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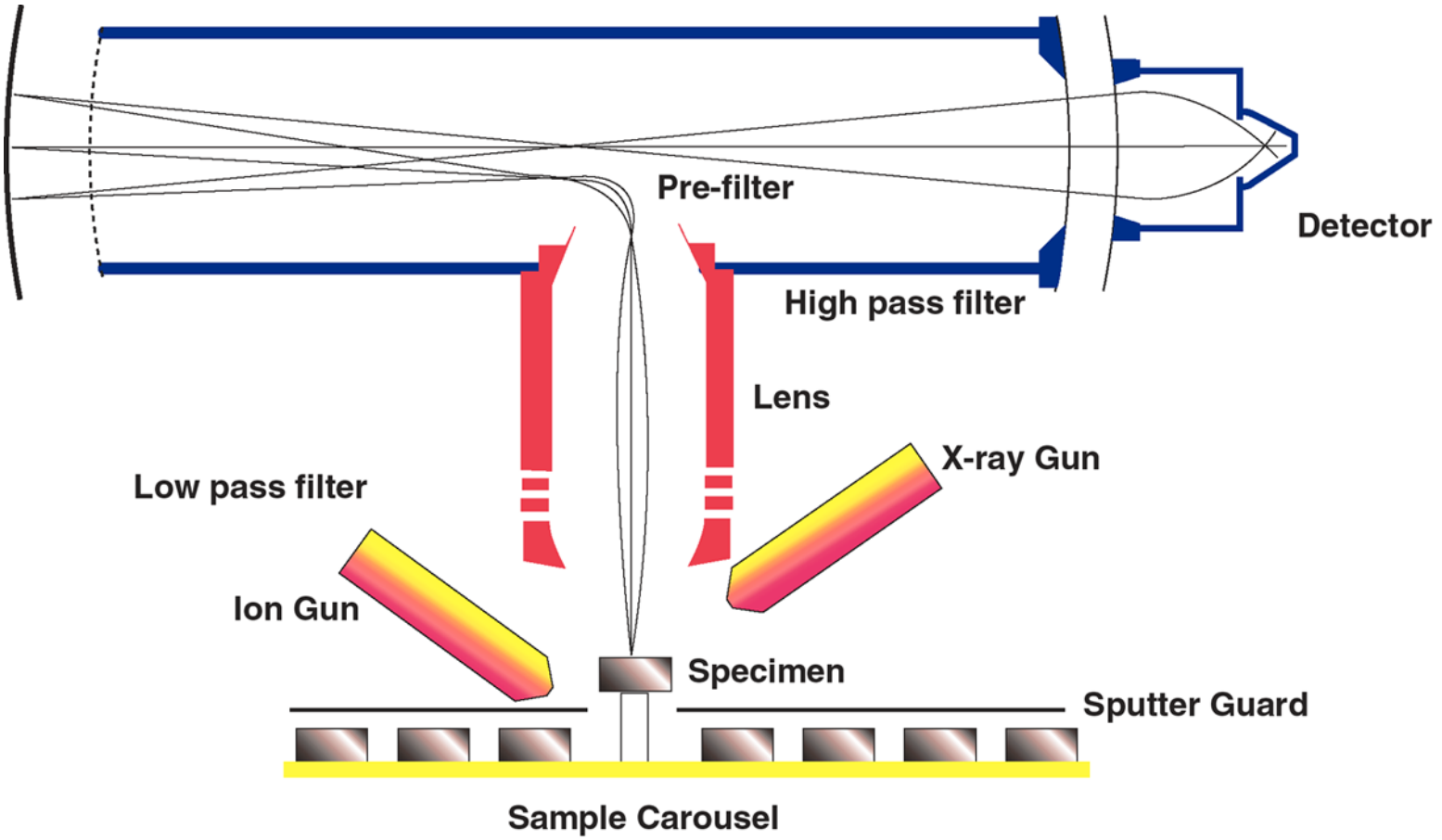
AMICUS Sample and Analyser Geometry



Microscopic Examination

EPMA

Electron Probe Microscope

SEM + WDX + CL

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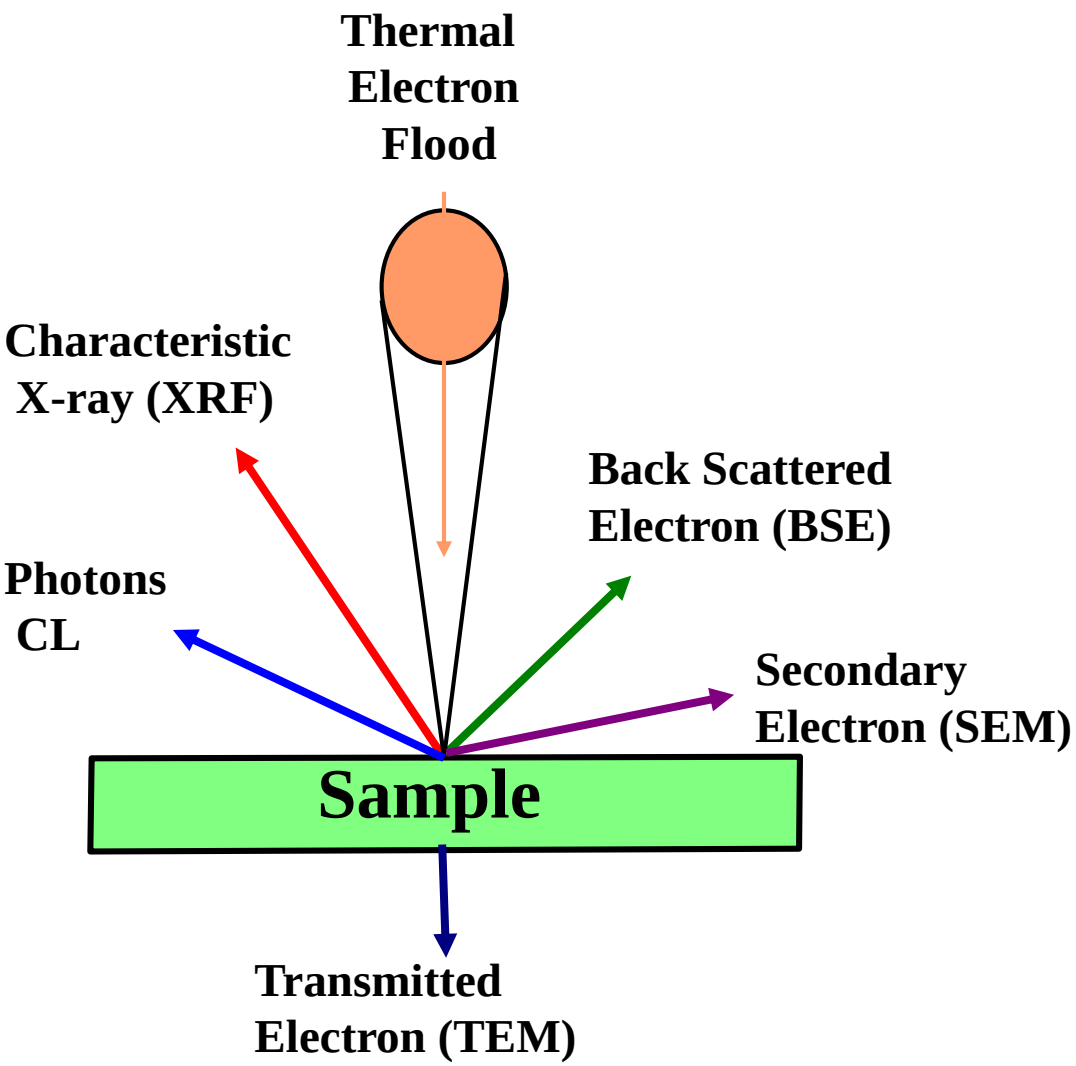
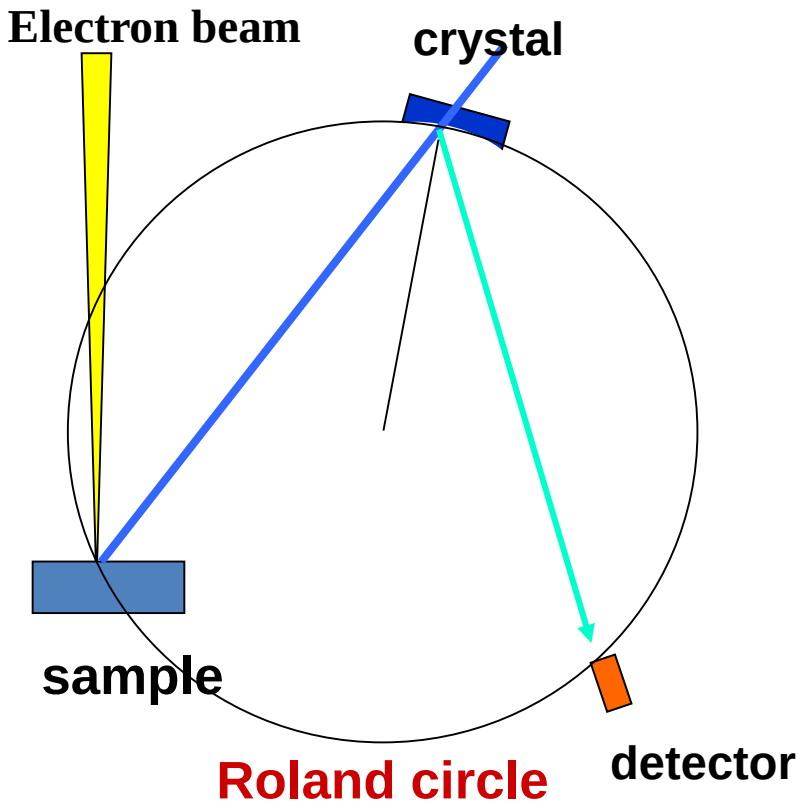
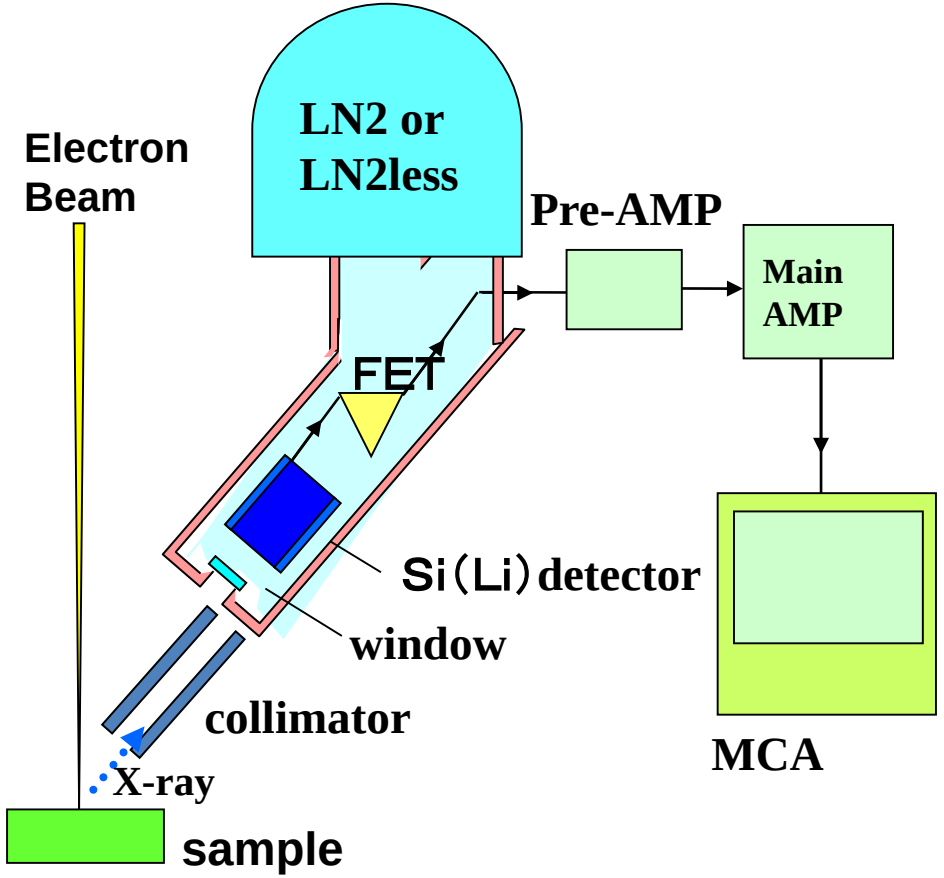
Electron Probe Micro-Analyzer



- Imaging down to 3nm Resolution
- Elemental mapping resolution down to a 0.1µm
- Elemental Range Be to U
- Light element detection down to 10 ppm.

Comparison between WDS & EDS

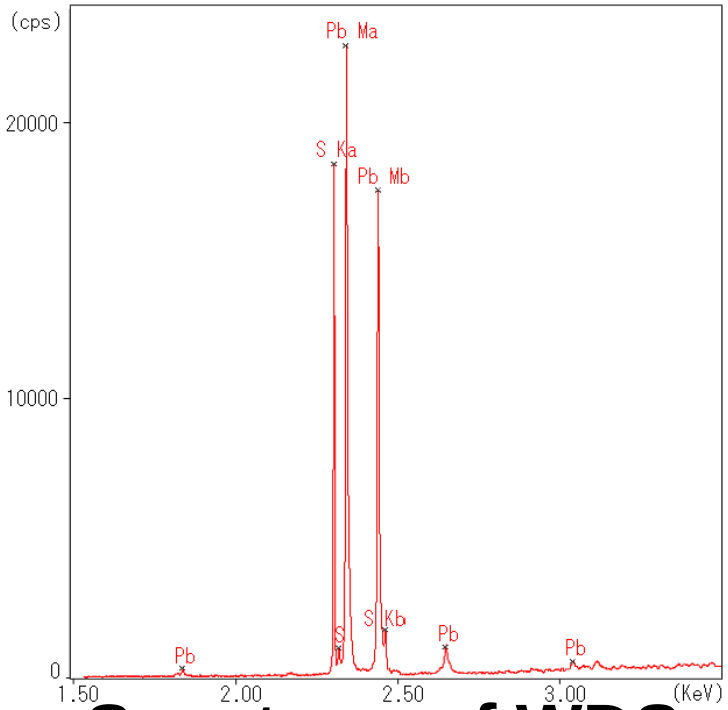




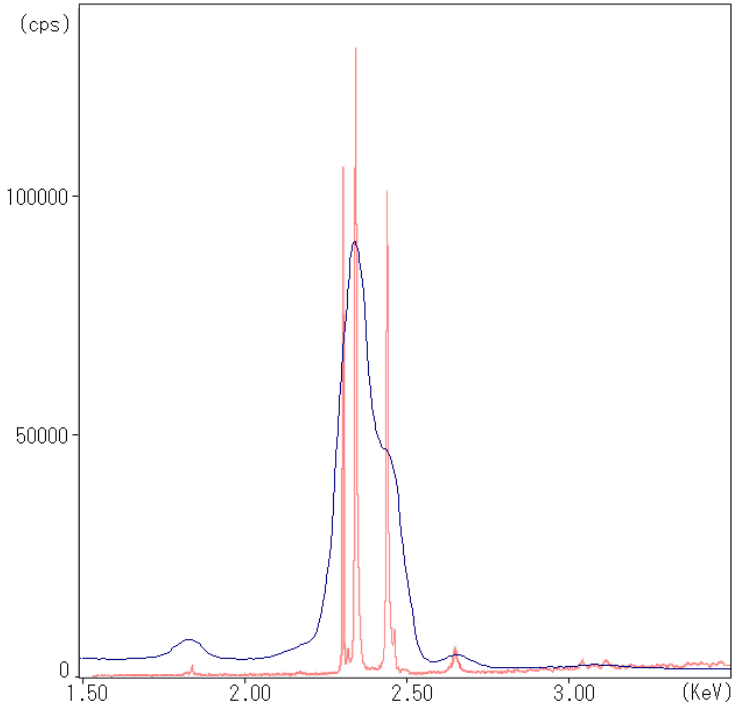
WDS (Wavelength Dispersive Spectrometer)

EDS (Energy Dispersive Spectrometer)

Advantages for WDS



Spectrum of WDS



Spectrum of EDS

①Higher resolution (brings precise identification)

② Higher Signal/Noise ratio (Good for lower quantity)

③Never saturate under big current condition (Can analyze from 100% to very small quantity)

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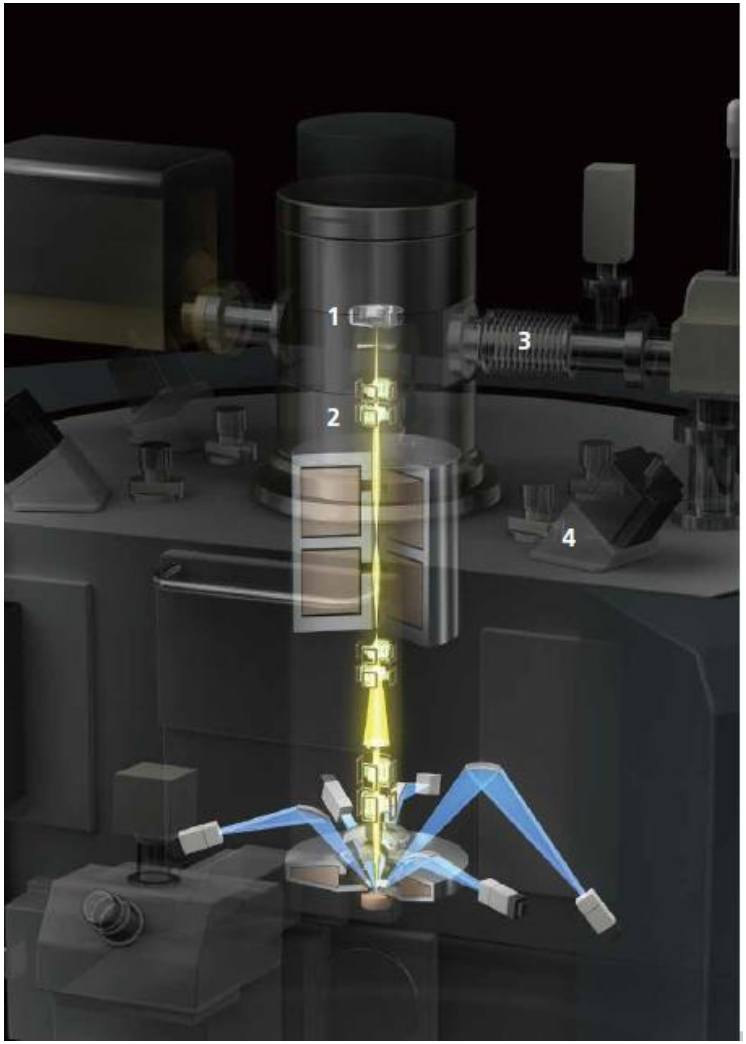
Electron Probe Micro-Analyzer



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Electron Probe Micro-Analyzer

EPMA-1720H

EPMA-8505G

Observation GUI

Beam Condition

EM Image

OM Image

Electron beam control

WDS control

Sample stage control

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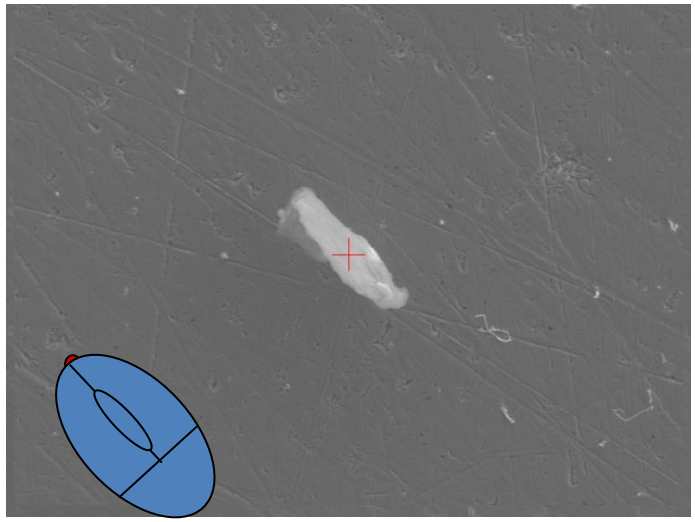
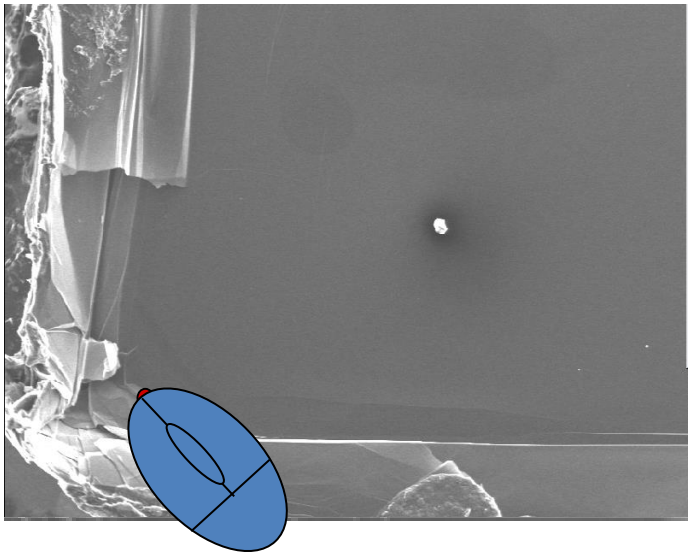
Sample Stage movement by mouse

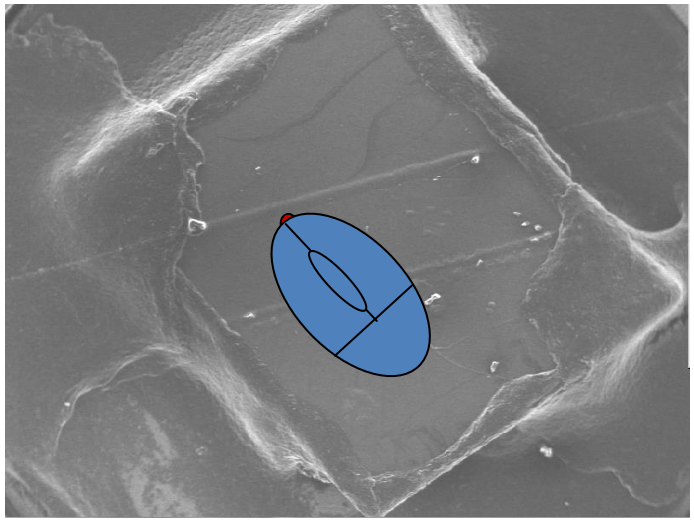
Centering by double clicking

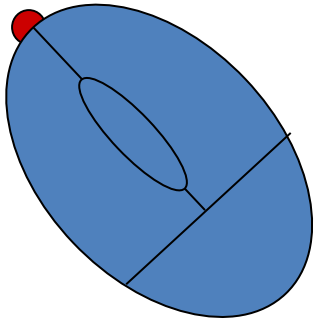


Sample movement by drag & drop



Sample movement by joystick





Mouse operation

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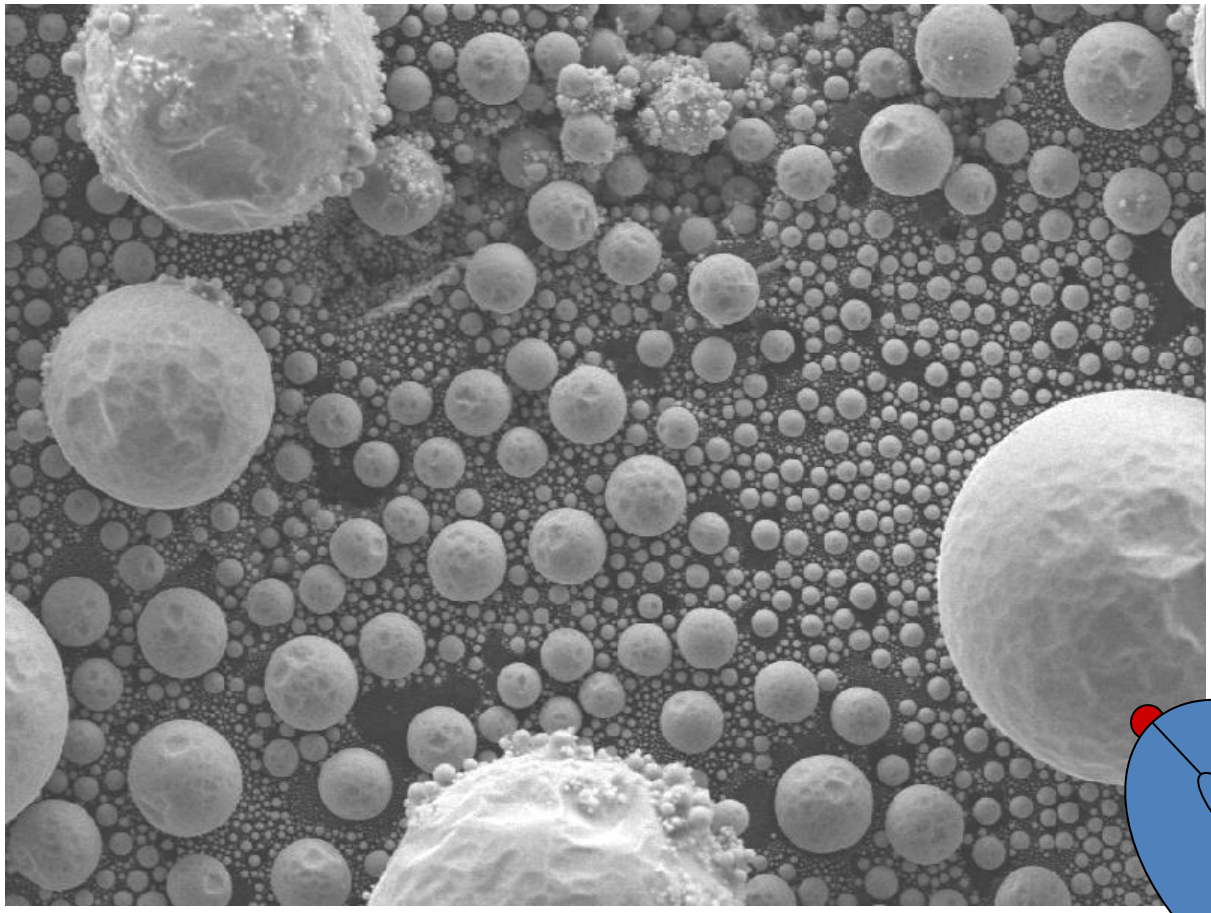
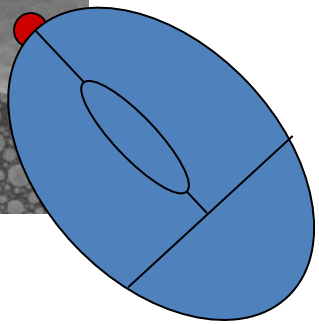
Focusing



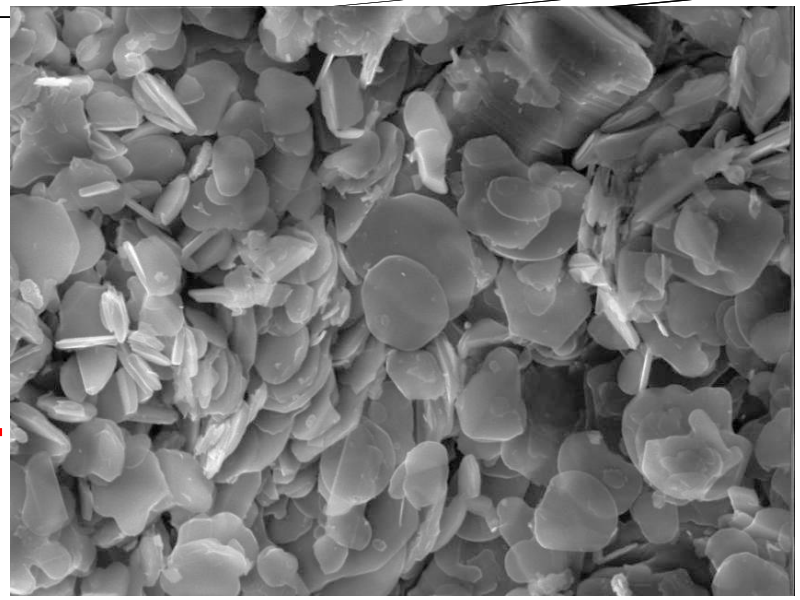


Mouse Operation

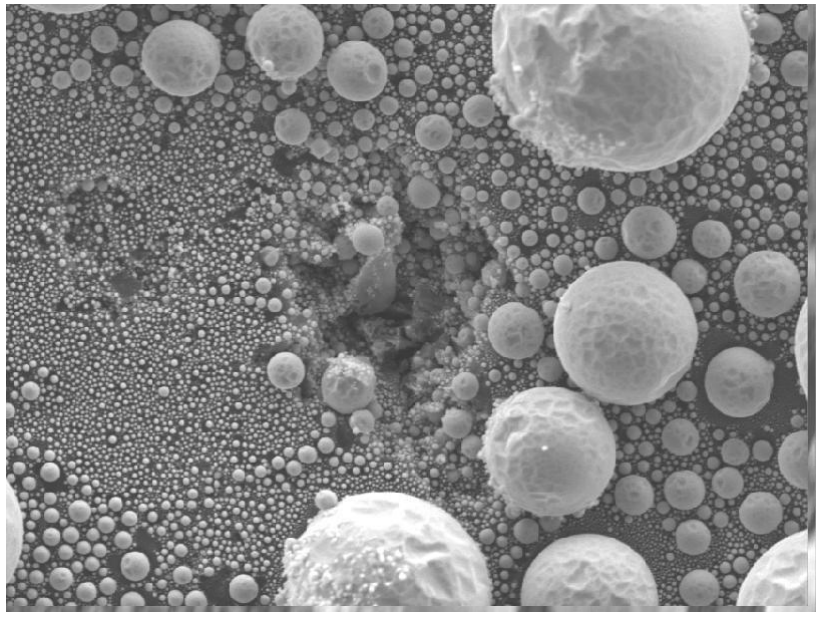
SHIMADZU

Auto Functions

Auto Contrast & Brightness



Auto Stigma & Focusing



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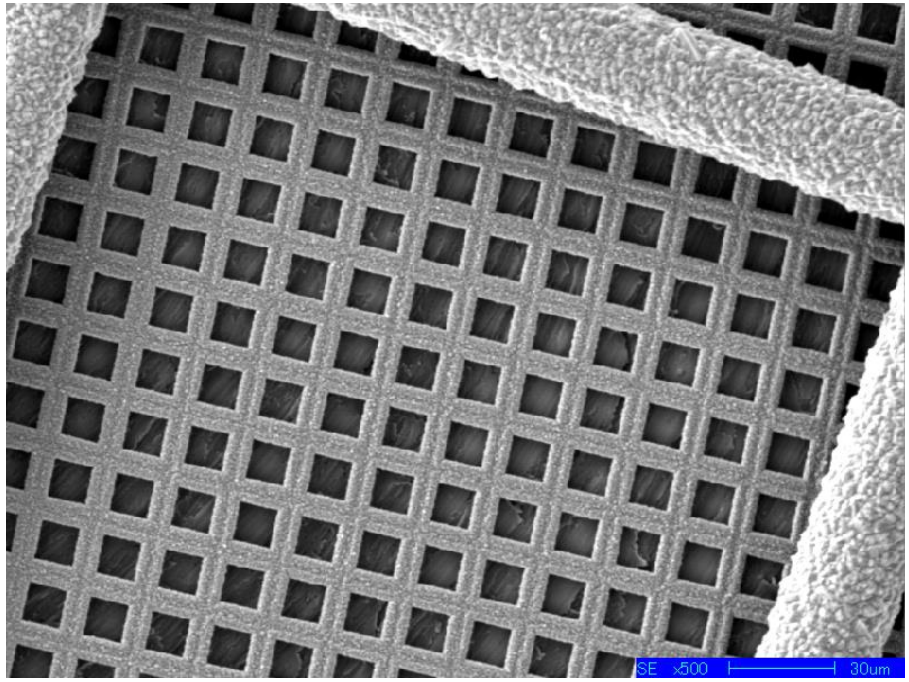
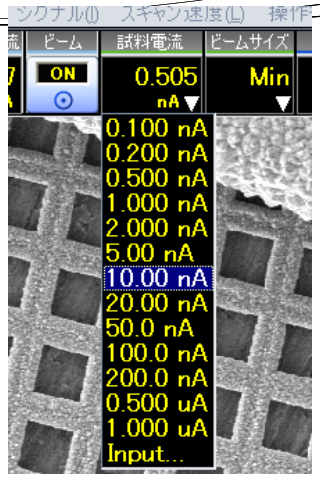
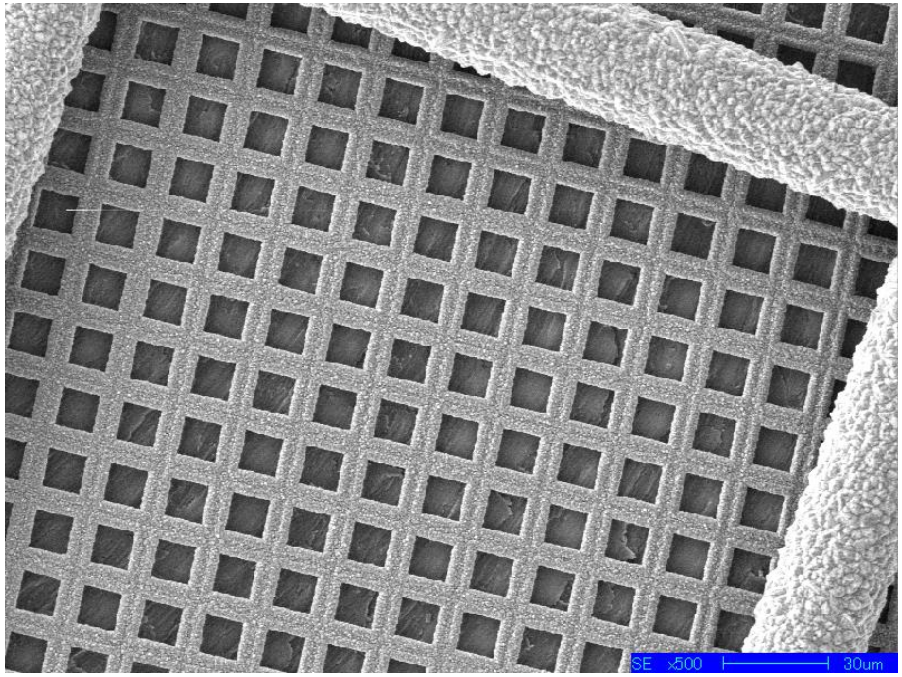
Change for Beam Current



Beam Current 500pA



Beam Current 10nA



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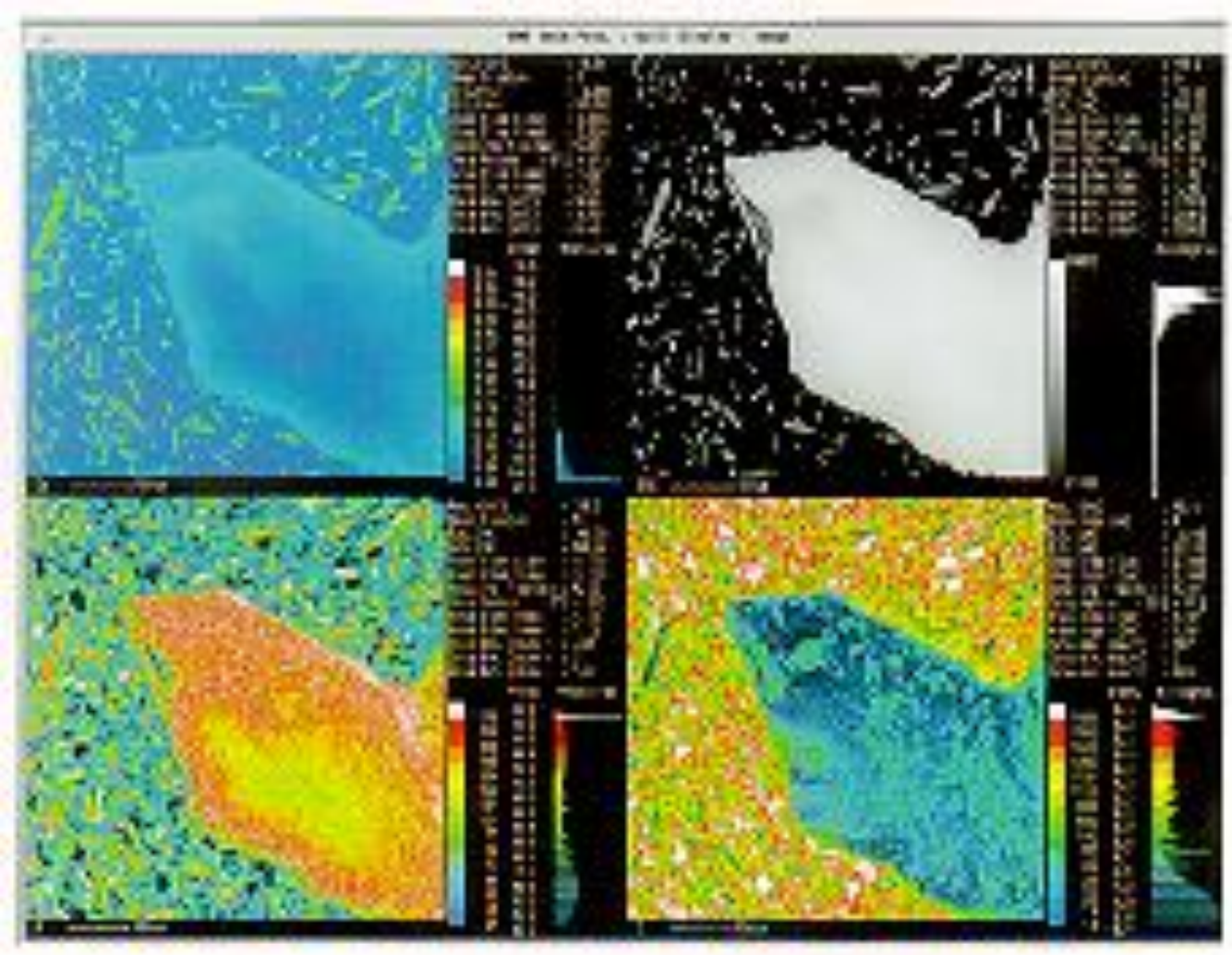
Electron Probe Micro-Analyzer

Ca

BSE



O

C

EPMA 1720 mapping - 500x500 µm²

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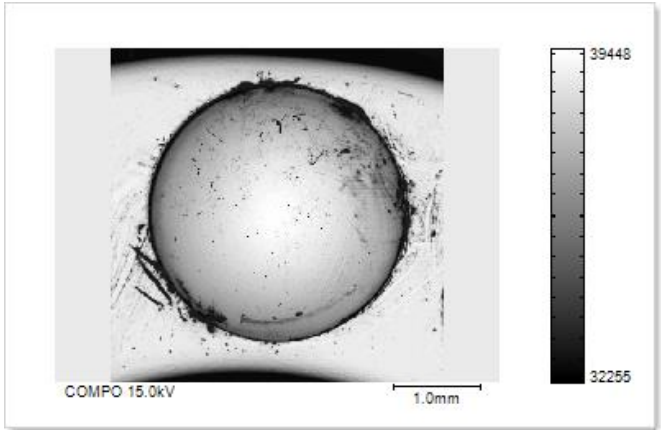
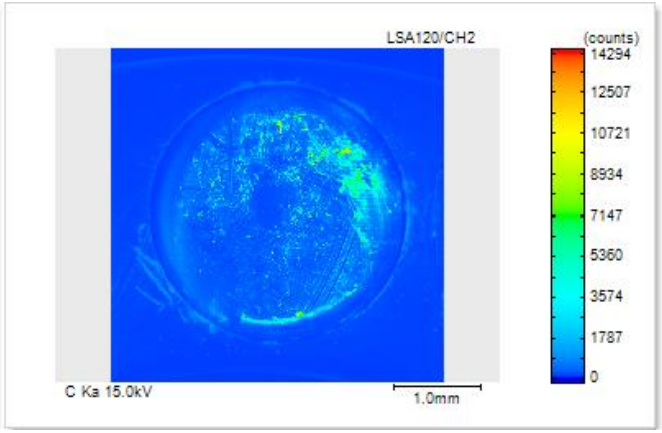
Trace mapping results

Trace mapping OFF



BEI



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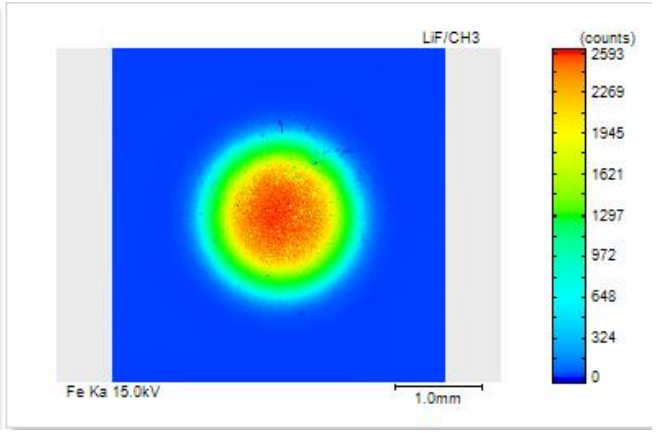
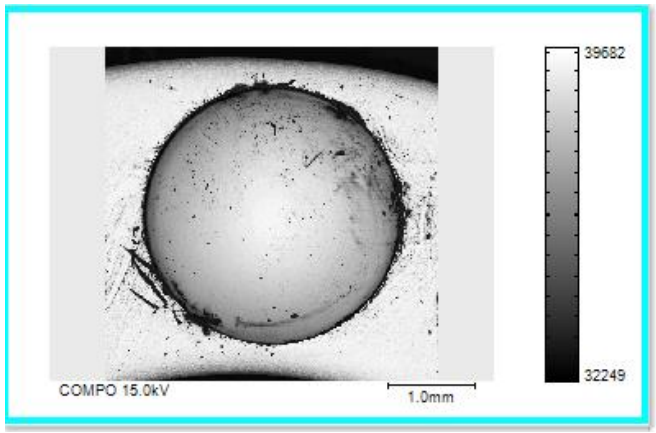
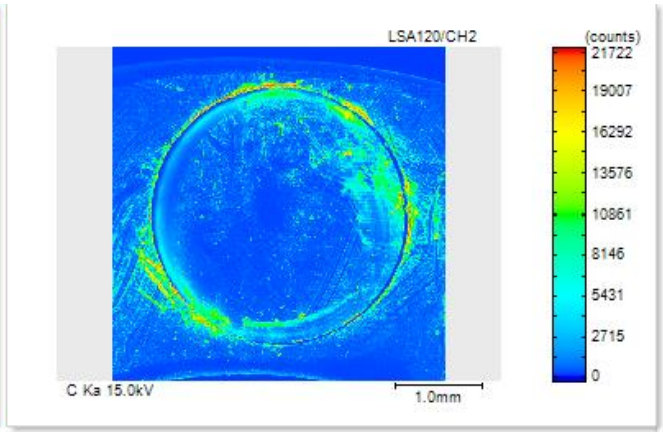


Fe

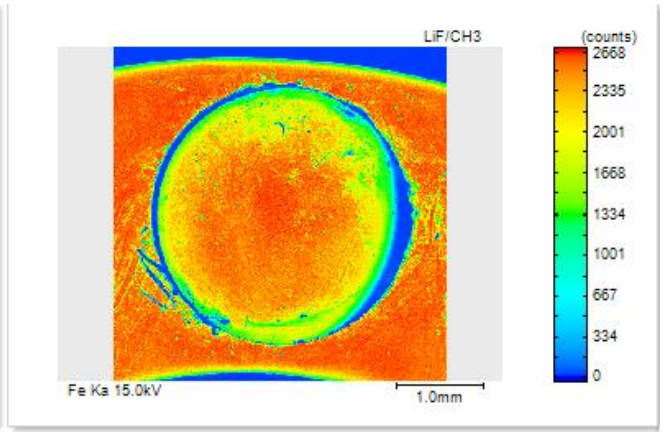
Trace mapping ON



BEI



C



Fe

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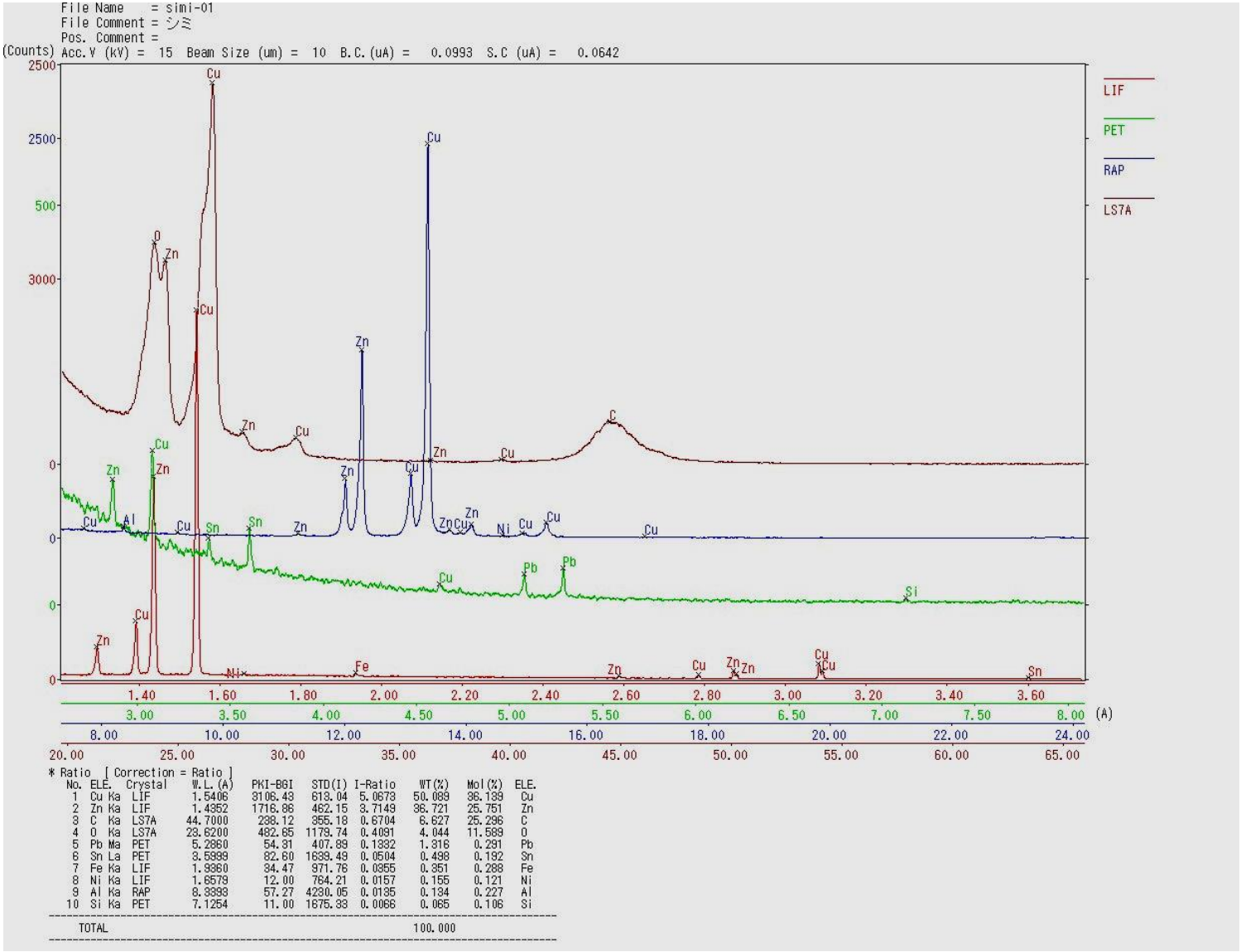
Qualitative Analysis by WDS



* Ratio [Correction = Ratio]

No.	ELE.	Crystal	W.L.(A)	PKI-BGI	STD(I)	I-Ratio	WT(%)	Mol(%)	ELE.
1	Cu Ka	LIF	1.5406	3106.43	618.04	5.0673	50.089	36.139	Cu
2	Zn Ka	LIF	1.4352	1716.86	462.15	3.7149	36.721	25.751	Zn
3	C Ka	LS7A	44.7000	238.12	355.18	0.6704	6.627	25.296	C
4	O Ka	LS7A	23.6200	482.65	1179.74	0.4091	4.044	11.589	O
5	Pb Ma	PET	5.2860	54.31	407.89	0.1332	1.316	0.291	Pb
6	Sn La	PET	3.5999	82.60	1639.49	0.0504	0.498	0.192	Sn
7	Fe Ka	LIF	1.9360	34.47	971.76	0.0355	0.351	0.288	Fe
8	Ni Ka	LIF	1.6579	12.00	764.21	0.0157	0.155	0.121	Ni
9	Al Ka	RAP	8.3393	57.27	4230.05	0.0135	0.134	0.227	Al
10	Si Ka	PET	7.1254	11.00	1675.33	0.0066	0.065	0.106	Si
	TOTAL						100.000		

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Debut of "the Grand EPMA"

With a Cutting-Edge FE Electron Optical System, the Ultimate in Advanced Shimadzu EPMA Analysis Performance !

Debut of "the Grand EPMA"

Refined stylish form !

The latest model of the full-faced-mask which only Shimadzu adopted in the world.
The solid and novel design appropriate for The high-end model brings necessary influence for EPMA including shield and temperature control as well as seemliness.

and

Shimadzu EPMA-8050G is an energy saving design!
Our cut consumption electricity more than 30% while being a superlative degree product giving the world's best performance !
(Comparison with EPMA-1720 series)

Shimadzu announces eco-friendly EPMA with a person by prominent operability and energy saving design.

SHIMADZU

The high-end model in pursuit of the beauty of the image

New electronic optical system & vibration insulation mechanism & Magnetic shield deployment

The secondary-electron image resolution of 3 nm (30 kV accelerating voltage) is the highest level for an EPMA system.

Comparison of SEM image EPMA-8050G VS. EPMA-1720H

EPMA-8050G

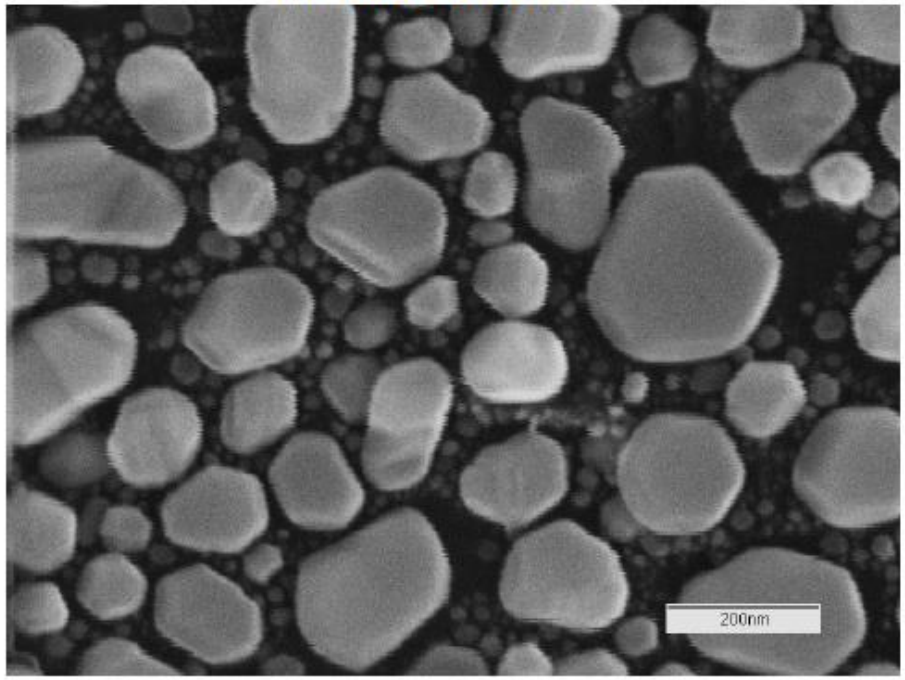


Image resolving power : 3 nm

EPMA-1720H

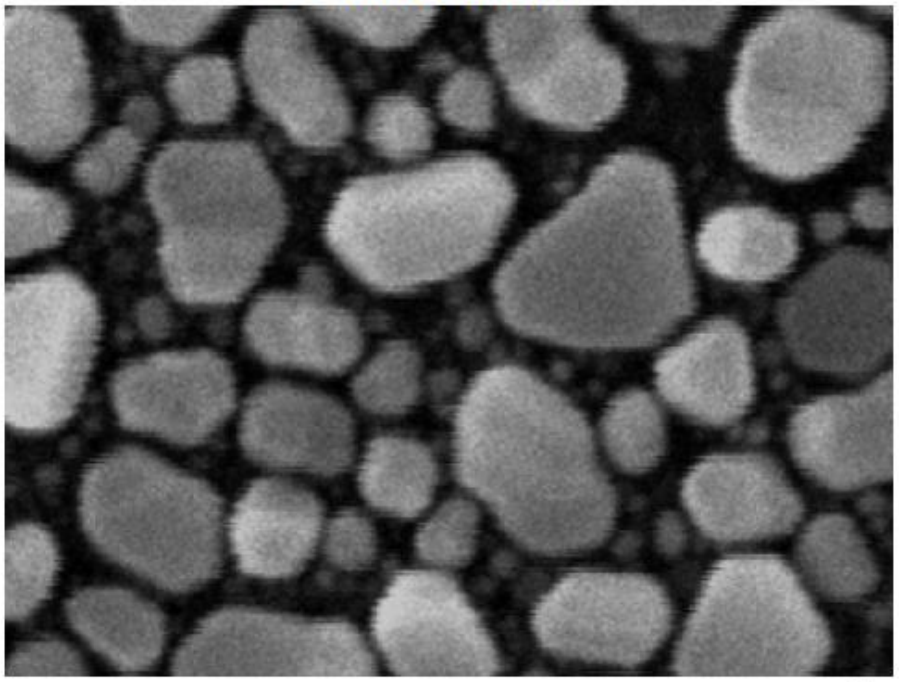
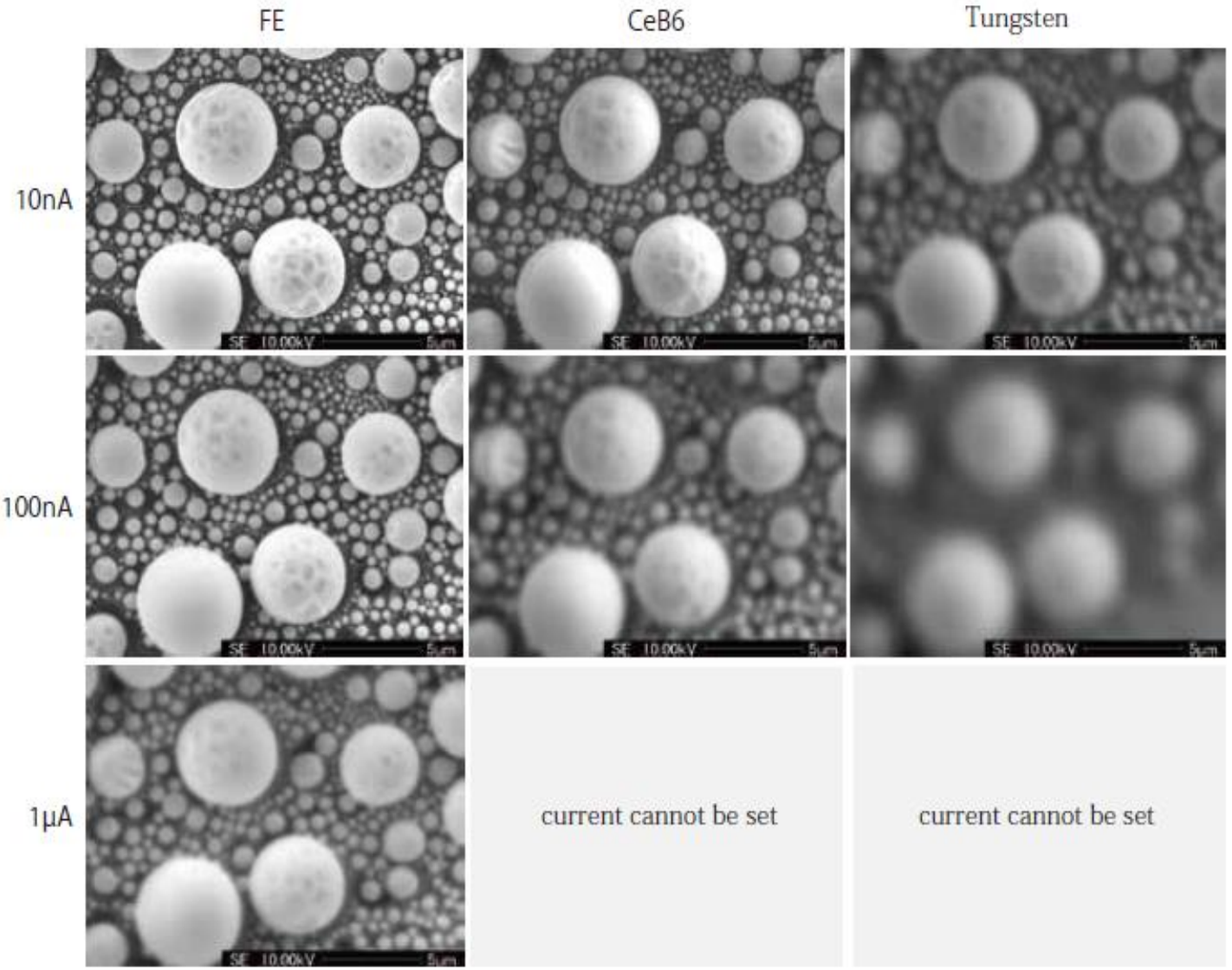


Image resolving power : 5 nm

Image Resolution



Comparison of Electron Gun Beam Characteristics (10 kV accelerating voltage)

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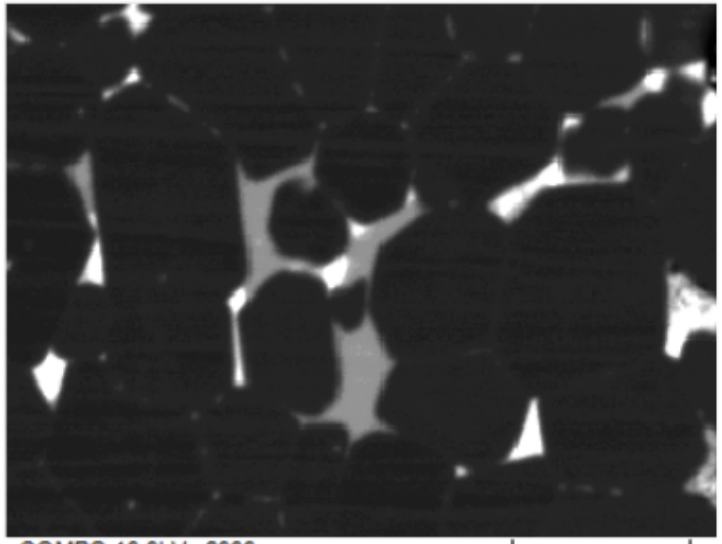
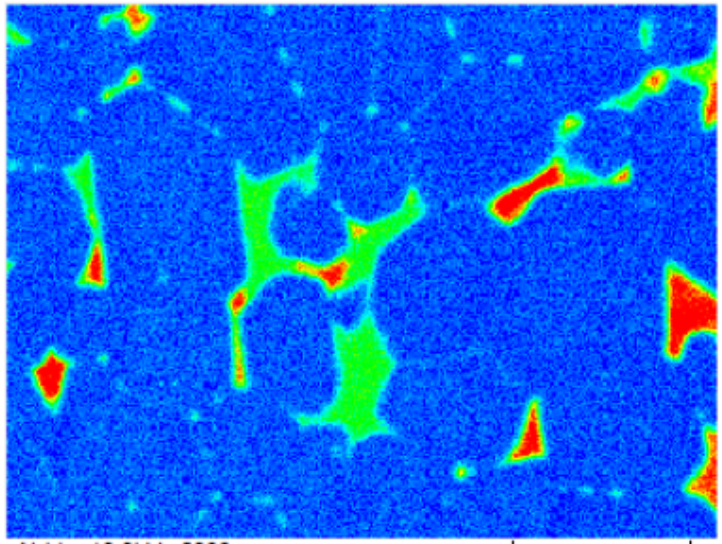
Ultra High Sensitivity Mapping

The neodymium magnet contributes to energy saving and the downsizing of the product by a strong magnetic field. However, it is dysprosium that is added to raise heat resistance because there is a fault that the neodymium magnet is vulnerable to heat. But most of dysprosium depend on the import from China. Therefore I can plan reduction of dysprosium by reducing alloy powder before baking a magnet, and hardening it conventionally, and optimizing the manufacture process so that it is thin, and an interface (neodymium aspect) surrounds it around a crystal particle uniformly. A characteristic (coercive force) evaluation was carried out conventionally, but, by these data, was able to confirm the neodymium aspect of the crystal interface visually for the first time.





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Specifications (EPMA-8050G)

Electron Source	**Schottky emitter**
Secondary-Electron Image Resolution	3 nm (30 kV accelerating voltage)
Analysis Conditions for Secondary-Electron Image Resolution	(10 kV accelerating voltage) 20 nm (10 nA beam current) / 50 nm (100 nA beam current) / 150 nm (1 μA beam current)
Accelerating Voltage	0.5 kV to 30 kV (in 0.1 kV increments. At 5 kV or less, can be set in 10 V units.)
Beam Current	0.2 nA to 3 μA (30 kV accelerating voltage)
Beam Current Stability	±0.3 %/h (Beam current: 50 nA, accelerating voltage: 10 kV)
Magnification	40× to 400,000×
Back-Scattered Electron Detector	4-block, semiconductor detector
Objective Aperture	Selection not required
Vacuum Level	Analysis Chamber: 1.0×10^{-3} Pa max. Electron Gun Chamber: 3.5×10^{-7} Pa max.
Evacuation Pump	Turbo molecular pumps: One unit for main evacuation; one unit for preliminary evacuation Rotary pumps: One unit for main evacuation; one unit for preliminary evacuation Ion pumps: Two units for the electron gun chamber; one unit for the intermediate chamber
Vacuum Detection	Penning gauge, Pirani gauge, and ion gauge
Automated Functions	Automatic evacuation (main chamber evacuation, shut-down, sample loading chamber evacuation), safety operations via error detection
PC	PC/AT compatible; main memory 8 GB or more; HDD 1 TB or more
Display	23-inch touch panel LCD (Full HD, 1,920 pixels × 1,080 pixels), two monitors
OS	Windows 7

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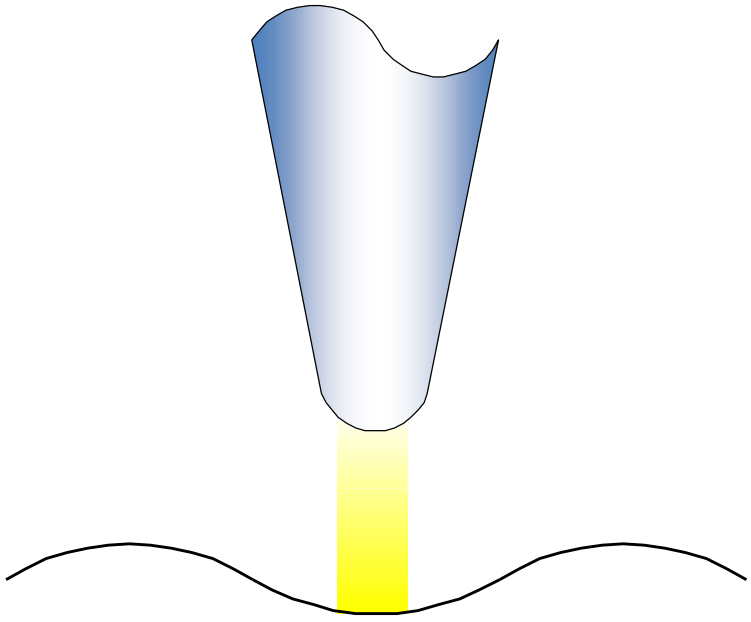
Topography Examination

Scanning Probe Microscope

AFM + LFM+KFM + STM+MFM+FMSPM



Sample Surface

Imaging of Interaction

Signals : Atomic Force (AFM)

Phase

Force Modulation

Current

Magnetic Force (MFM)

Surface Potential (KFM)

Lateral Force (LFM)

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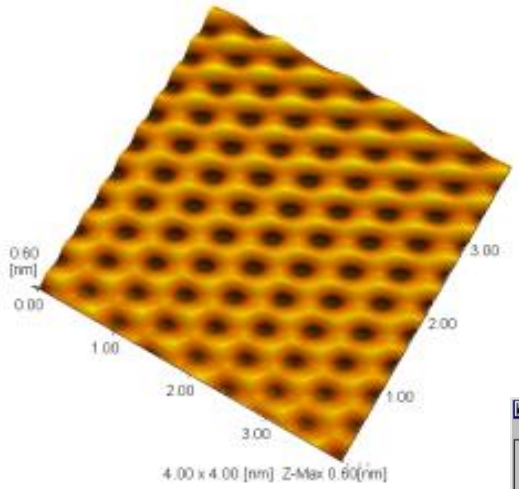
Scanning Probe Microscopy

SPM-9700

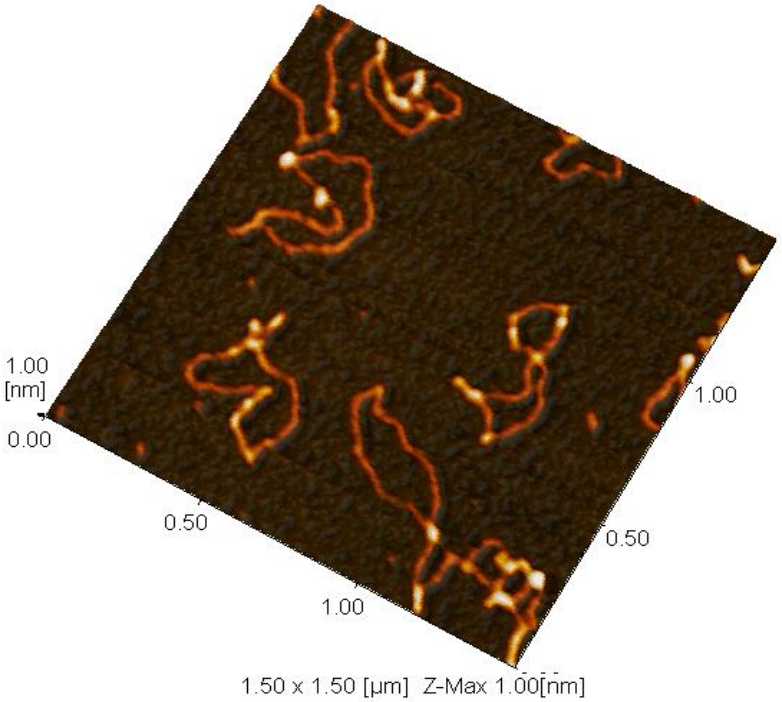
SHIMADZU

Function SPM 9700

High Resolution



mica

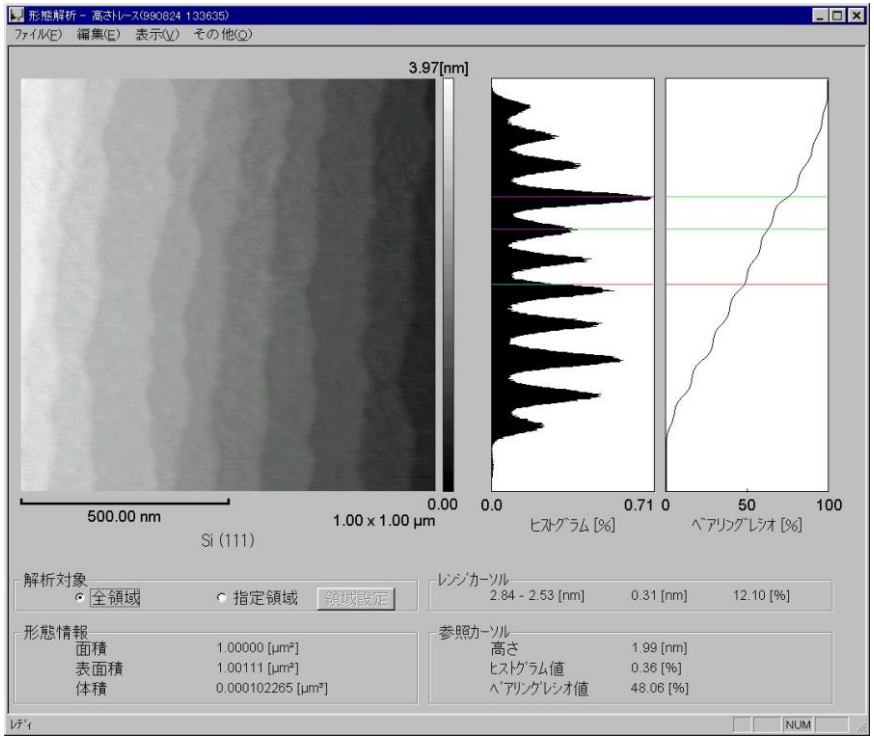


plasmid DNA

Digital Control

XY：Full-time 16bit accuracy

Z：max. 22bit accuracy



Si（111）

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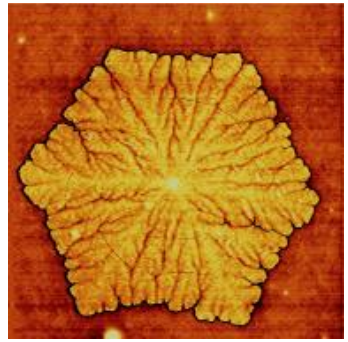
SPM Application

- Observation of various sample
  such as semiconductor, thin film, powder
  and bio samples.
- Shape measurement, Step measurement,
  Micro roughness measurement
- Physical properties measurement,
  Electric and Magnetic measurement,
  Dynamic measurement



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Function

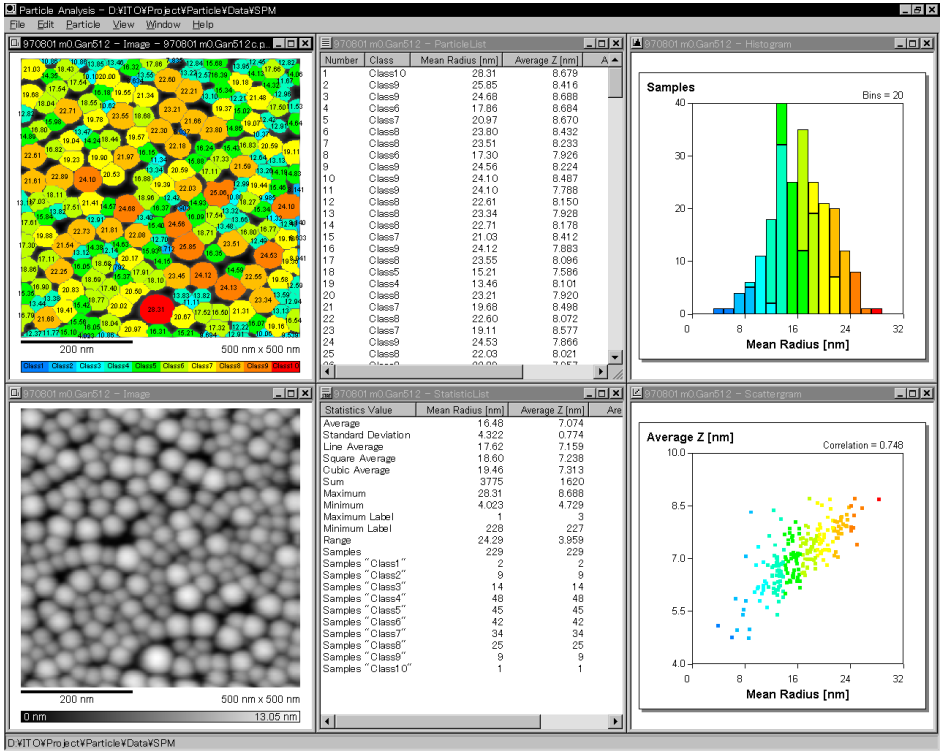
Particle Analysis Software

Particle or hole shapes are extracted from image

The features of individual particles is determined.

Statistic Processing
Classification of particles

Features : 29types (Radius, Height, Surface Area, Area,Volume,etc)



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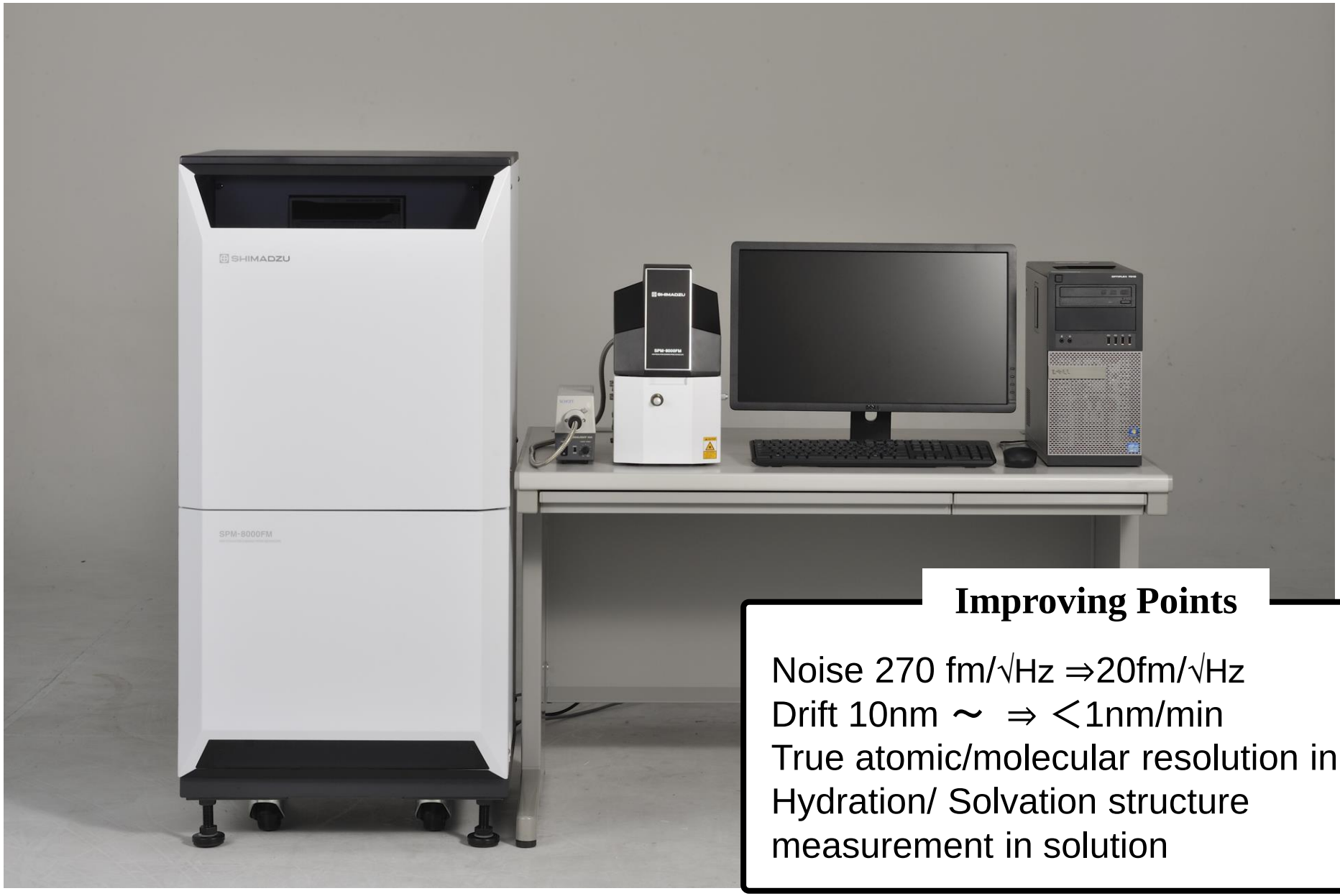
SPM - 8000FM

High Resolution Scanning Probe Microscope
SPM-8000FM

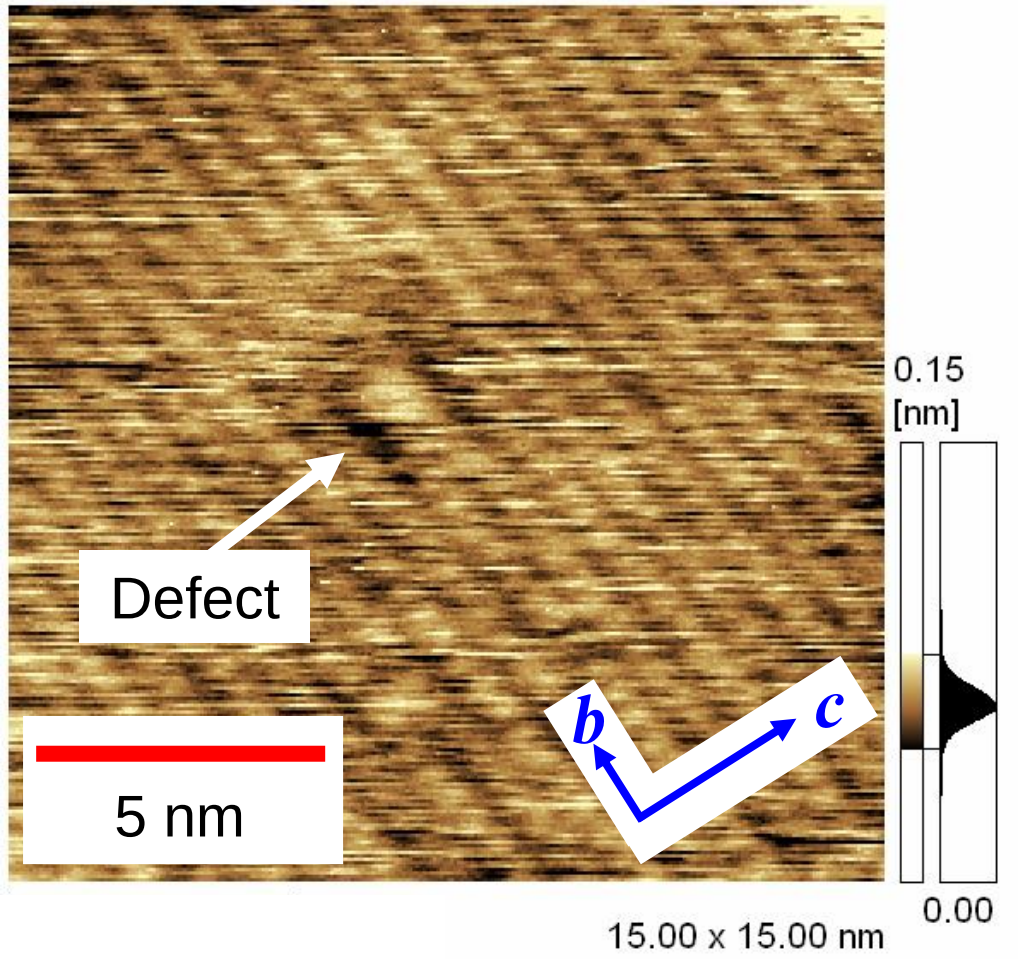


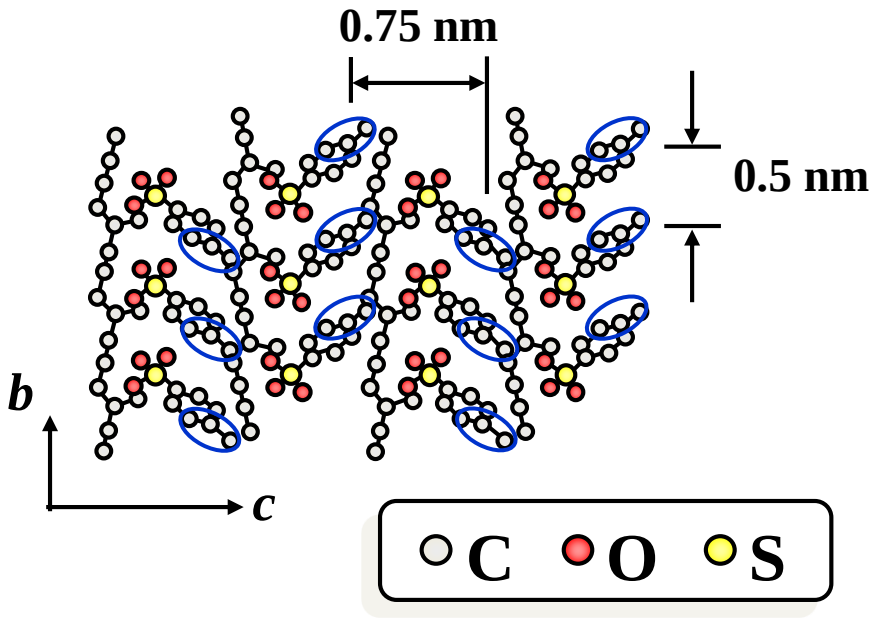
Improving Points

Noise 270 fm/√Hz ⇒20fm/√Hz
Drift 10nm ～ ⇒ ＜1nm/min
True atomic/molecular resolution in air
Hydration/ Solvation structure measurement in solution

High Resolution Topography in Air

Poly diacetylene single crystal





The side chains on the topmost surface

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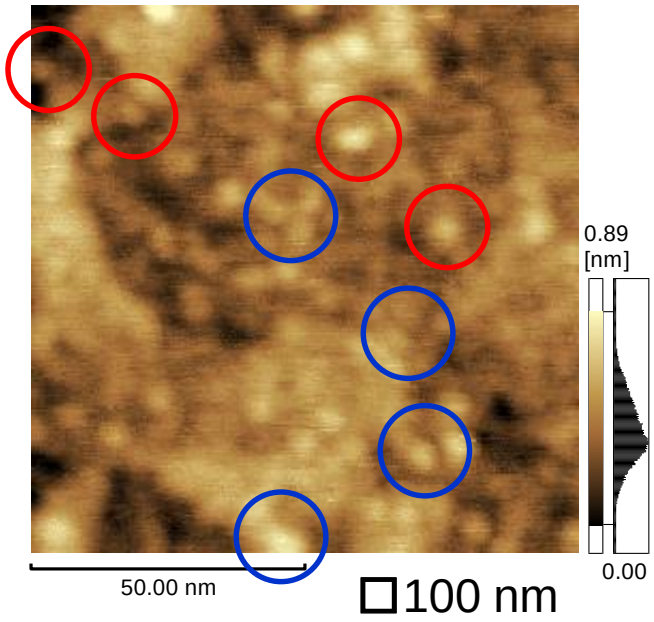
Physical Properties Measurements

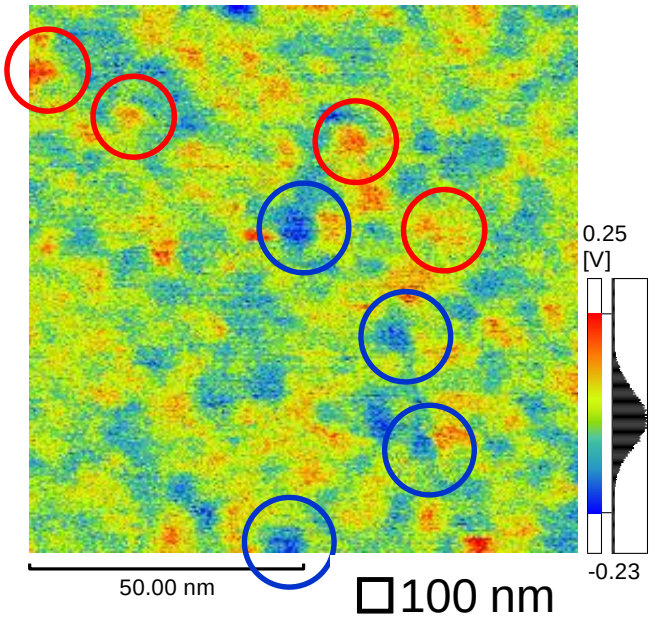
Surface Potential Measurement in Gas

Contact Potential Deference Distribution in Gas

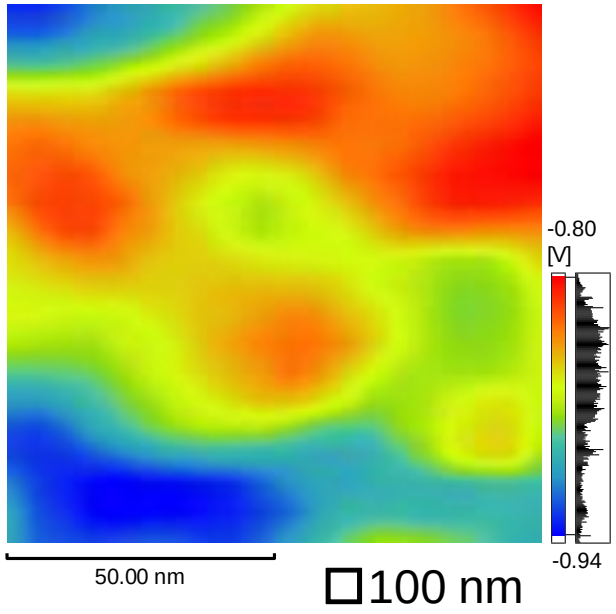
Pt clusters / TiO_2



Topography

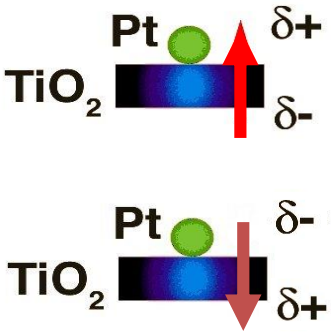


CPD by KFM



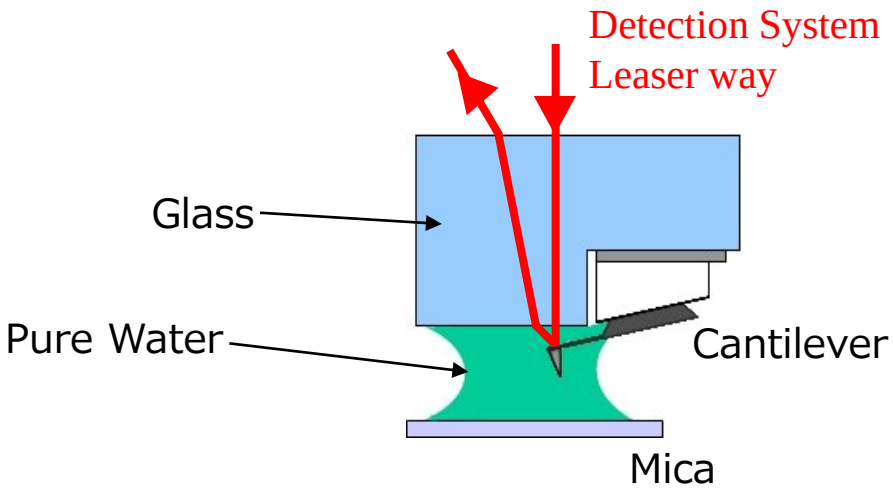
Conventional KFM

Single-nm resolution image observed in an atmospheric pressure N_2 gas environment



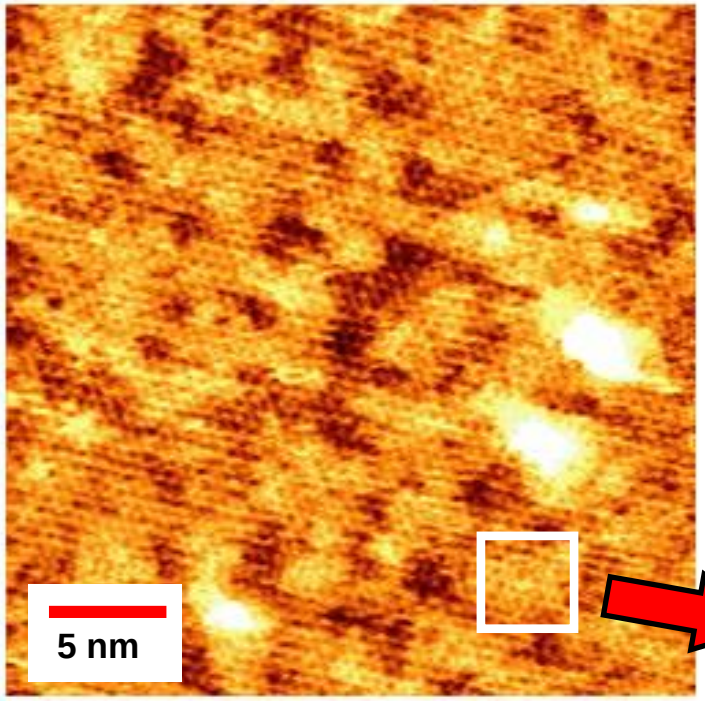
Ryohei Kokawa,et al., Chemistry - An Asian Journal, 7, 1251-1255 (2012).

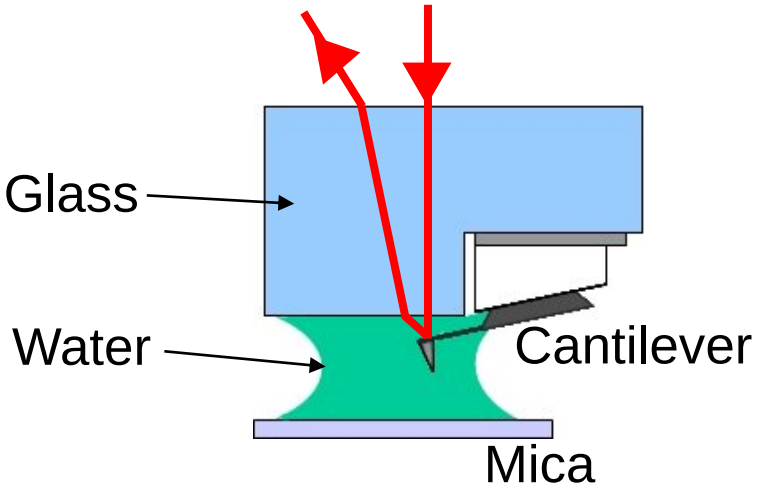
High Resolution Observation in Solution



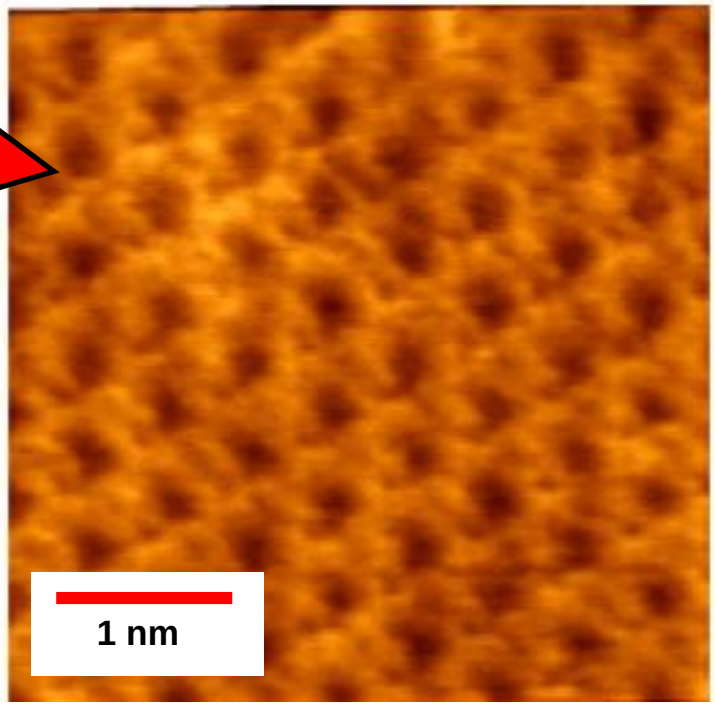
High Resolution Topography in Water

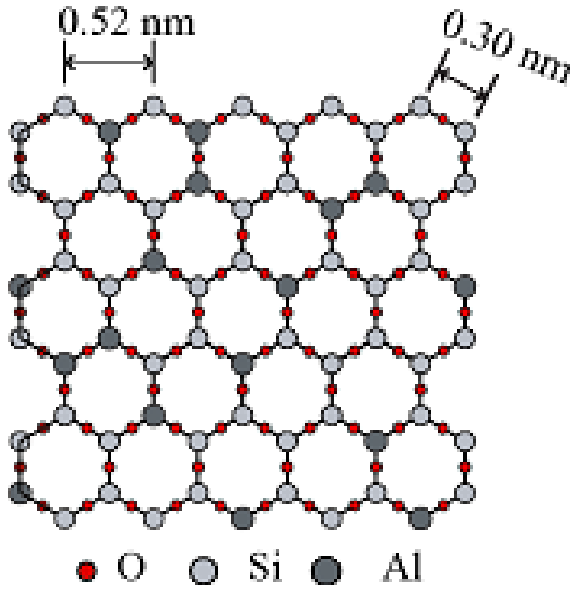
Muscovite mica





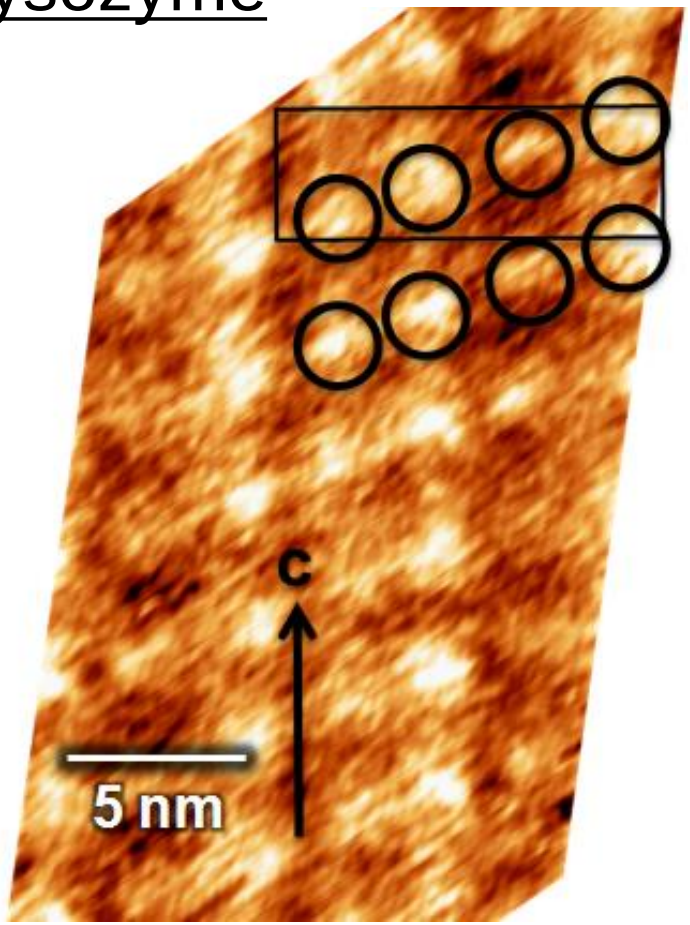
Cleavage plane
immersed in water





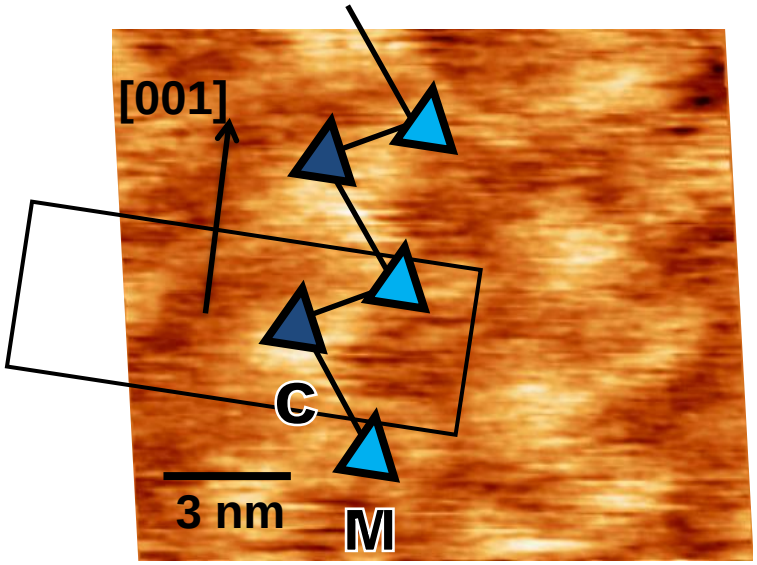
Molecular Resolution Observation of Soluble Protein Crystals

Lysozyme

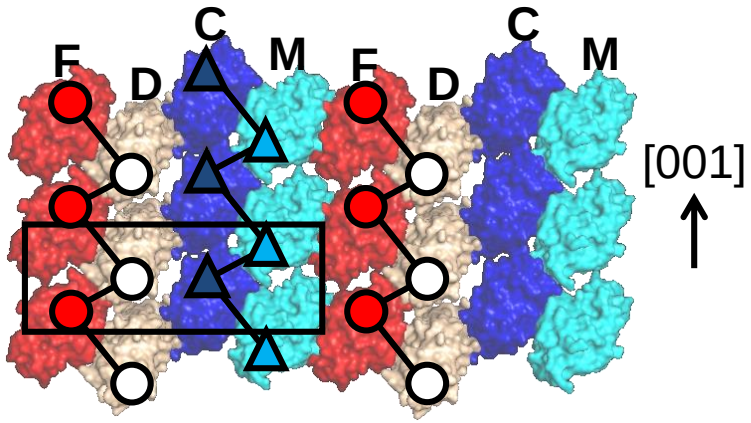


The rectangle represents a surface unit cell with the arrow indicating the c-axis.

Molecular resolution image observed in a saturated solution



Tetragonal lysozyme (110) face



Nagashima et al., JVST B 28 (2010) C4C11

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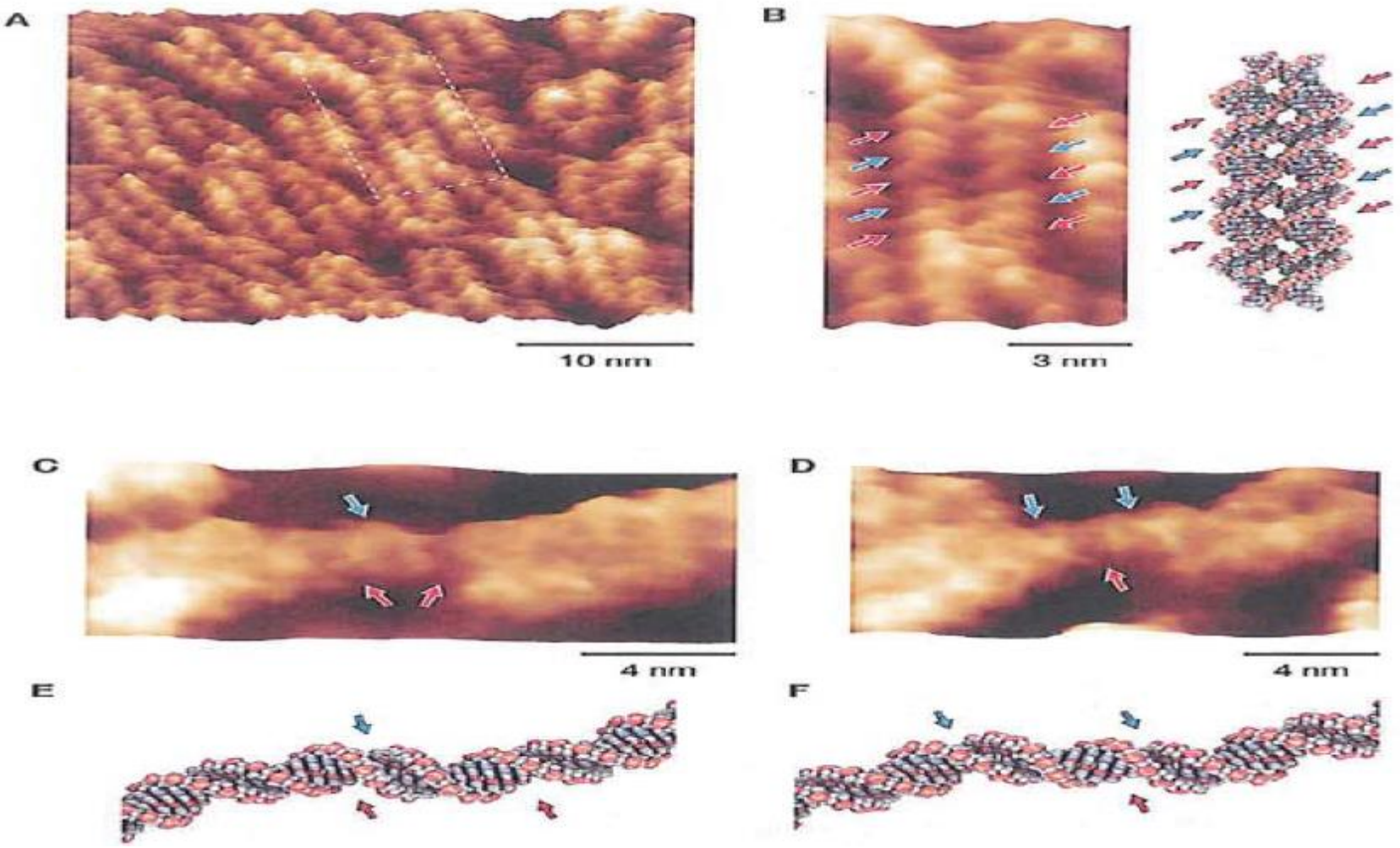
Beyond the Helix Pitch: Direct Visualization of Native DNA in Aqueous Solution



Antibody Observation reported in Japanese newspaper and TV

Y字の抗体 じゅうたん模様

京大チーム観察

原子間力顕微鏡で観察した抗体

規則正しく並ぶ

1個の抗体はY字形

50ナノメートル

5ナノメートル

溶液の成分を調節すると、抗体が6個1組で環状に集合

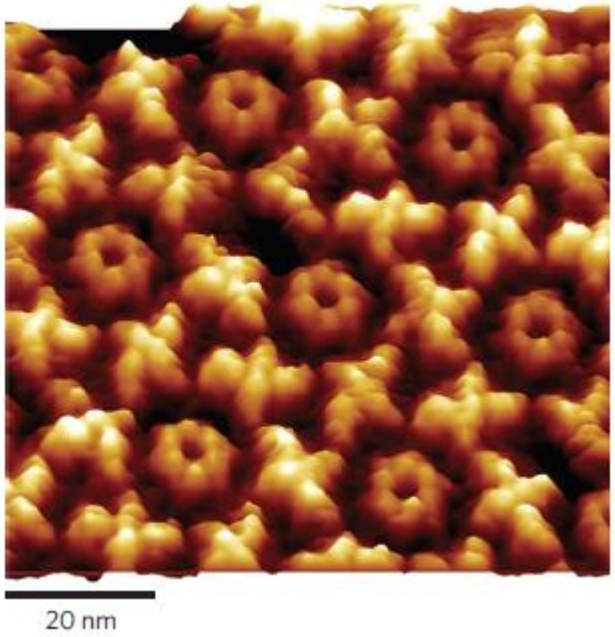
へこんでいるため画像には映っていない

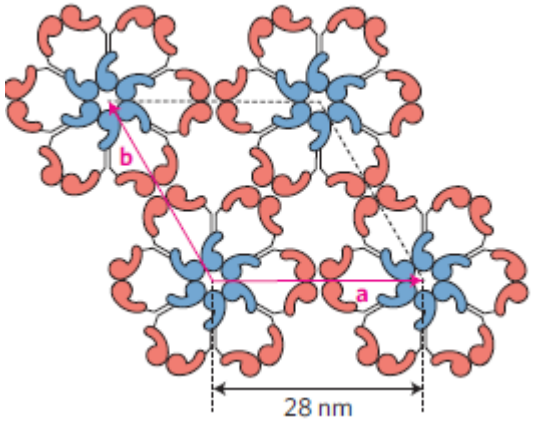
（写真は山田准教授提供）

体内に侵入した病原体から体を守る「抗体」の構造を、高精度の顕微鏡を使って詳細に観察することに成功したと、京都大の山田啓文准教授らのチームが発表した。抗体に特有なY字形がはっきりと見え、抗体がじゅうたんの模様のように整然と並ぶこともわかった。20日の科学誌ネイチャー・マテリアルズ電子版に論文が掲載される。

抗体はY字形をしており、2本の腕がウイルスなどのたんぱく質を捉える。チームは、超極細の針先で物質表面をなぞって細かな形を画像化する「原子間力顕微鏡」を利用。針先の感度を高め、マウスの抗体（長さ約10～20ナノ・メートル、ナノは10億分の1）を生体内に近い溶液に浸した状態で観察した。さらに、溶液の成分を調節すると、抗体は6個1組で環状に集まり、規則正しく並んだ。免疫反応を高めるためグループ化するとみられる。

山田准教授は「高い密度で集合した抗体は、ウイルスの有無を調べる高感度センサーとして利用できるだろう」と話している。





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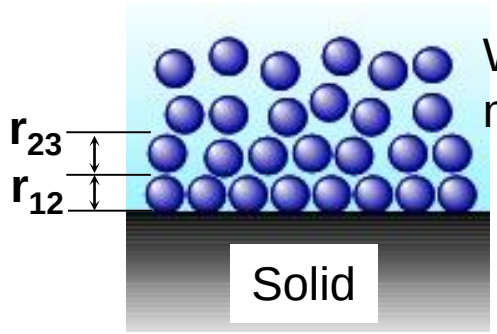
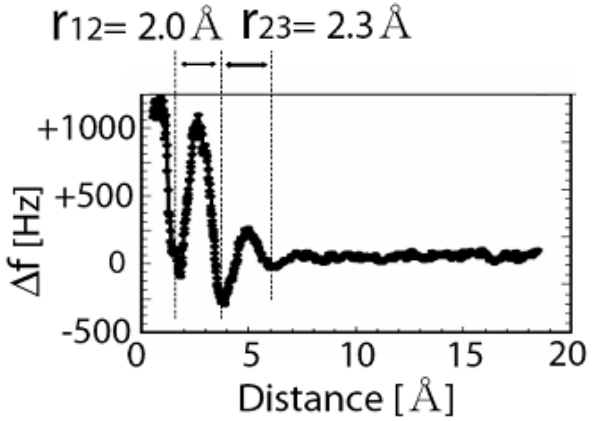
Hydration / Solvation structure measurement

Water Structure at Interfaces

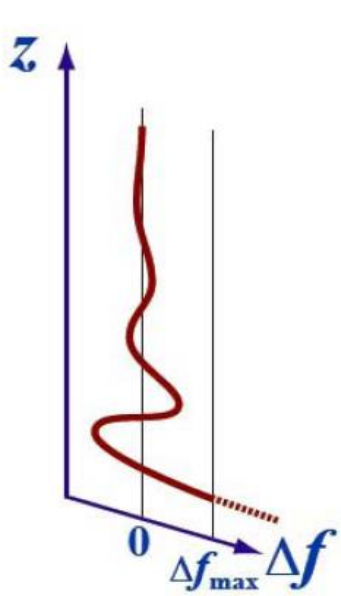
Structure of water

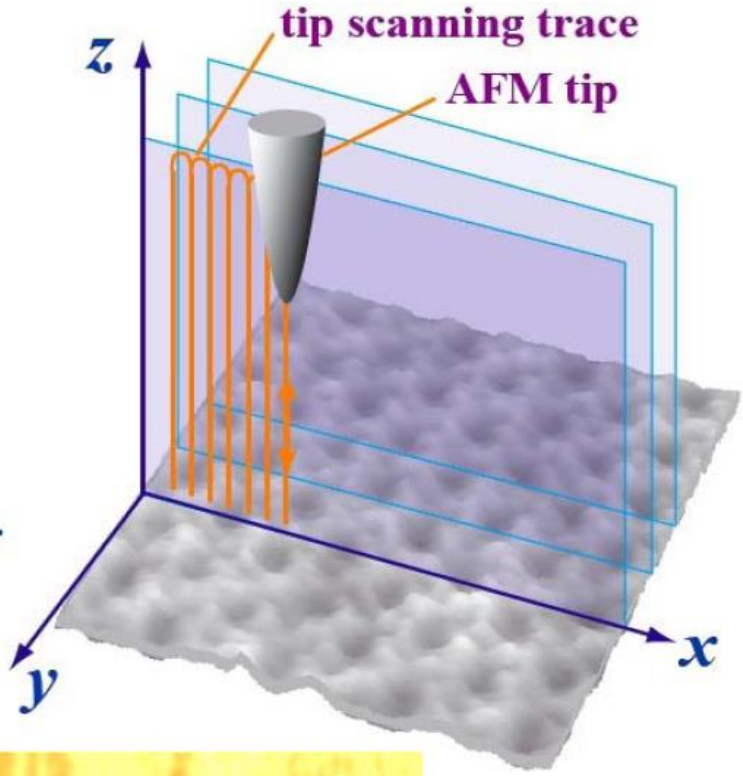
･･･Hydration structure

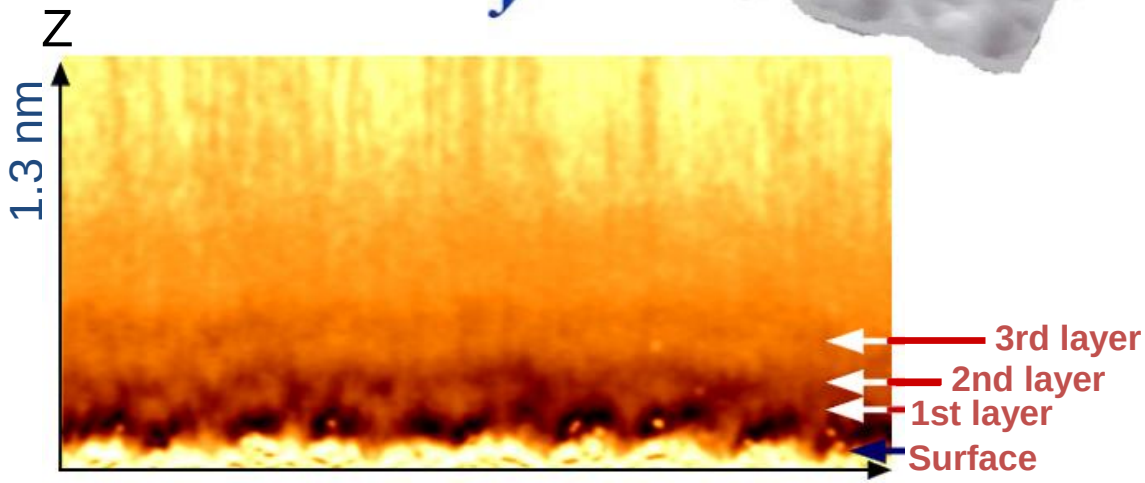




Δf vs distance curve







X-Z mapping of Δf

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Nano Search Microscope OLS4500

From millimeter to nanometer size observation in one.

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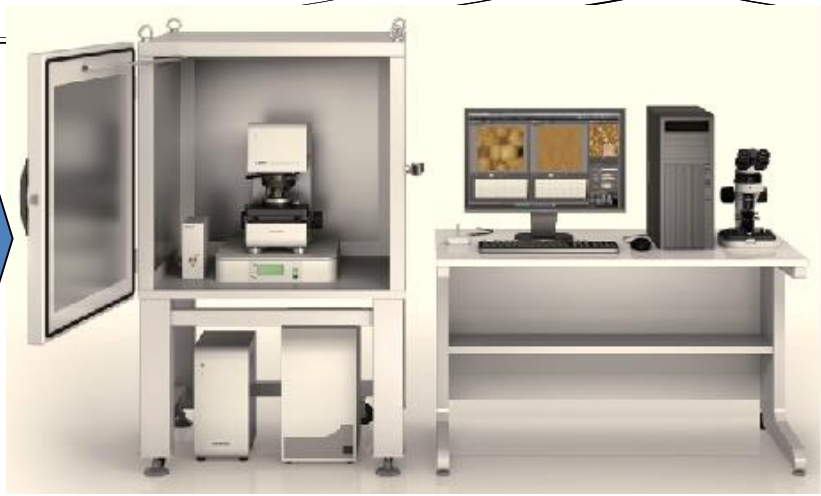
Nano-Search Microscope

Optical Microscope : ×100～×2000

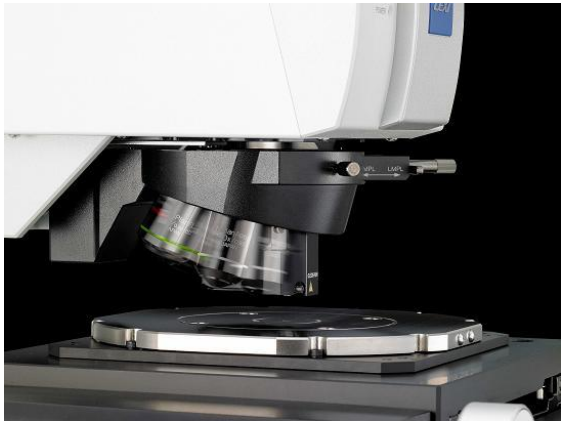
Laser Scanning Microscope (LSM)
Magnification : ×100～×14000

Atomic Force Microscope (AFM)
Magnification : ×1000～×1000000



Hybrid Microscope

Coaxial Object lens and AFM Tip



From millimeter to nanometer size observation in one.

Never miss the destination.
LSM ←→ AFM

In Air
No Coating

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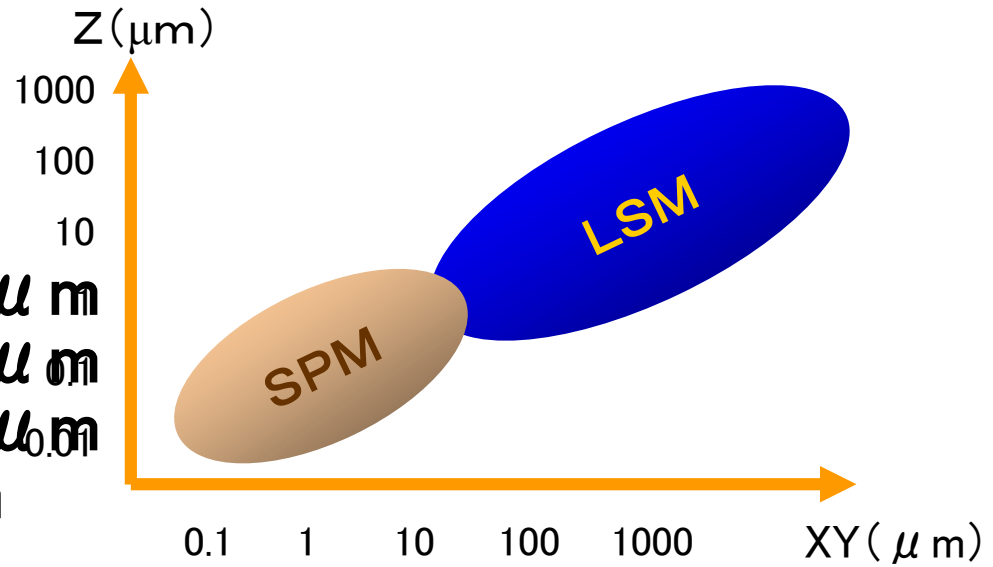
From mm to nm size observation in one

- Continuous Observation
  - Objective Lenz
  - 5×：2600μm～430μm
  - 20×：640μm～110μm
  - 100×：130μm～20μm
  - SPM： 30μm～sub μm

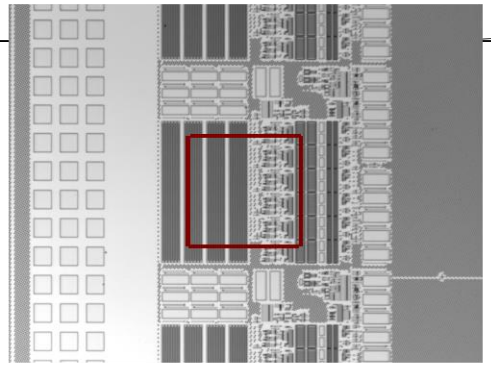


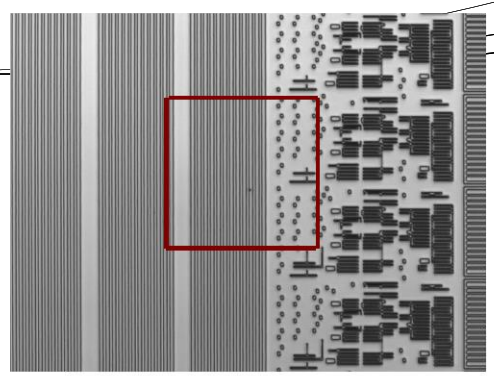
- Object lens and AFM Tip is coaxial

- **SPM Tip Position is strictly inside in 100X Objective Sight.**

Wafer（Mag.：200x～1,000,000x）

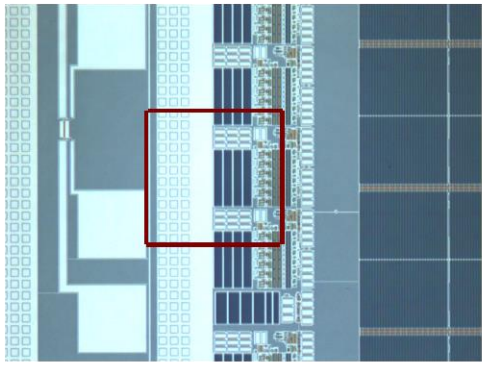
256×192μm
LSM

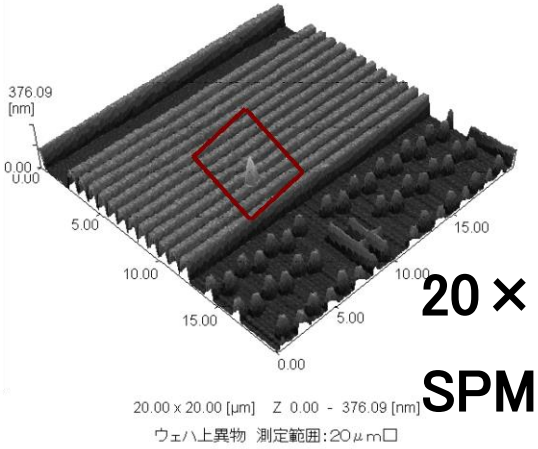




64×48μm
LSM

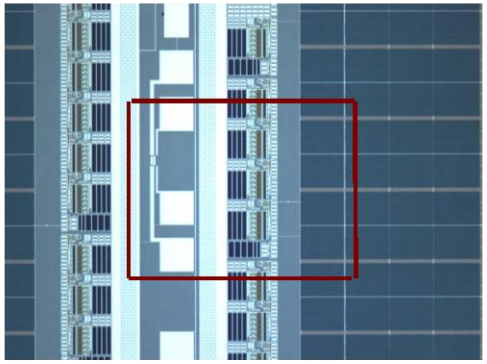
640×480μm
OM Image

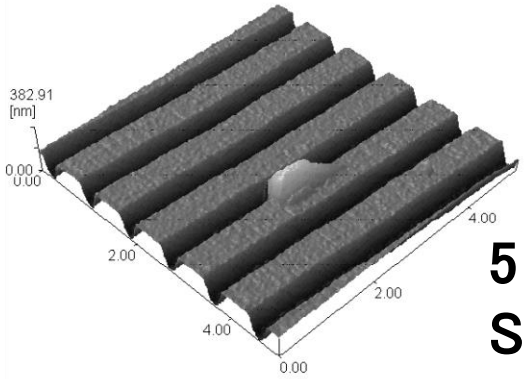




20×20μm
SPM

1280×960μm
OM Image





5×5μm
SPM

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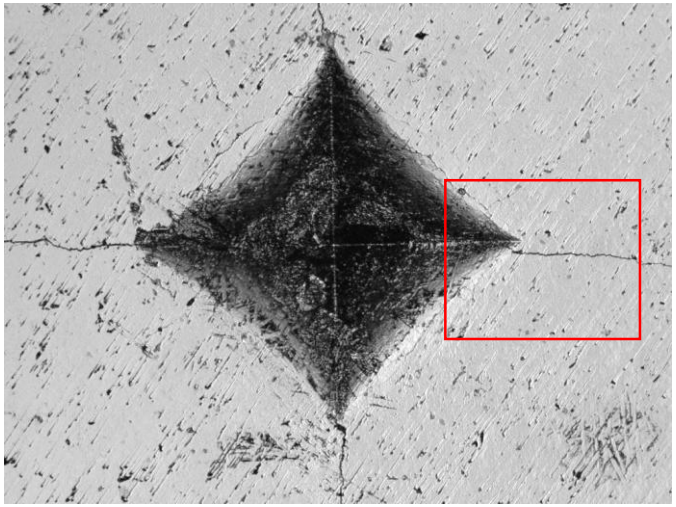
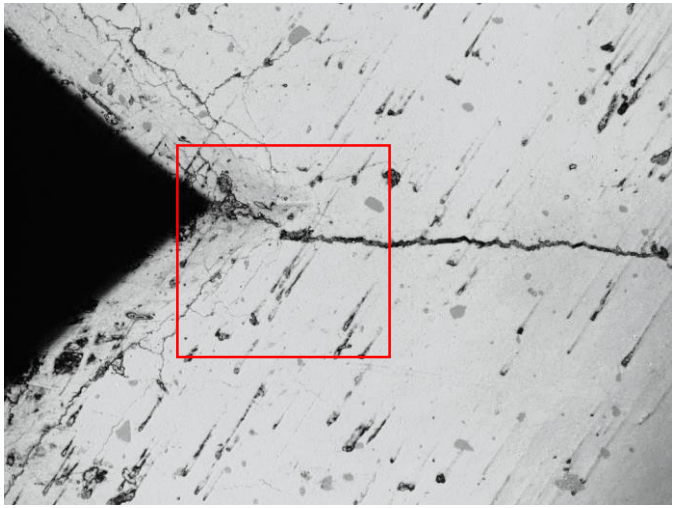
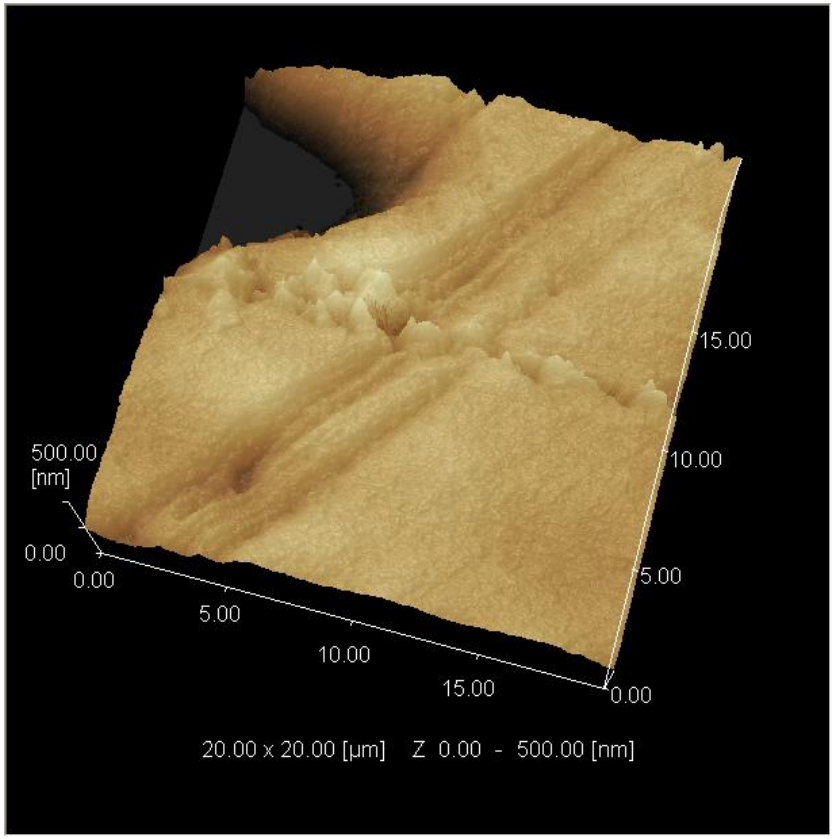
A mark of Micro Vickers



LSM Image
400 × 300 μm ↑

64 × 48 μm →





SPM Image 20 × 20 μm 3D

The change in height that built on both sides of the crack can be measured.

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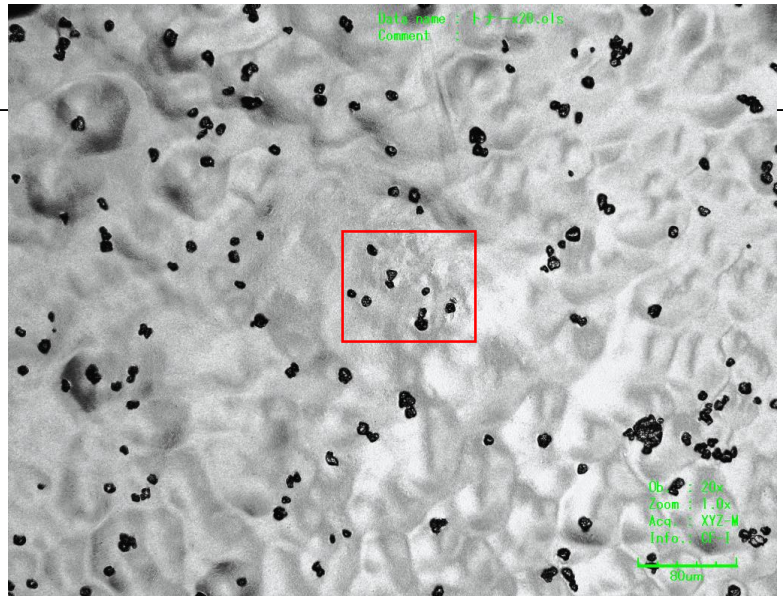
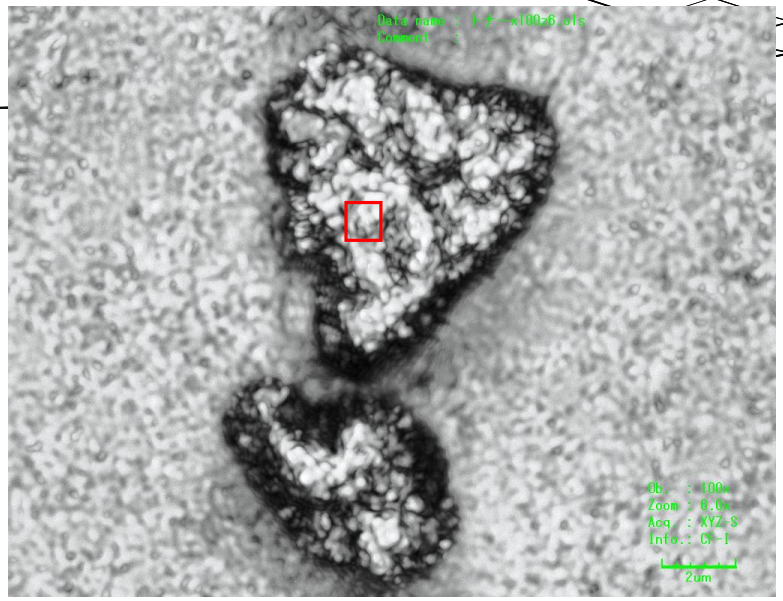
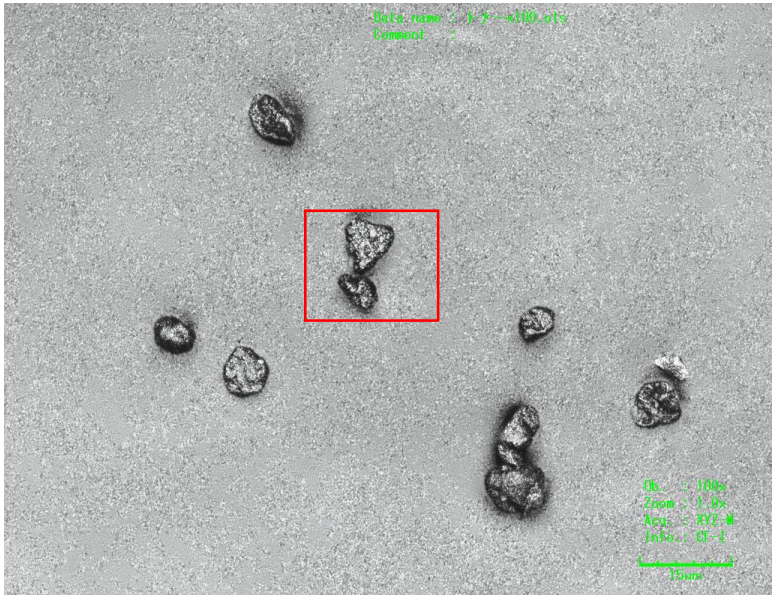
Toner



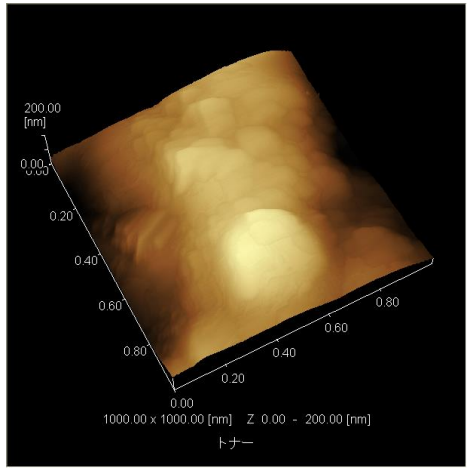
LSM 640×480μm

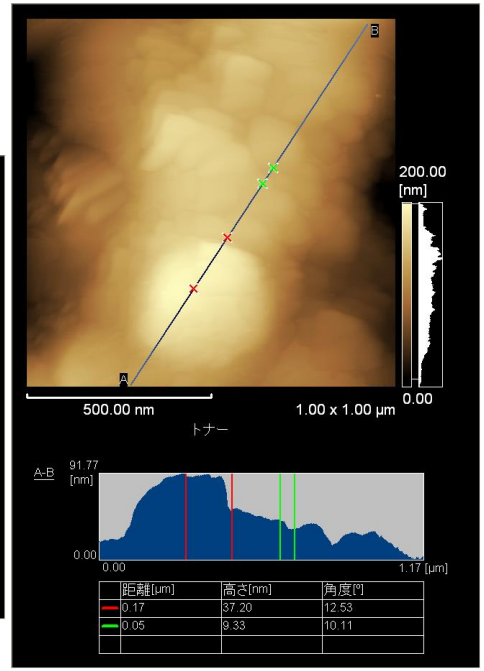


LSM 21×16μm



LSM 128×96μm





SPM 1×1μm

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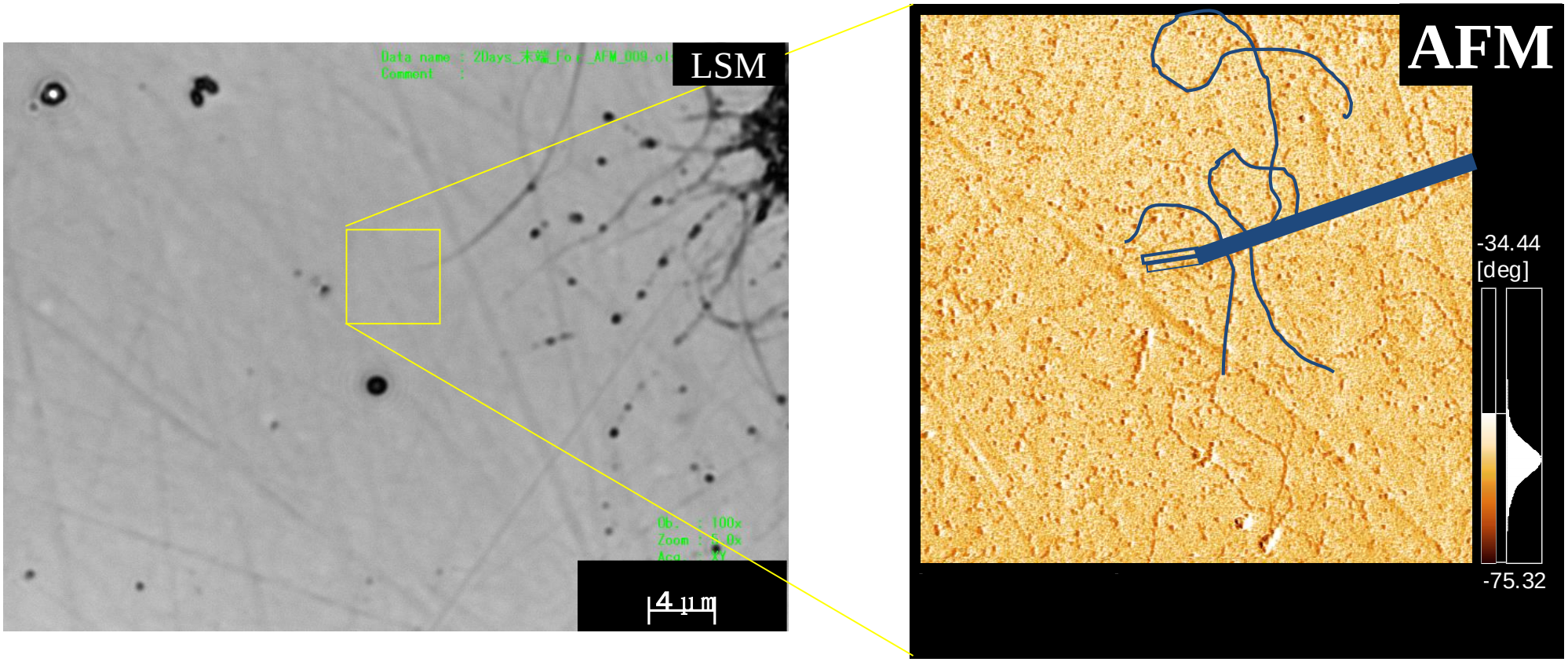
Observation of Collagen End



Magnification x5000

Mag. x25000

A thinner fiber can observe at the collagen end.

Courtesy of Dr. Akira Monkawa, NIMS

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Material Characterisation Tools

Elemental Analysis

AA AA+GF ICPS ICPMS

EDX XRF EPMA XPS

Compound Analysis

GC LC GCMS LCMS MSMS

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Material Characterisation Tools

Structural Analysis

XRD FTIR SALD DTG TGA

MALDI XPS

Imaging

SPM FMSPM Nanoserach

SHIMADZU

Material Characterisation Tools

Failure Analysis

Servo hydraulic machines
Universal Testing Machines

Hardness Testers

X-Ray Inspection

XPS EPMA FTIR-Microscope

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Shimadzu Provides ALL

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THANK YOU

Mahendra Chaudhari