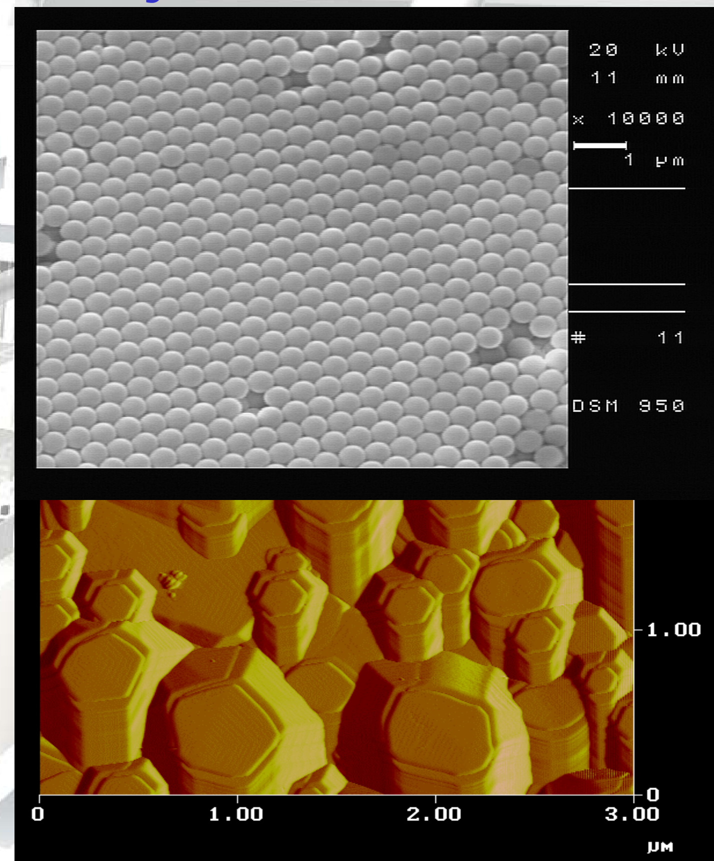
Optoelectronics Laboratory

TEKNILLINEN KORKEAKOULU
HELSINKI UNIVERSITY OF TECHNOLOGY

MICRONOVA
CENTRE FOR MICRO- AND NANOTECHNOLOGY

Optoelectronics Laboratory

- **Employees: 19 (13 graduate students)**
  - professor Harri Lipsanen (nanotechnology), open: physics(optoelectronics) and photonics
- **Fields of research**
  - optoelectronics and integrated optics
  - compound semiconductor technology
  - nanotechnology, quantum structures
  - optical spectroscopy, x-ray diffraction
- **Teaching**
  - majors: photonics, nanotechnology, physics in electrical engineering
  - Master's Programme in Micro- and Nanotechnology



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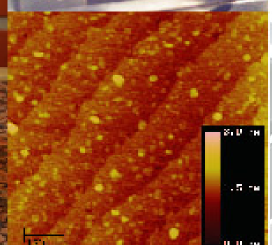
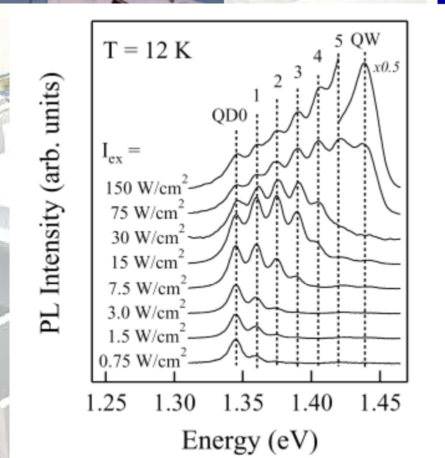
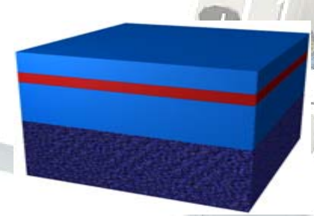




Research in Optoelectronics

- **Fabrication of compound semiconductor structures by metalorganic vapour phase epitaxy**
- **Materials characterisation by optical spectroscopy, x-ray diffraction and atomic force microscopy**



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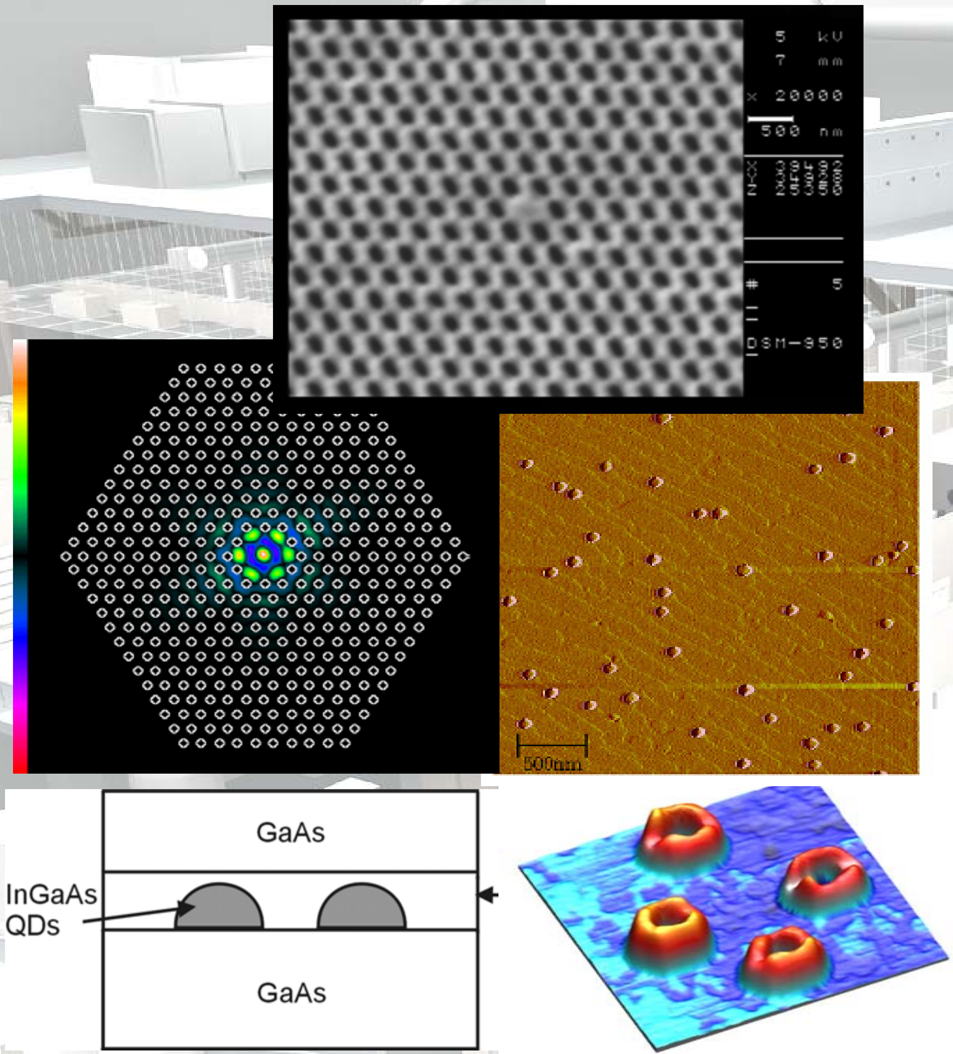

Advanced semiconductor structures

- Development of self-assembled quantum dot structures and photonic crystals for novel optoelectronic devices
- Gallium nitride technology for blue emitters and high-temperature electronics
- GaAs and InP technology for infrared applications

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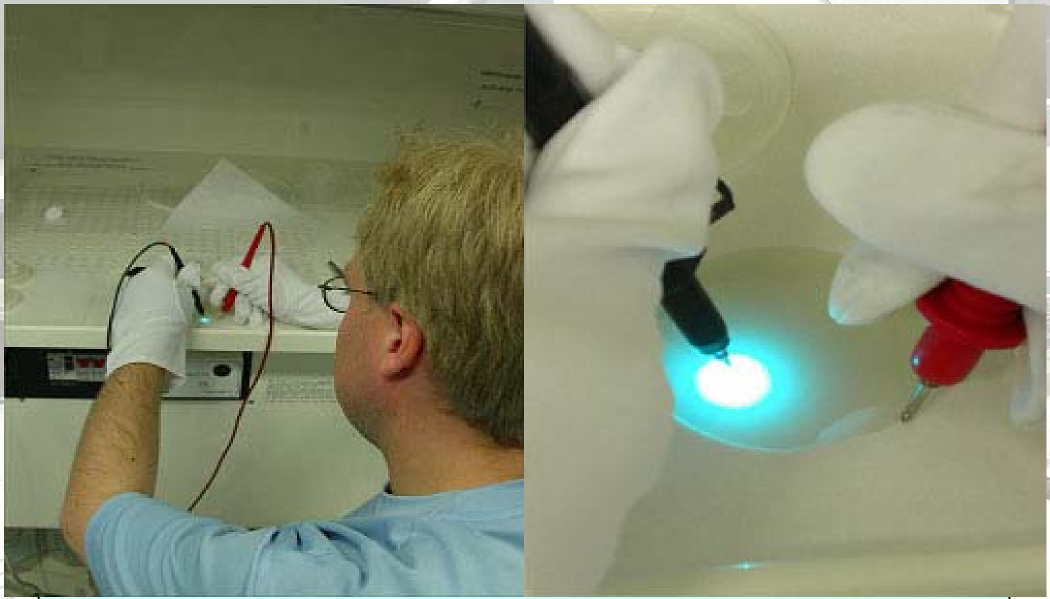

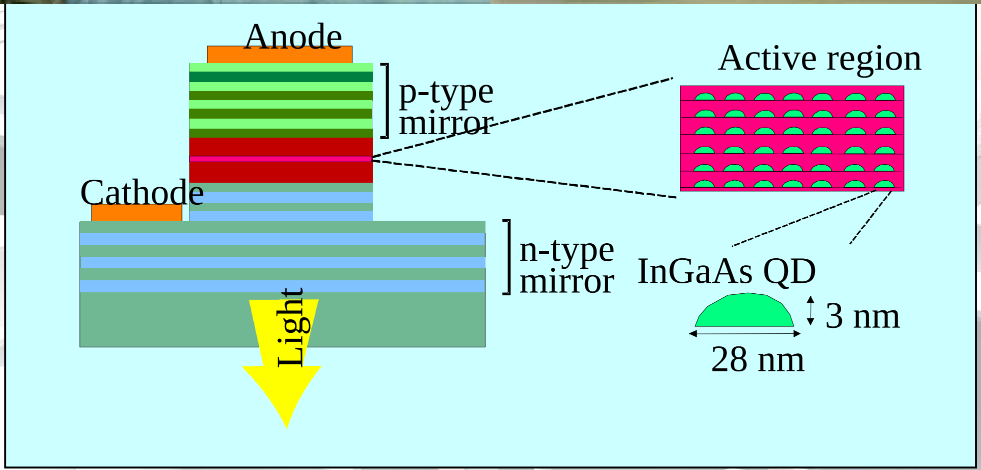

Component processing

- **Devices: diode lasers, LEDs, detectors, optical waveguides, microcavities and photonic crystals**
- **Processes: lithography, dry etching, metallisation, etc.**
- **Materials: GaAs-based, InP-bassed, GaN-based, InAs, GaSb, SOI**

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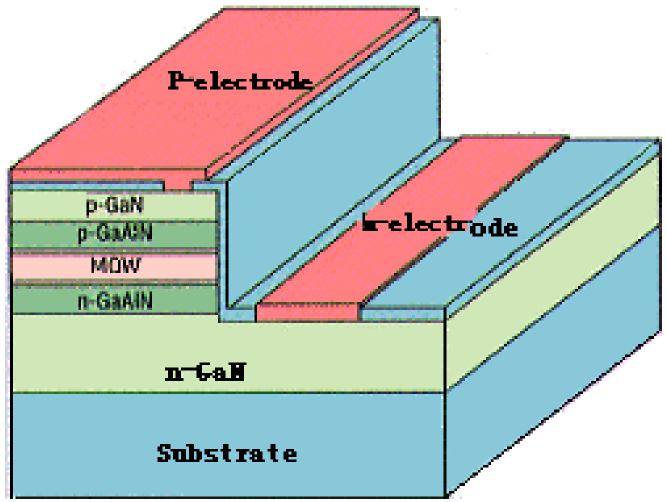
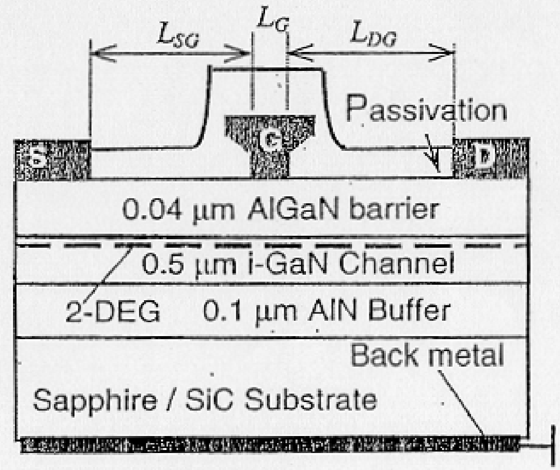
Applications for the AlGaInN system

- **Optoelectronics**
  - ultrabright LEDs
  - UV emitters and detectors
  - blue/UV laser
- **Electronics**
  - power HEMTs



Device structure of a blue-light-emitting laser diode



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•Objectives

2-year target:	a) optically pumped lasing
	b) electrically pulsed laser diode
long term target:	cw blue laser

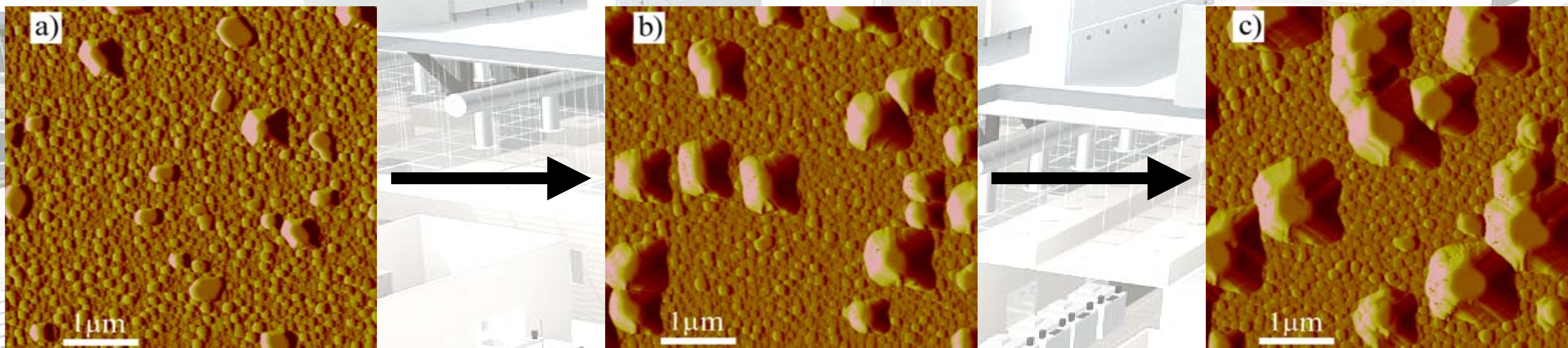
• Materials research

- MOCVD growth of AlGaInN compounds on sapphire with reduced dislocation density
- improved GaN buffer layers on sapphire

• Device research

- high efficiency emitters by improvement in material quality, p-type doping
- development of GaN processing by ICP-RIE

GaN nucleation on sapphire



1x 2x 4x

- A cyclic method for nucleation layer optimization

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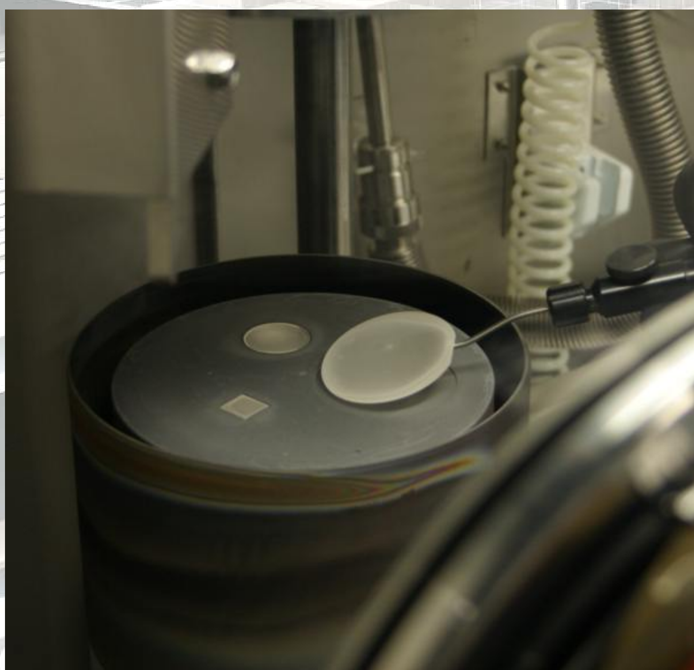
EPITAXY:

MOCVD system for GaN epitaxy
Thomas Swan 3x2” CCS reactor

MATERIALS GROWN:

GaN, InN, AlGaN, InGaN



MOCVD system for III-V epitaxy: 1” horizontal reactor

MATERIALS GROWN:

GaAs, InP, InAs,...
InGaAs, InGaP, GaAsN,...
GaInNAs, InGaAsP,...

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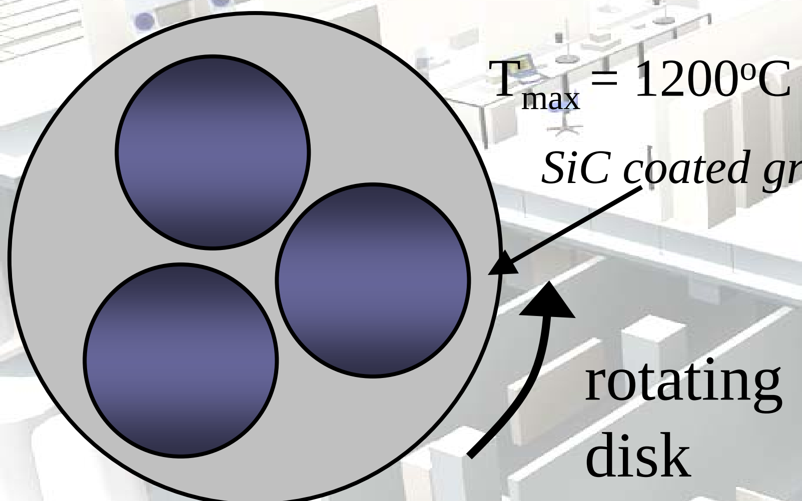
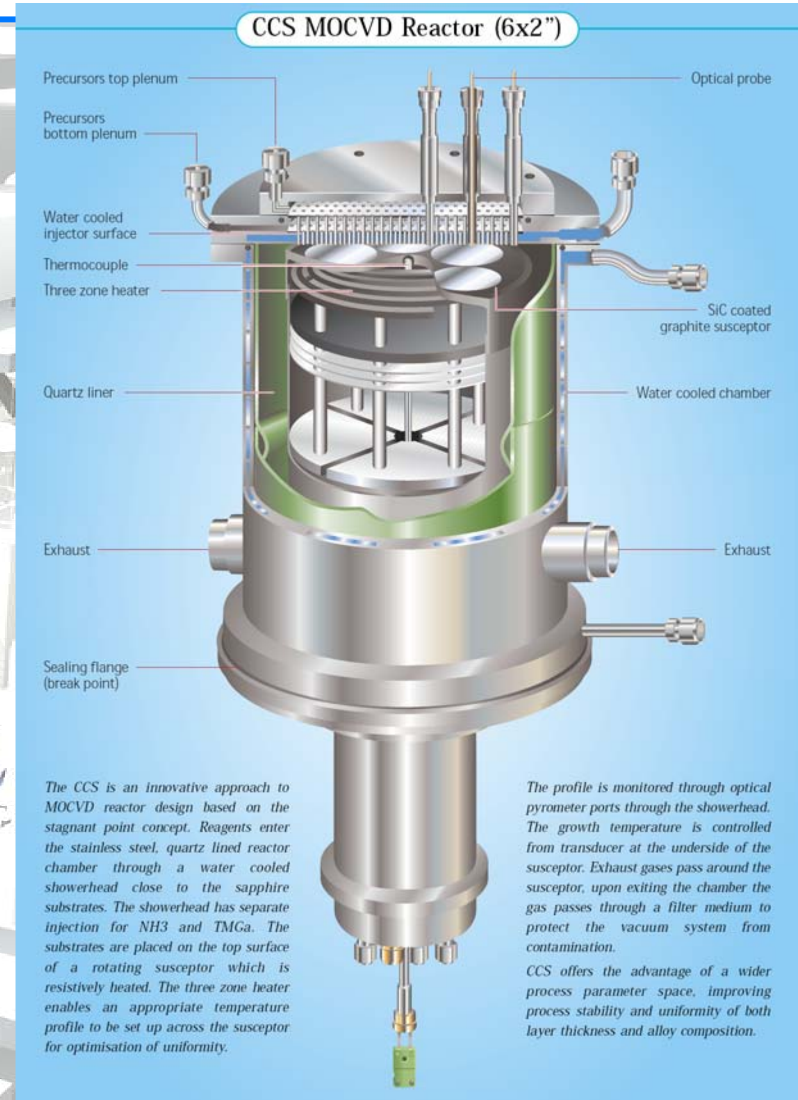
Vertical 3 x 2” showerhead reactor

- growth of gallium nitride and other III-V’s (arsenides and phosphides)
- real-time optical monitoring of growth (layer thickness, surface temperature...)
- excellent uniformity of thickness and alloy composition
- suitable for both research and production

$T_{max} = 1200^{o}C$





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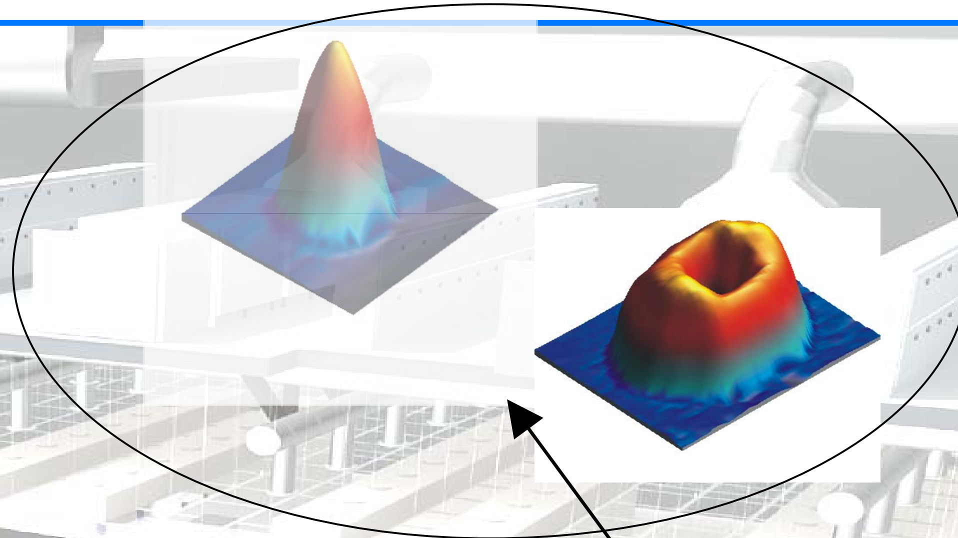
PROCESSING:

- **ICP-RIE etching**
- **Metallization**



CHARACTERIZATION:

Optical spectroscopy

X-ray diffraction

Atomic force microscopy