Scanning Near-Field Optical Microscopy (SNOM).

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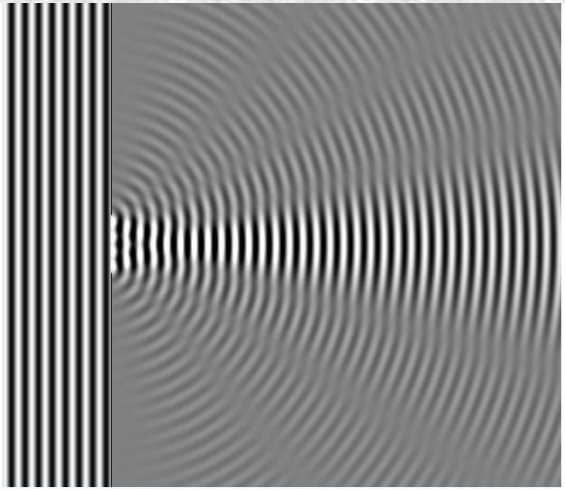
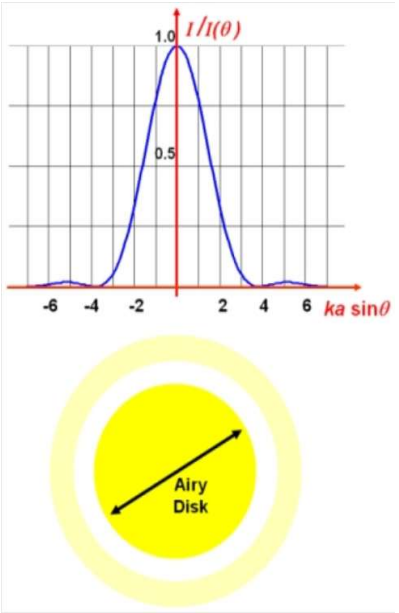
Diffraction I

- **Physical Property.**



http://en.wikipedia.org/wiki/Image:Wave_Diffraction_4Lambda_Slit.png

- **Airy Disks.**



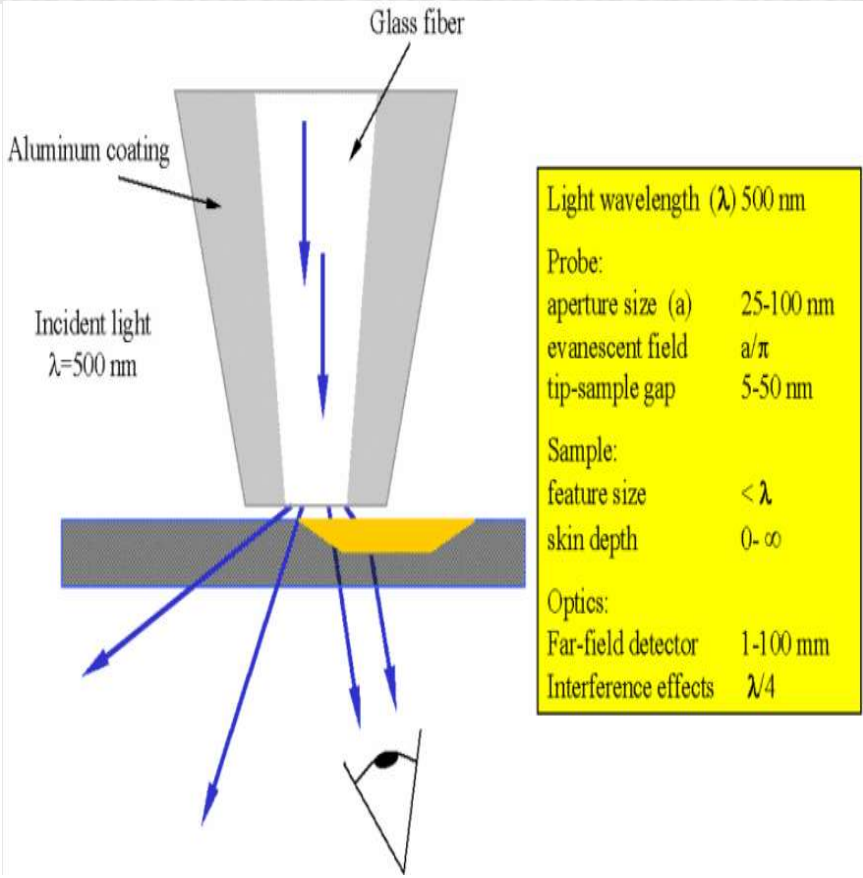
http://astronomy.swin.edu.au/cms/astro/cosmos/A/Airy+disk

Diffraction II

- **Resolution.**
- **Abbe Diffraction limit** $d = \dfrac{\lambda}{2\, n \sin\theta}.$
- **Maximum Resolution** $d_{Max} = \dfrac{\lambda}{2}.$
- **Near-Field** $r \ll \lambda.$
- **Far-Field** $r \gg \lambda.$

Apertured Probe

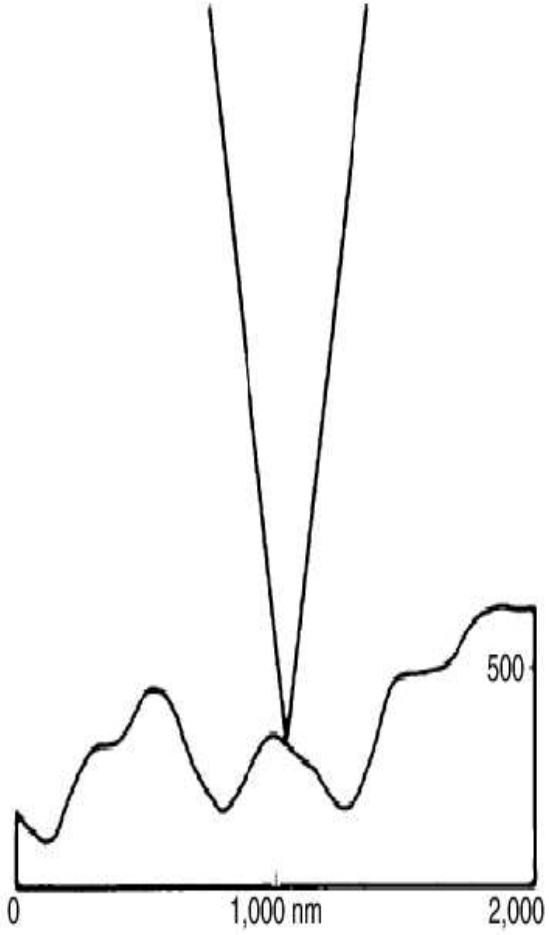
- **Fiber Probe Coated by Thick Metal.**
- **High Temperature.**
- **Advantage.**
- **Disadvantage.**



http://physics.nist.gov/Divisions/Div844/facilities/nsom/nsom.html

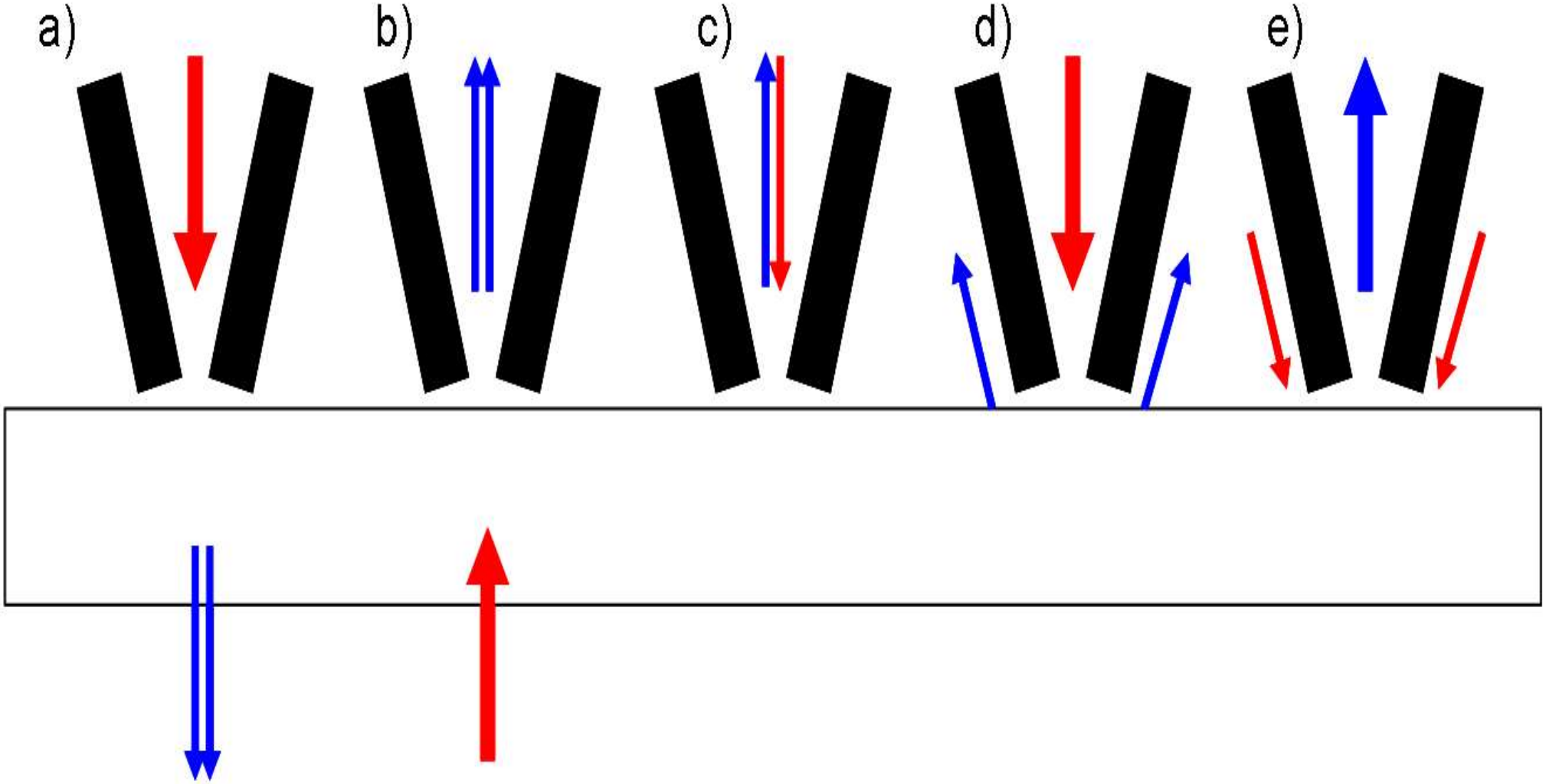
Aperture-less Probe

- **Fiber Probe.**
- **No Heat.**
- **Advantage.**
- **Disadvantage.**



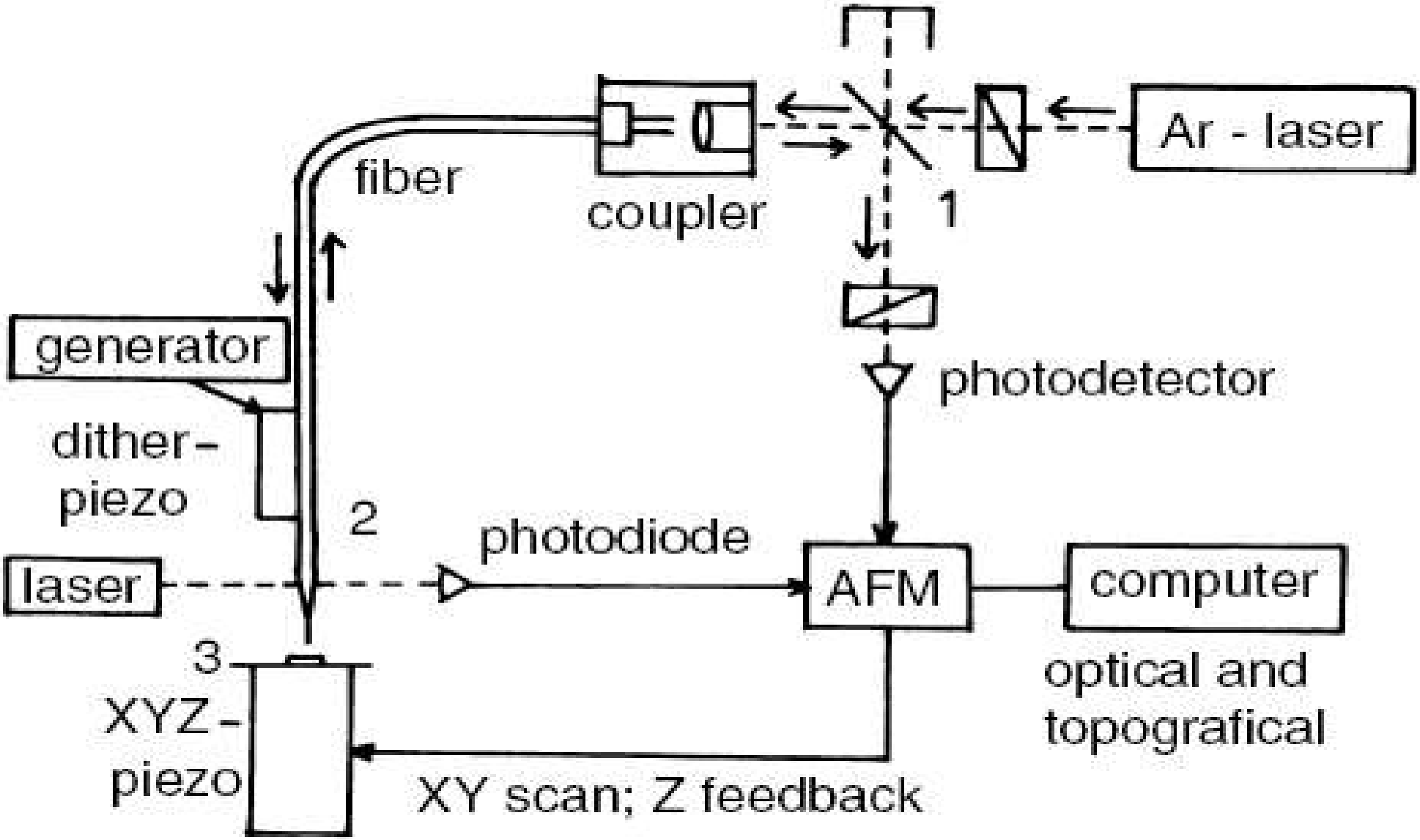
G. Kaupp, Atomic force microscopy, scanning near field optical microscopy and nanostructuring.

Apertured Modes of SNOM



http://en.wikipedia.org/wiki/NSOM

The Equipment



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Applications on SNOM

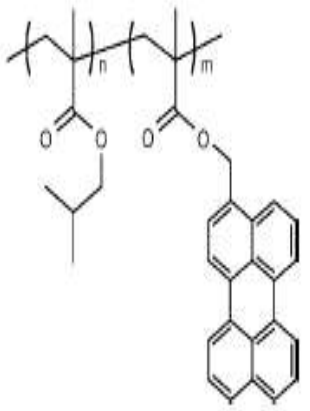
- **Physics and Chemistry (Conformation of single molecule, Imaging surfaces, ...).**

- **Biology (Imaging biological samples like blood, tissues, cancer cells, ...).**

- **Medicine.**

Application I: Conformation of Molecules

- Poly(isobutyl methacrylate)(PiBMA).
- Using Apertured SNOM.
- PiBMA molecule should be flat.
- The solution is water.
- preparing one molecule is impossible.
- Mixing of diluted dying PiBMA with non-dying PiBMA.
- The detector is sensitive to the dying molecules.



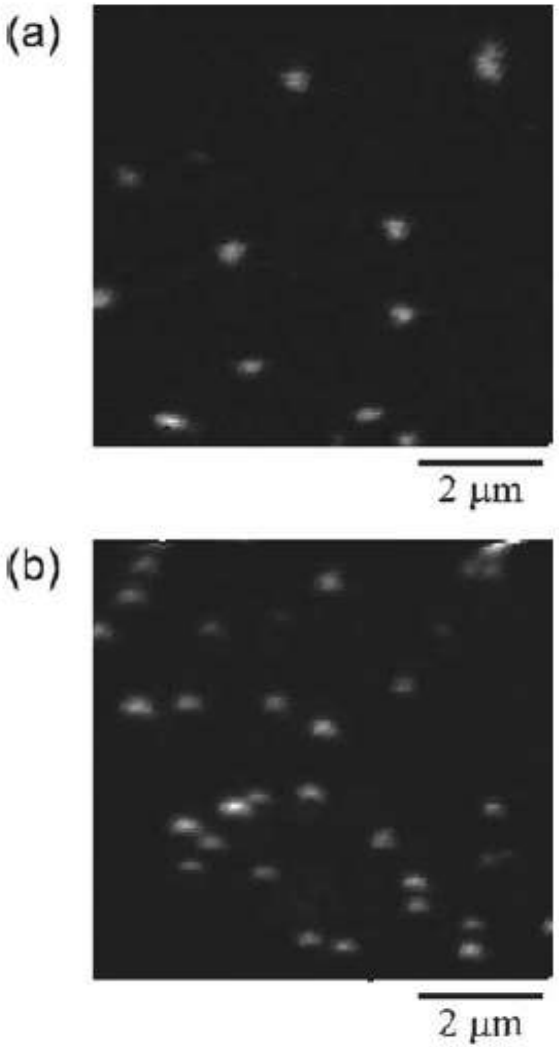
H. Aoki, M. Anryu and S. Ito, Two-dimensional polymers investigated by scanning near-field optical microscopy: Conformation of single polymer chain in monolayer, Polymer 46 (2005) 5896-5902.

Experiment

- **Illumination Mode.**
- **Laser of 415 nm.**
- **Aperture diameter 100 nm.**
- **Normal distance between the probe and the sample is 10 nm.**
- **Shear force feedback is not required.**

The Images

- Sample (a) with concentration 10%.
- Sample (b) with concentration 25%.
- White spots represent the dying PiBMA.
- PiBMA has a circular shape in 2D.
- PiBMA has random walk shape in 3D



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Application II: Biological Sample

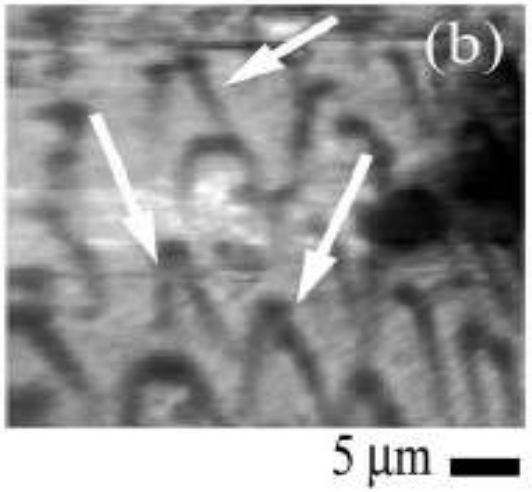
- The biological material is a mosquito wing.
- The wing surface is not flat.
- The wing was fixed over LiF film.
- Using soft X-rays and EUV.
- color centers (CCs) will appear on the LiF.

Using SNOM

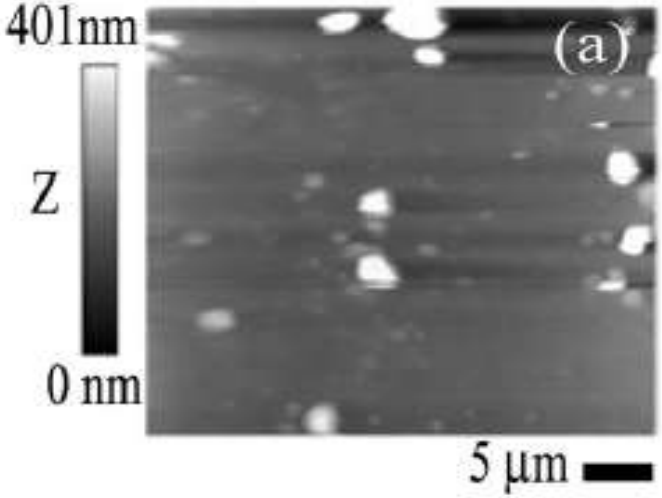
- **Using apertured SNOM of illumination mode.**
- **A sharp tip was attached at the end of the aperture.**
- **Aperture diameter 50 nm.**
- **Ar laser of 458 nm (illuminated light).**
- **Collected light has wavelengths 550-650 nm.**
- **Expected resolution is** $\lambda/2$.

SNOM Images

- **Fluorescence image.**

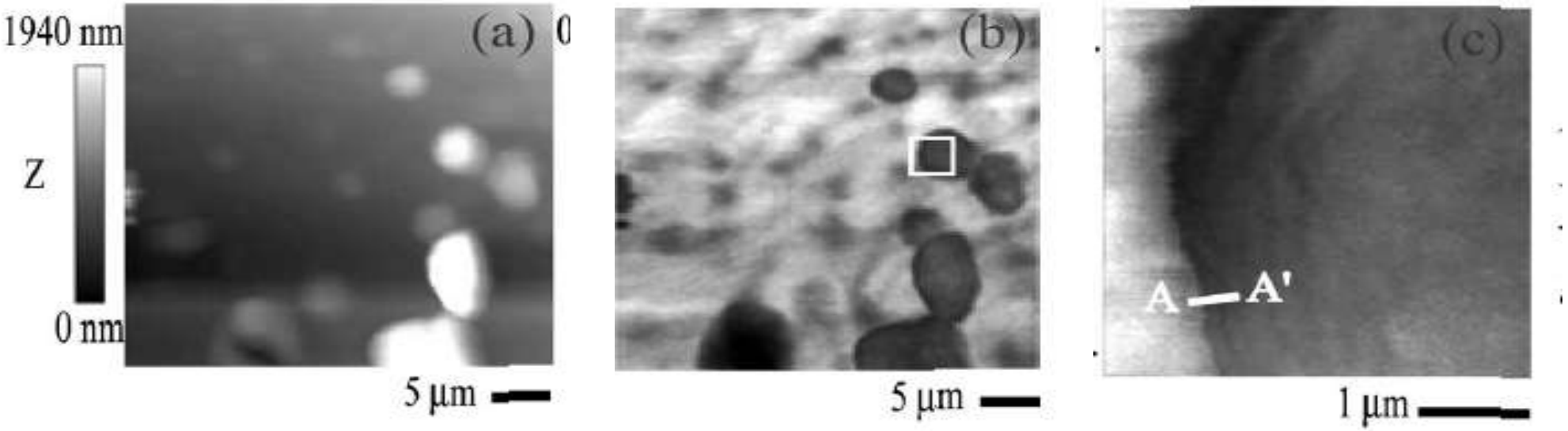


- **Topographical Image.**



A. Ustione, A. Cricenti, F. Bonfigli, F. Flora, A. Lai, T. Marolo, R. Montereali and G. Baldacchini, Scanning near-field optical microscopy images of microradiographs stored in lithium fluoride films with an optical resolution of /12, Applied Physics letters 88, 141107 (2006).

Unexpected Result

- 

- **AA' distance is 50 nm.**
- **Resolution** $\sim \frac{\lambda}{12}$.

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Thank You For Listening

Questions ??