam expander:** magnification factor 1.8 - 7.2
- **Edge filters positioner:** three-position
- **Interference filters positioner:** six-position
- **Confocal pinhole:** variable from 0 to 1.5 mm
- **Laser beam attenuator:** VND filter

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MONOCHROMATOR-SPECTROGRAPH MS5004i

- **Configuration:** vertical
- **Focal length:** 520 mm
- **Ports:** 1 input, 2 output (CCD & PMT)
- **Flat field:** 28 mm x 10 mm
- **Grating mounts:** 4-position turret
- **Spatial resolution:** 0.008 µm
- **Slit control:** 0 - 2.0 mm, step size 0.5 mm

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MONOCHROMATOR-SPECTROGRAPH MS5004i

• Gratings (grooves/mm):	150	600	1800	75
• Blaze wavelength (nm):	500	500	500	Echelle
• Dispersion (nm/mm):	12.7	3.17	0.94	0.149 – 0.504
• Spectral resolution (nm):	0.24	0.06	0.02	0.0052 – 0.0176
• Wavelength accuracy (±nm):	0.32	0.12	0.04	0.013 – 0.047
• Wavelength repeatability (±nm):	0.089	0.022	0.007	0.0016

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Digital Slow Scan CCD Camera PROSCAN HS-101H

for spectrograph

- A high sensitive back-thinned CCD sensor 1024 × 58 pixels
- Spectral response range from 200 nm to 1100 nm
- Pixel size 24 x 24 µm
- Digitalization rate up to 1 MHz
- ADC 14 bit, correlative double sampling
- Peltier cooling with thermo stabilization & water cooling
- 10 / 100 Ethernet data transfer

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3 PHOTOMULTIPLIER TUBES (PMT)

- PMT for laser confocal microscope
- PMT for spectrograph
- Reference PMT

Hamamatsu R928

Wide Spectral Response	185 to 900 nm
High Cathode Sensitivity	
Luminous	250 A/lm
Radiant at 400nm	74 mA/W
High Anode Sensitivity (at 1000V)	
Luminous	2500 A/lm
Radiant at 400nm	$7.4 \cdot 10^5$ A/W

Low Drift and Hysteresis

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LASER

He-Cd 441.6 nm, 70 mW

COMPUTER / ELECTRONICS

Pentium IV 3GHz, 1GB RAM,
3D Video card with 128 MB RAM,
...

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EXAMPLES OF APPLICATIONS

- Imaging of Silicon Gratings for Scanning Probe Microscopy
  "calibration"
- 3D Confocal Microscopy
  "optical tomography"
- Optical Lithography
  "information storage"
- 2D Confocal Imaging and Raman Spectroscopy
  "chemical phase mapping"

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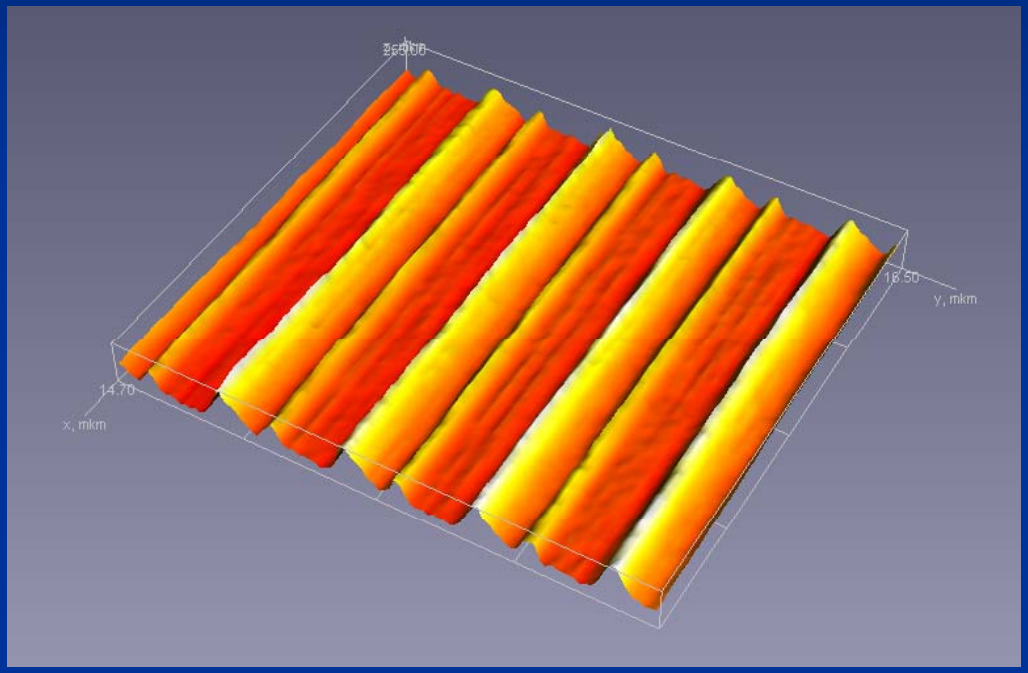
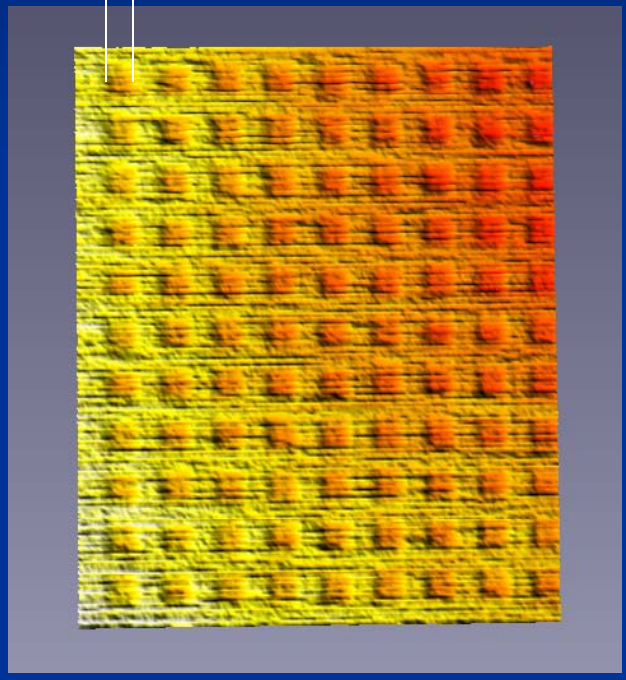
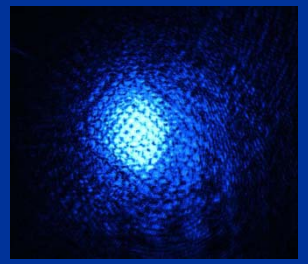
Calibrating Silicon Gratings for Scanning Probe Microscope





TGG1:
image size 36.8×34.8 µm



TGQ1:
image size 27.0×34.5 µm

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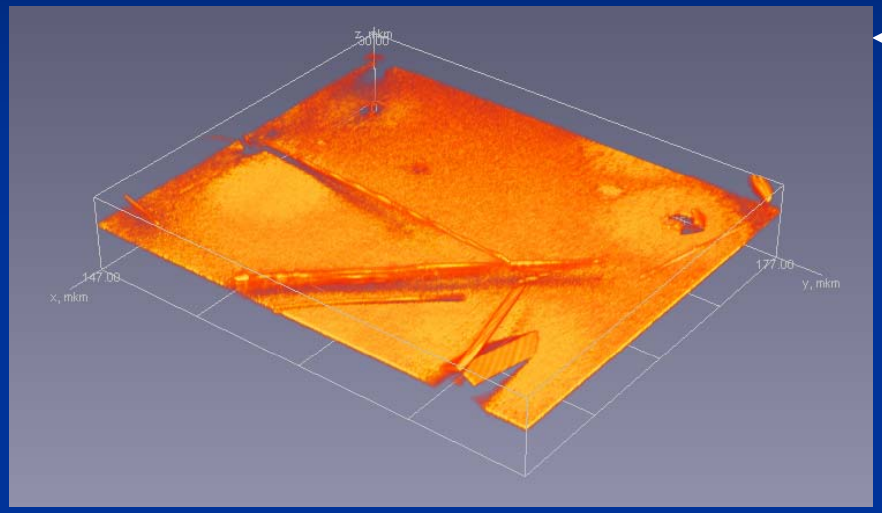
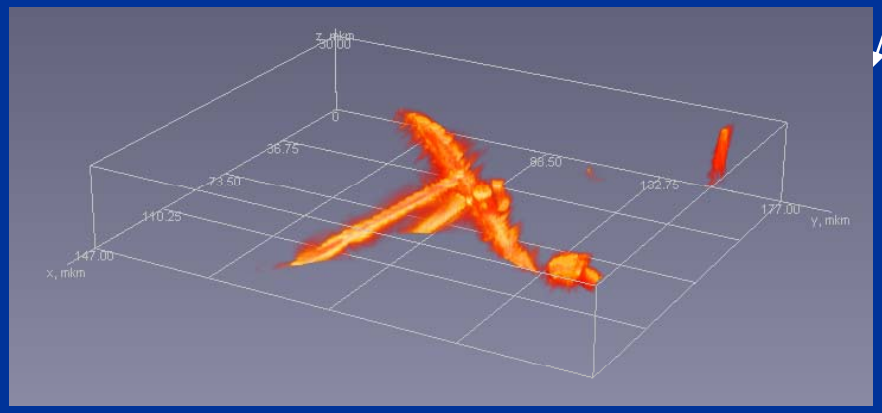
3D Confocal Microscopy

Atmospheric pressure chemical vapour deposition (APCVD) of ZnO microcrystals on Si substrate

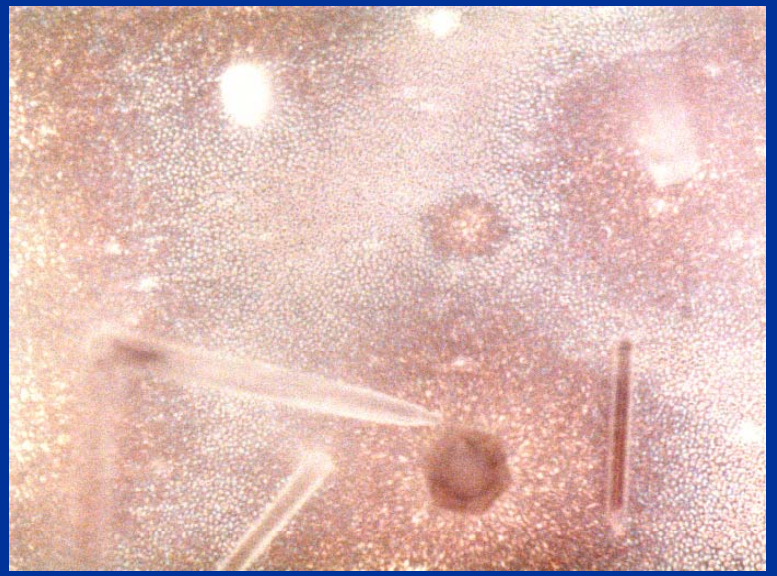




3D confocal images:

110 x 132 x 30 µm

2D optical image



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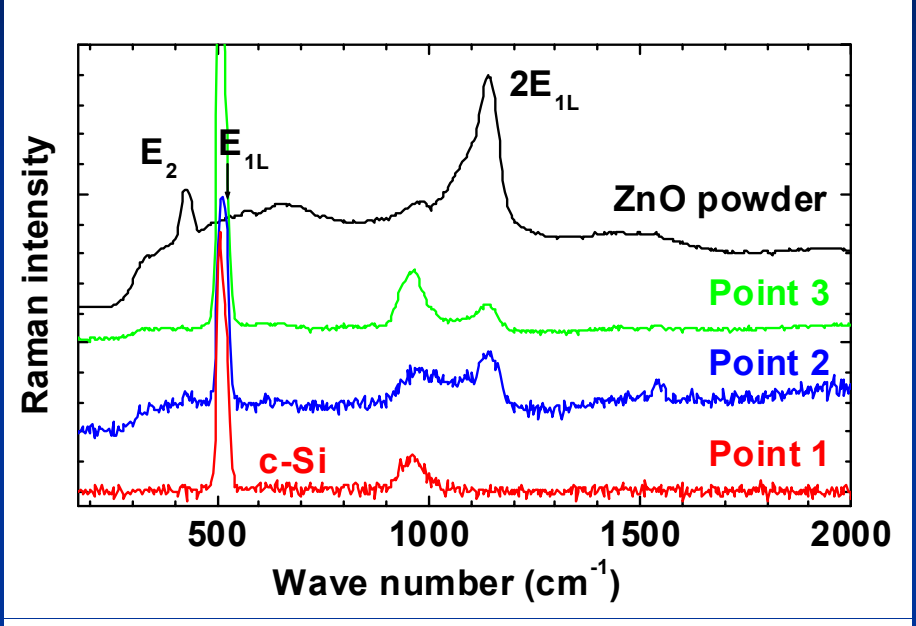
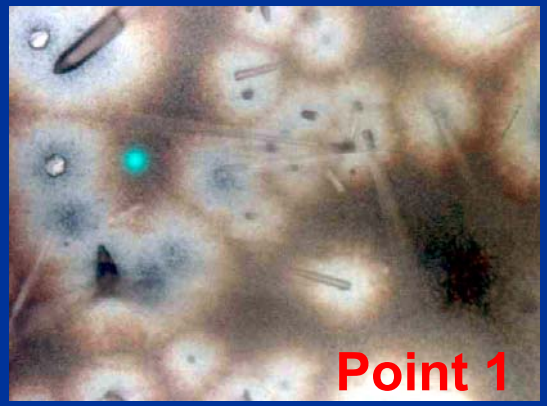
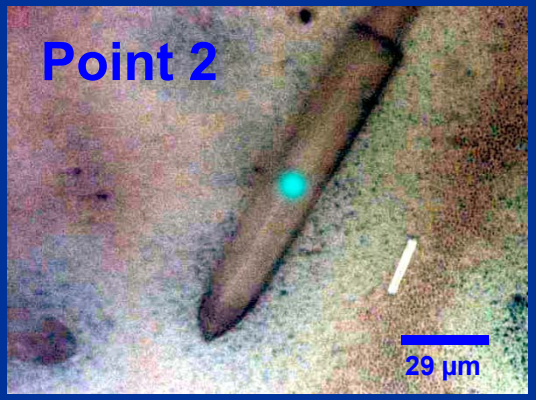
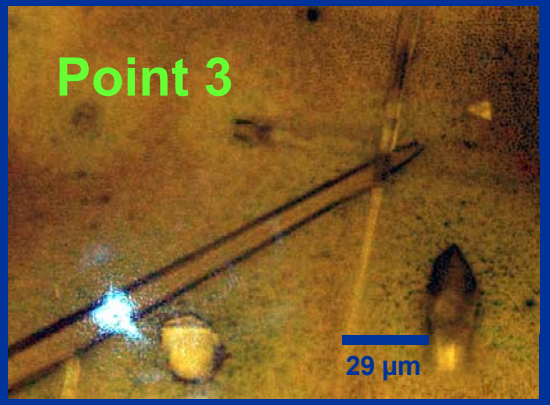
Imaging and Raman Spectroscopy of ZnO needles









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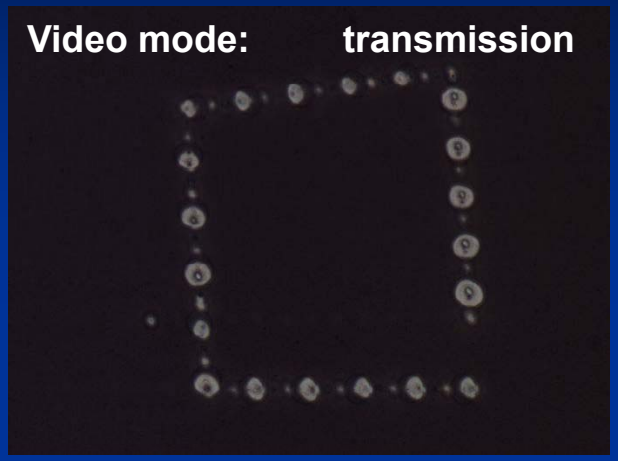
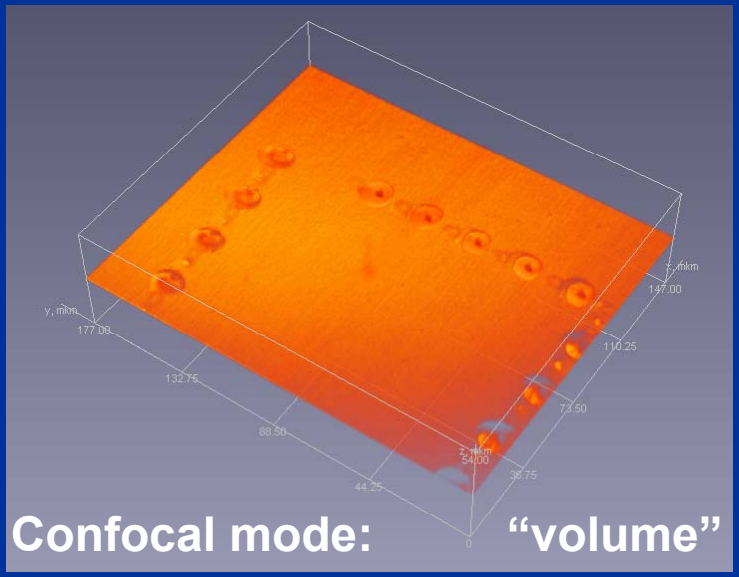
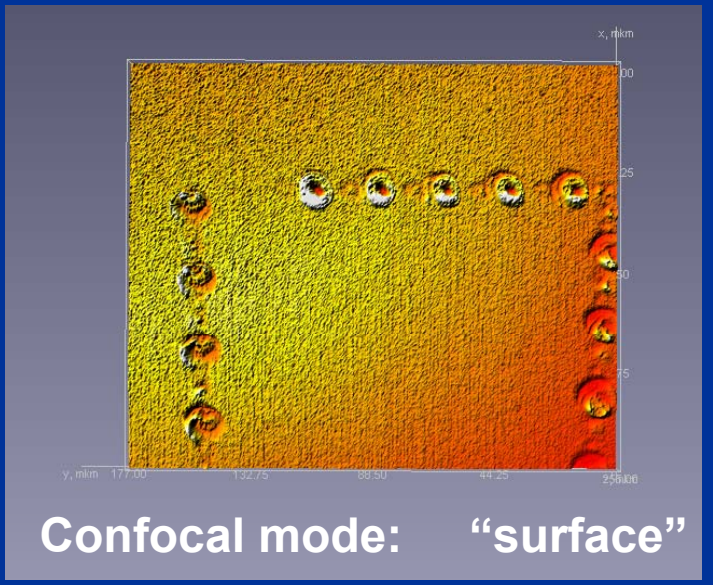
Materials for Optical Information Storage



ZnO_x thin film





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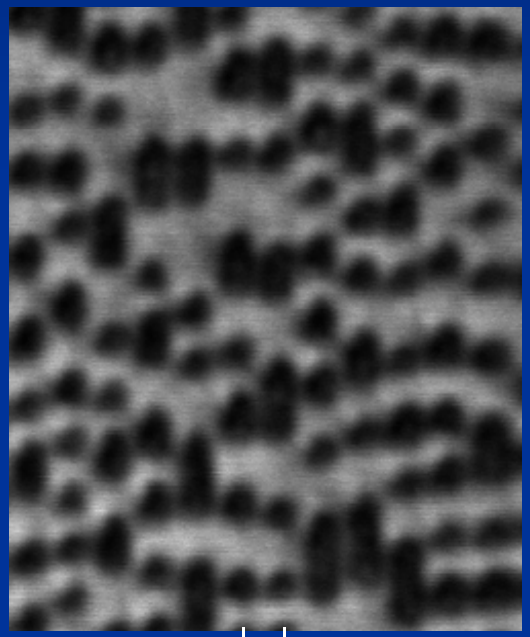
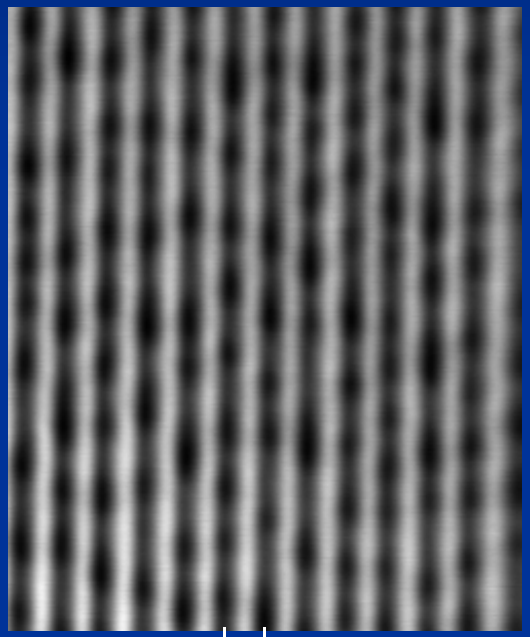
Optical Data Storage

CD-ROM



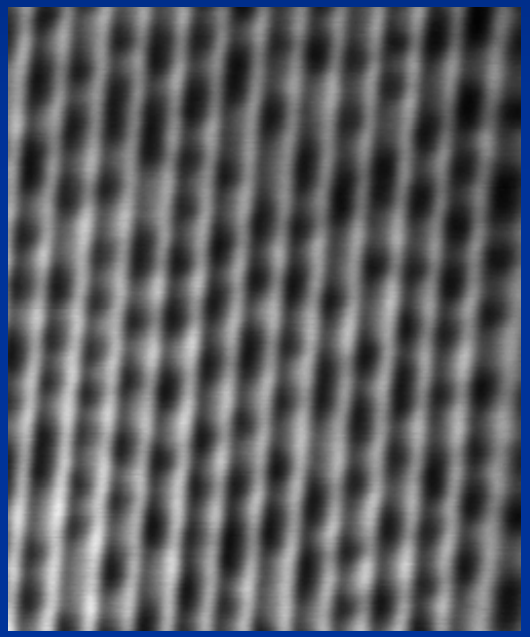
Track pitch = 1.6 μm

CD-R



Track pitch = 1.6 μm

CD-RW



Images size: 20×24 μm

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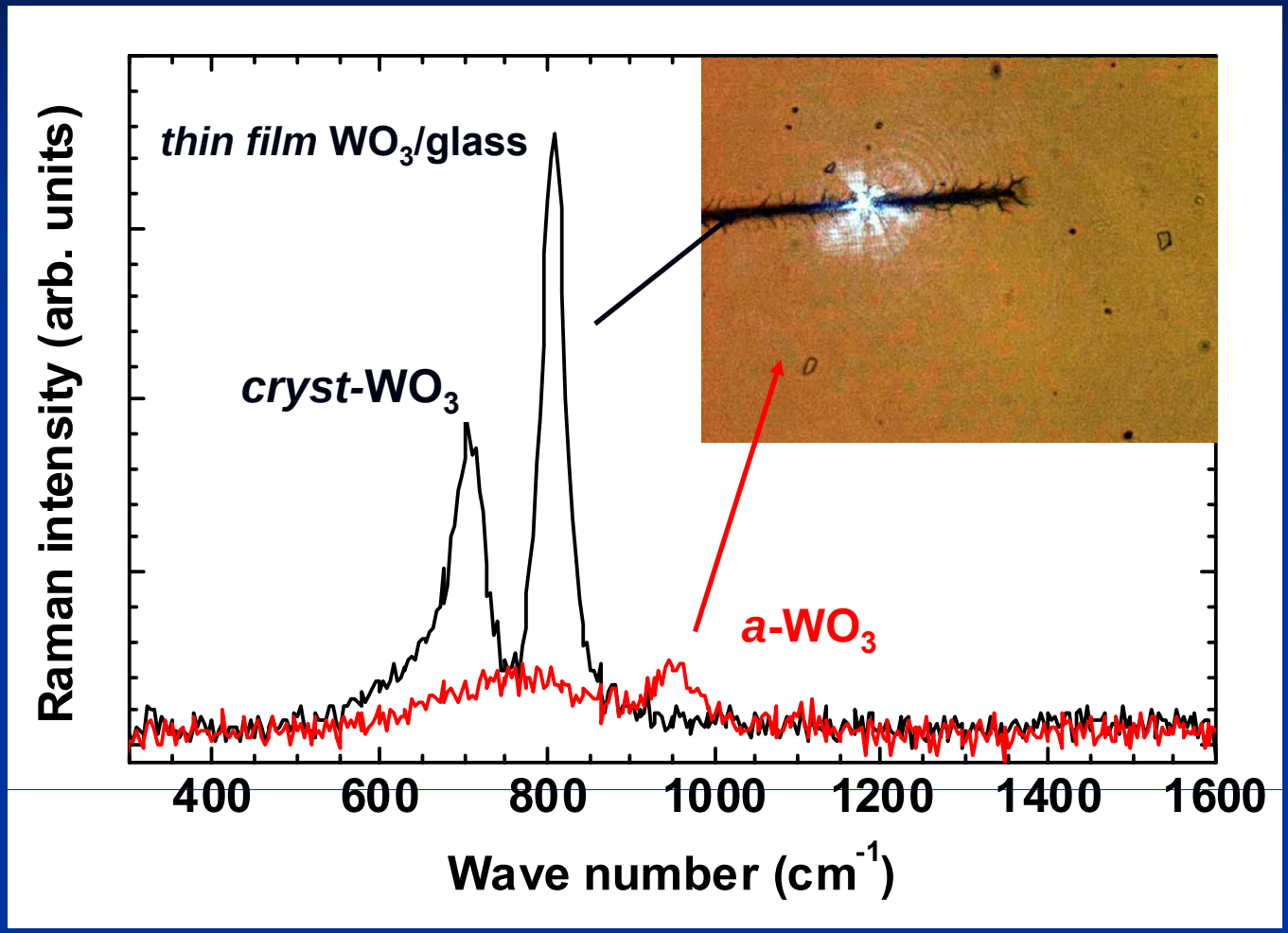
a-WO_3 → cryst-WO_3 phase transition under laser irradiation



Objective 40×; laser power: 70 mW for writing, 12 mW for reading; detection by CCD.

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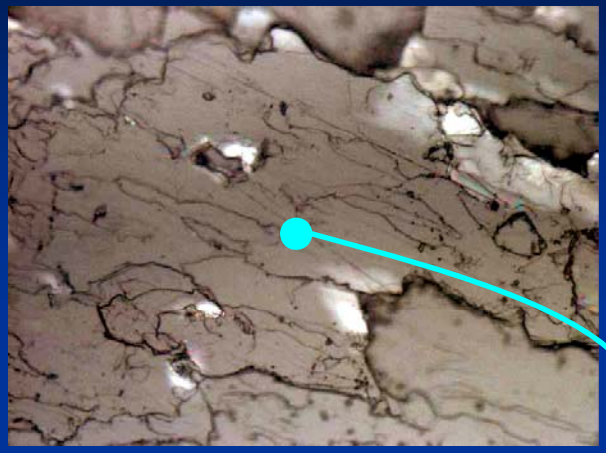
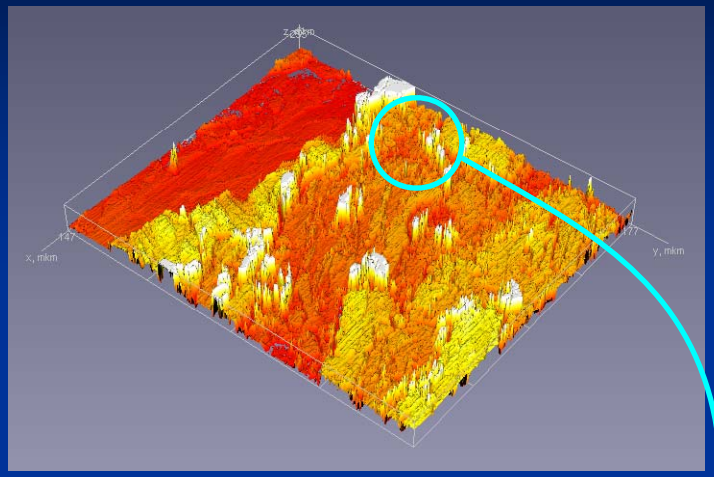
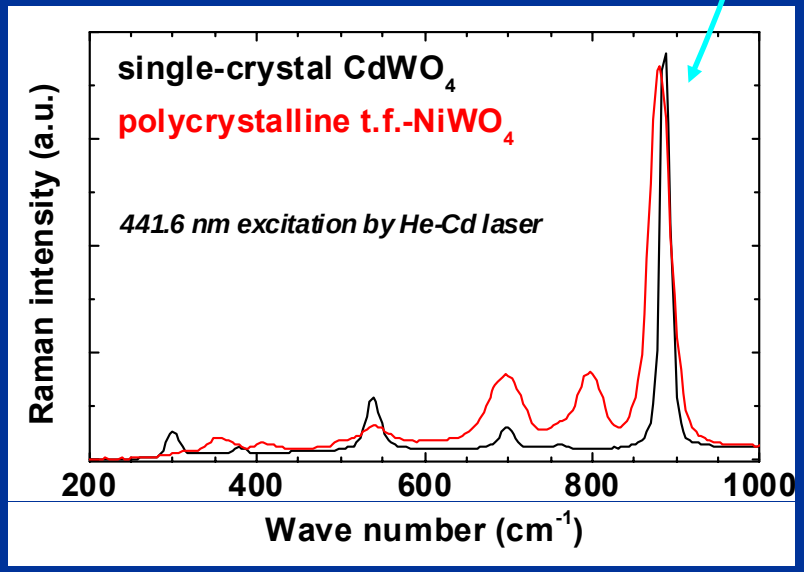
Confocal Imaging and Raman Spectroscopy

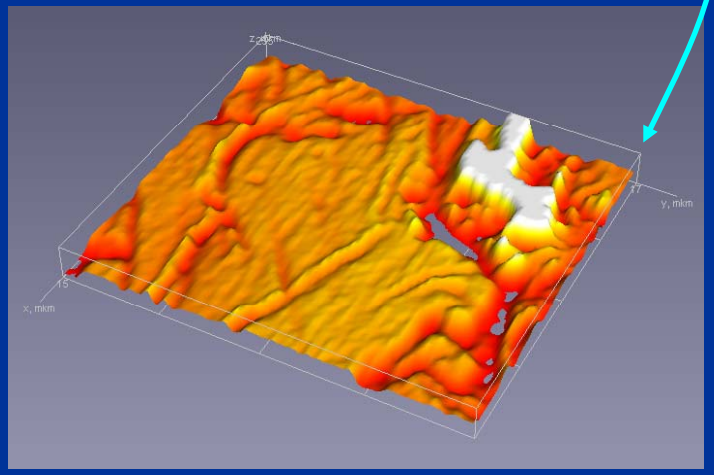


$CdWO_4$: video mode 66×89 μm



Confocal mode: 110×132 μm





Confocal mode: 11×13 μm

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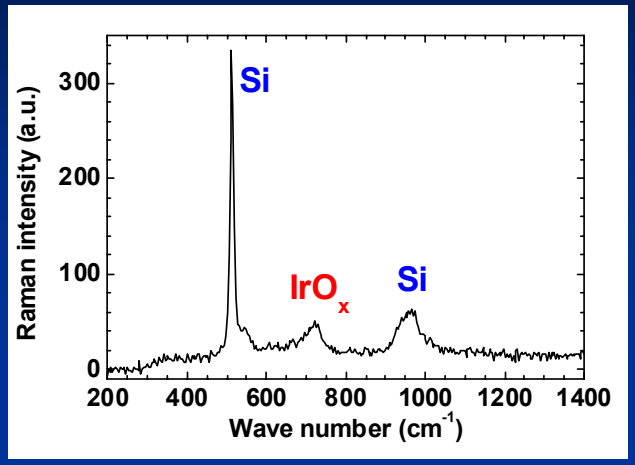
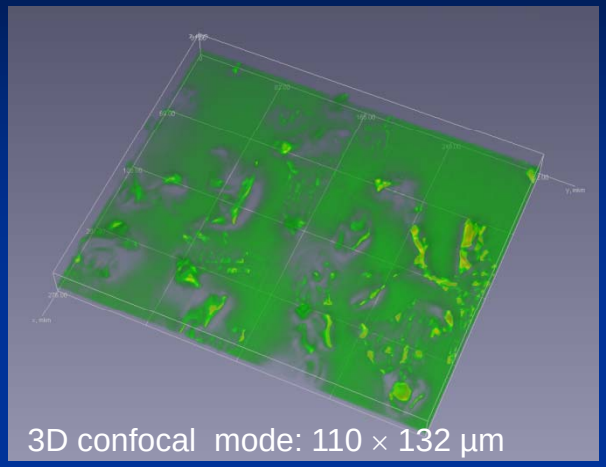
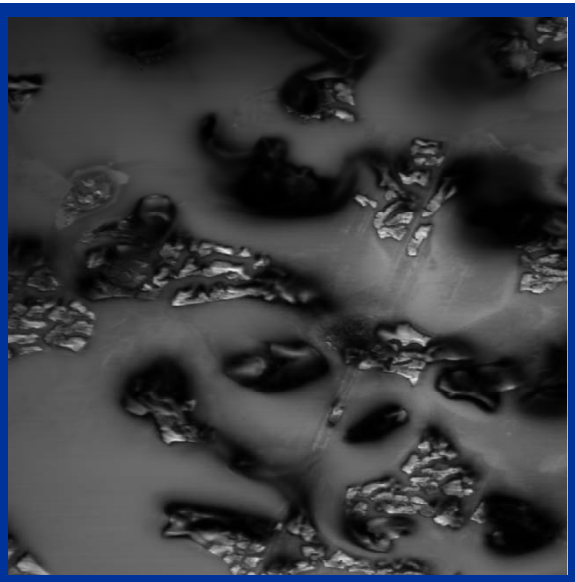
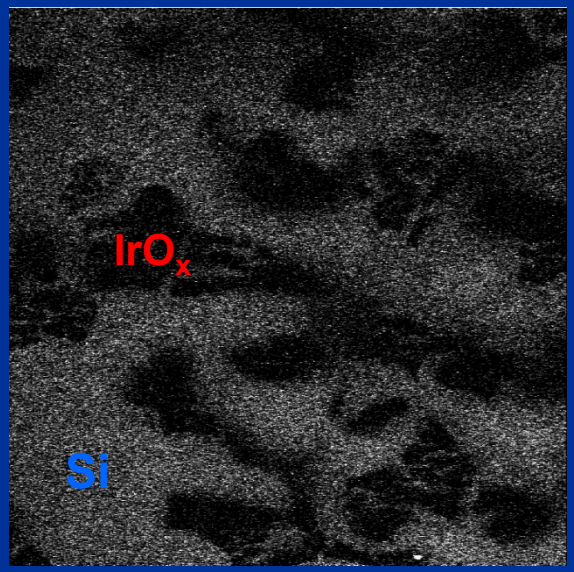
2D Chemical Phase Mapping in Oxide Films







2D confocal mode: 110 × 132 µm



Raman mapping at 520 cm^{-1}

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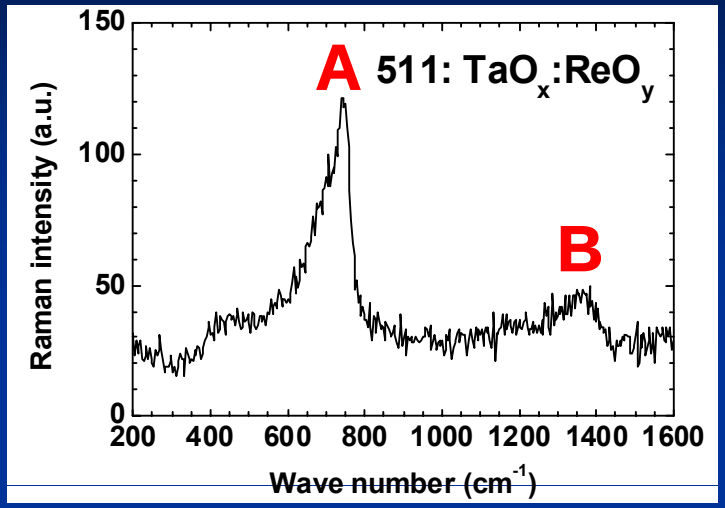
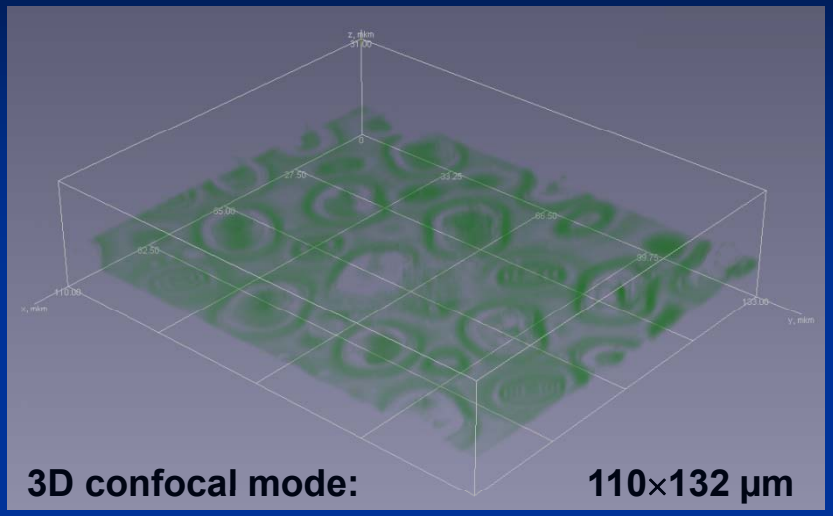
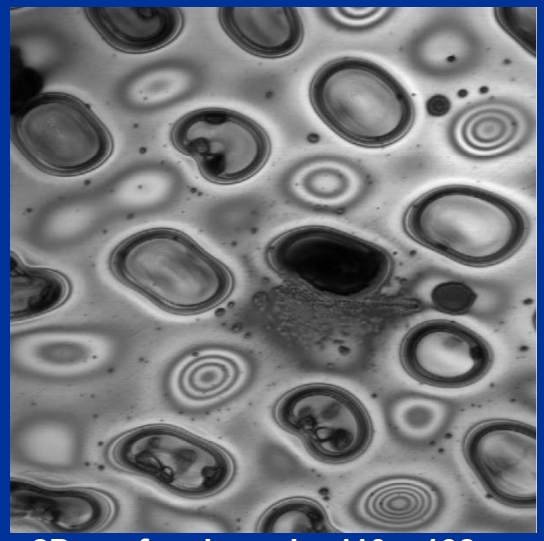
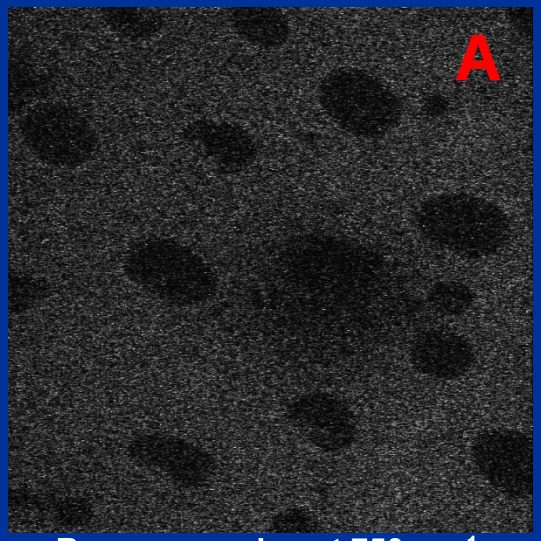
2D Chemical Phase Mapping in Oxide Films



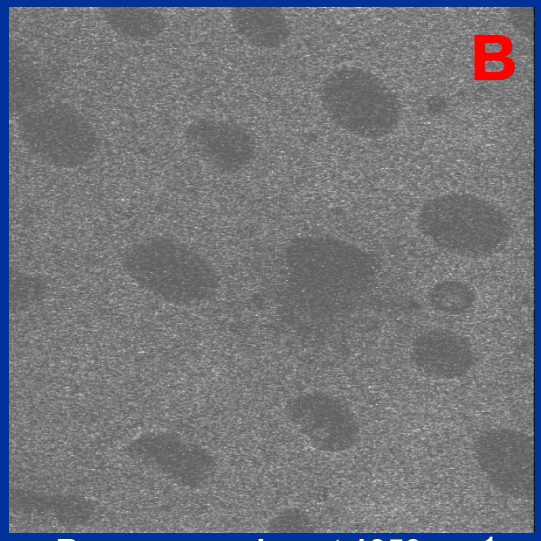




2D confocal mode: 110 × 132 μm



Raman mapping at 750 cm^{-1}



Raman mapping at 1350 cm^{-1}

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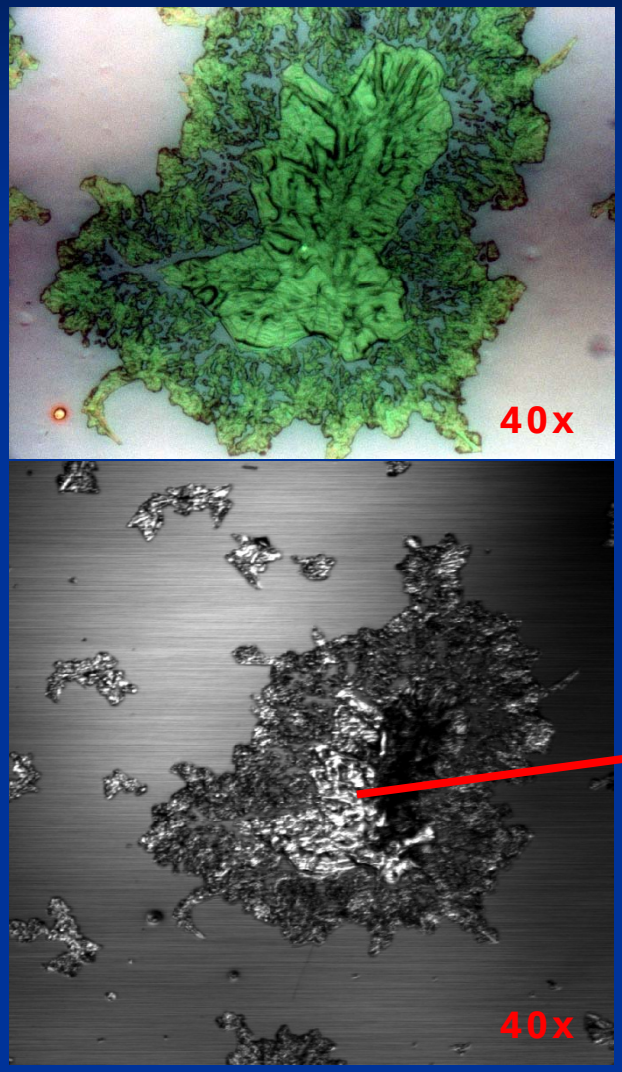
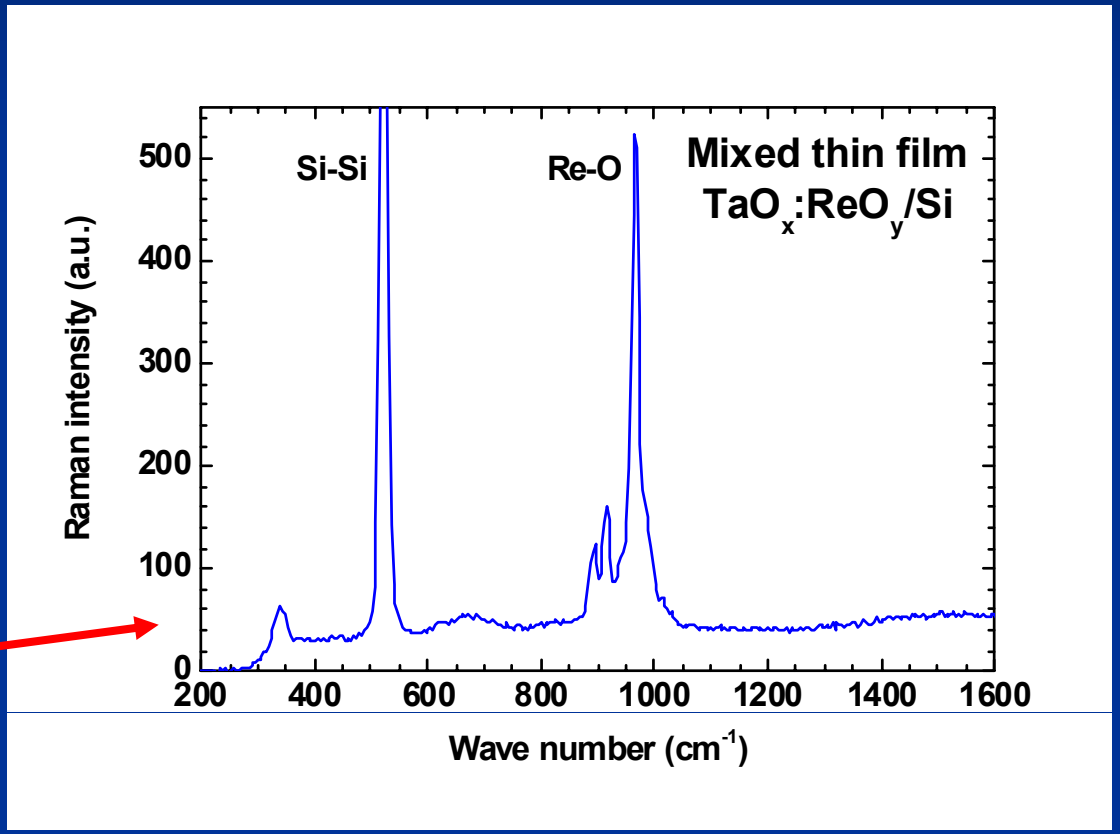
2D Confocal Imaging and Raman Spectroscopy of Films





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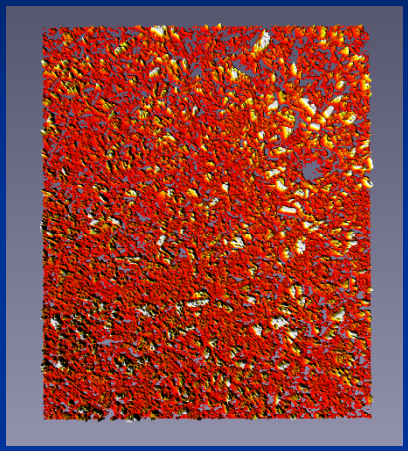
Institute of Solid State Physics, University of Latvia

Confocal Imaging and Raman Spectroscopy of Magnons in Antiferromagnetic Compounds

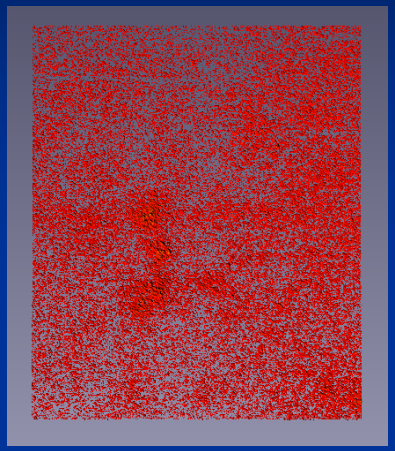
Confocal mode: 275 x 330 μm

NiO/MgO

NiO/MgO
irradiated by neutrons

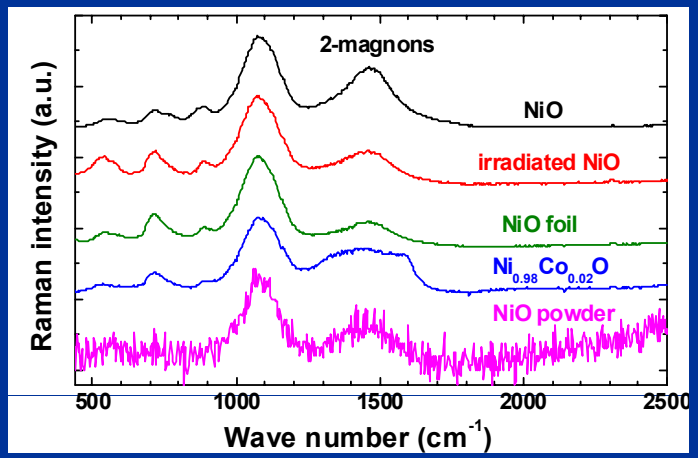


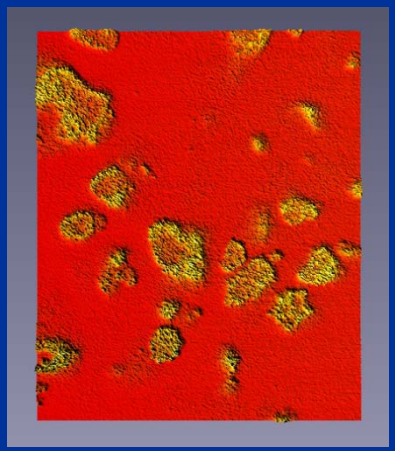
$Ni_{0.98}Co_{0.02}O$/MgO



NiO powder

NiO foil





nano-NiO

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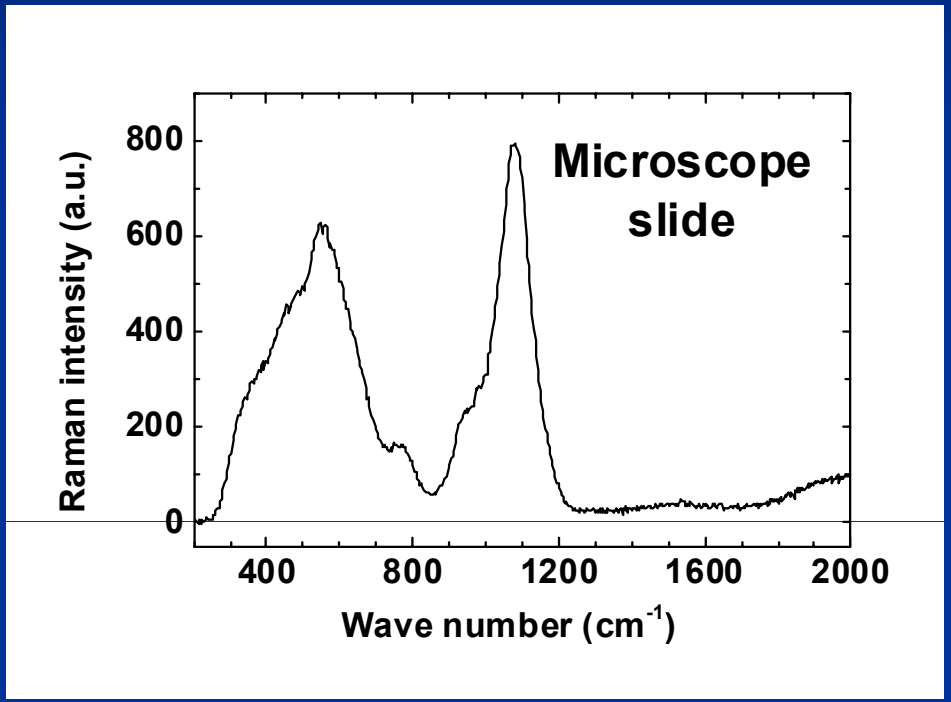
2D Confocal Imaging and Raman Spectroscopy of Glasses

Confocal mode: 275 × 330 μm



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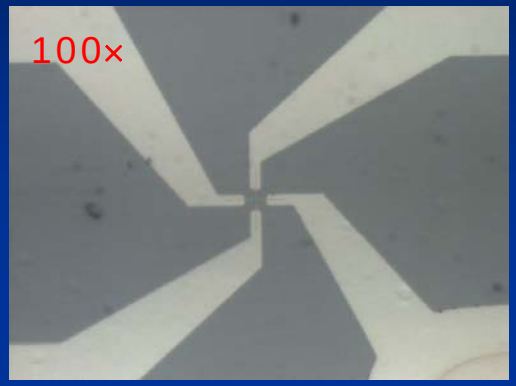
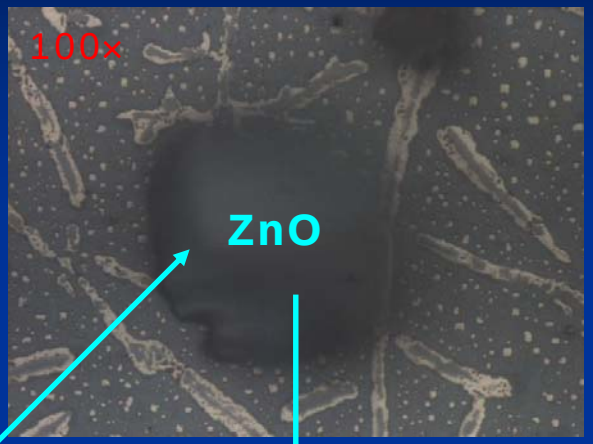
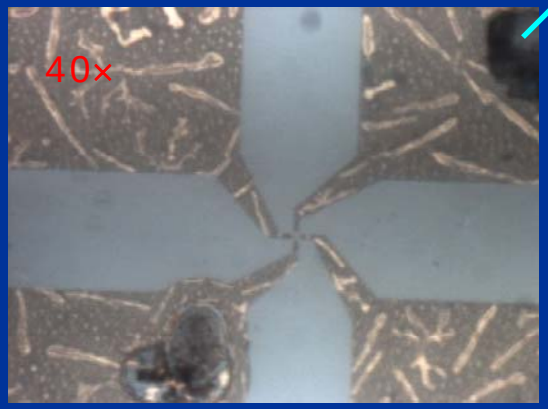
2D & 3D Imaging of Technological Process

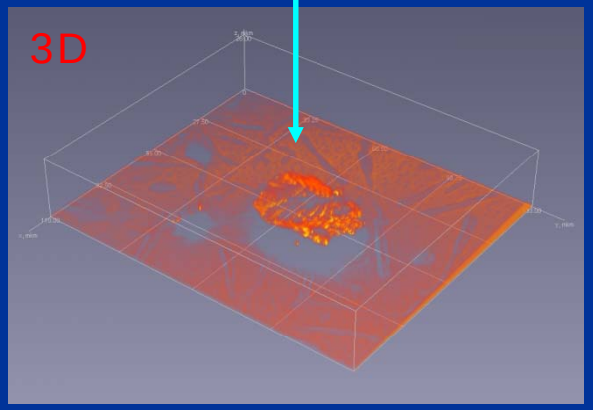


Gold contacts on silicon

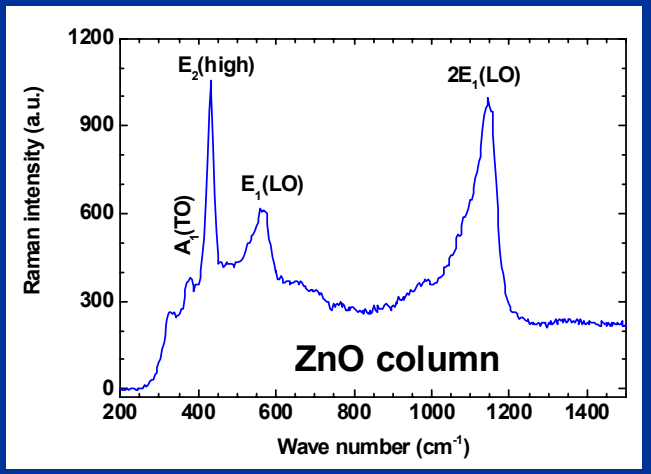




Contacts after heat treatment at 700°C and ZnO deposition



133×110×26 μm



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