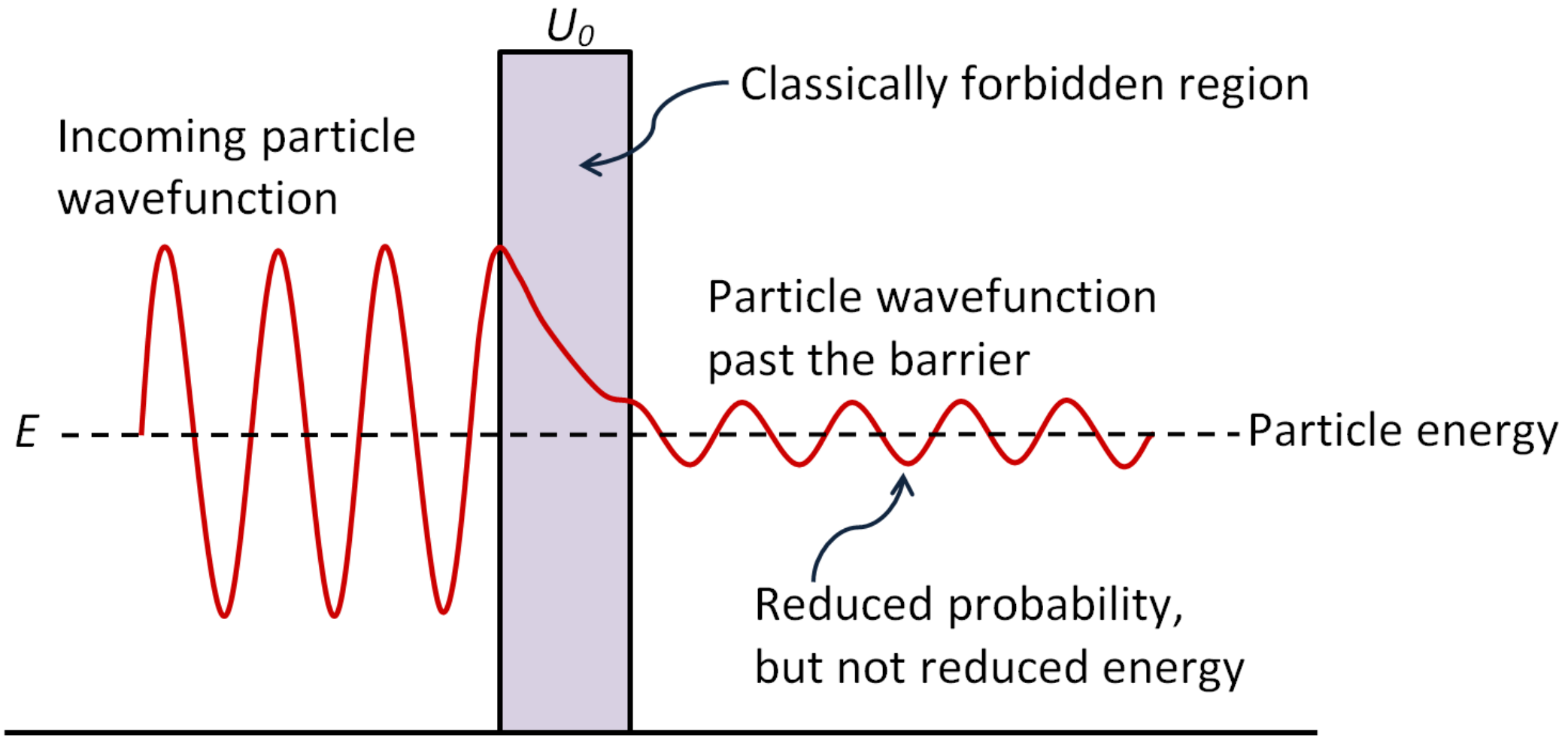
Characterization of Surfaces and Interfaces

Modern Techniques of Surface Science

– D.P. Woodruff and T.A. Dechar

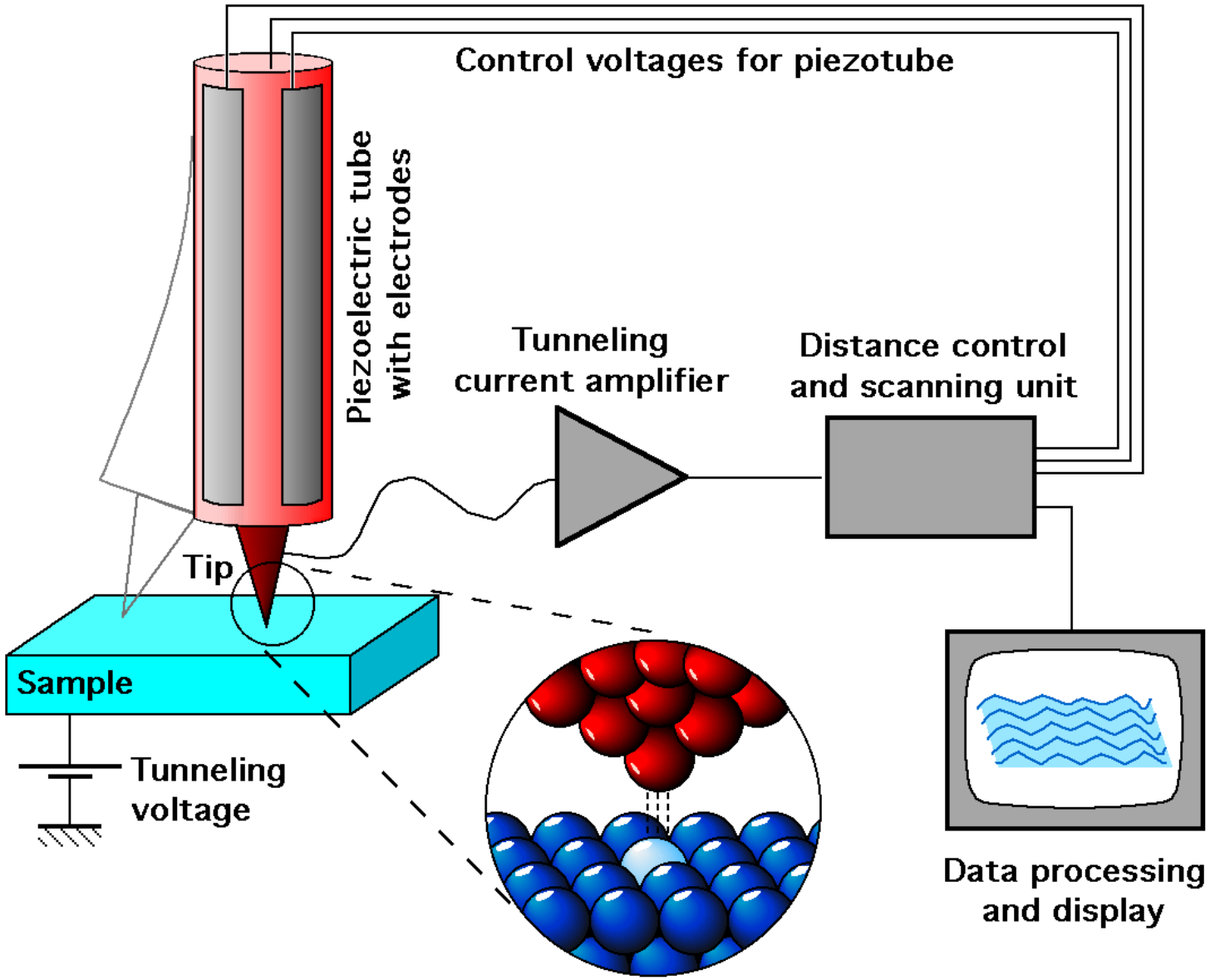
Scanning Tunneling Microscope (STM)



The Tunneling Effect

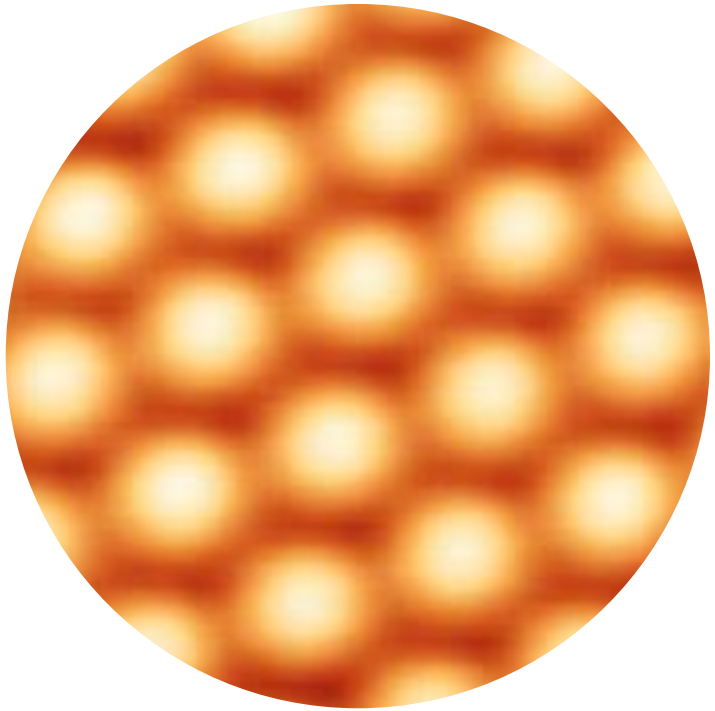
The tunneling effect consists of the propagation of a particle through a region where the particle's energy is smaller than the potential energy. Classically this region is forbidden to the particle where its kinetic energy would be negative. Quantum mechanically, however, since particles display wave features, the quantum waves can tunnel through the barrier.

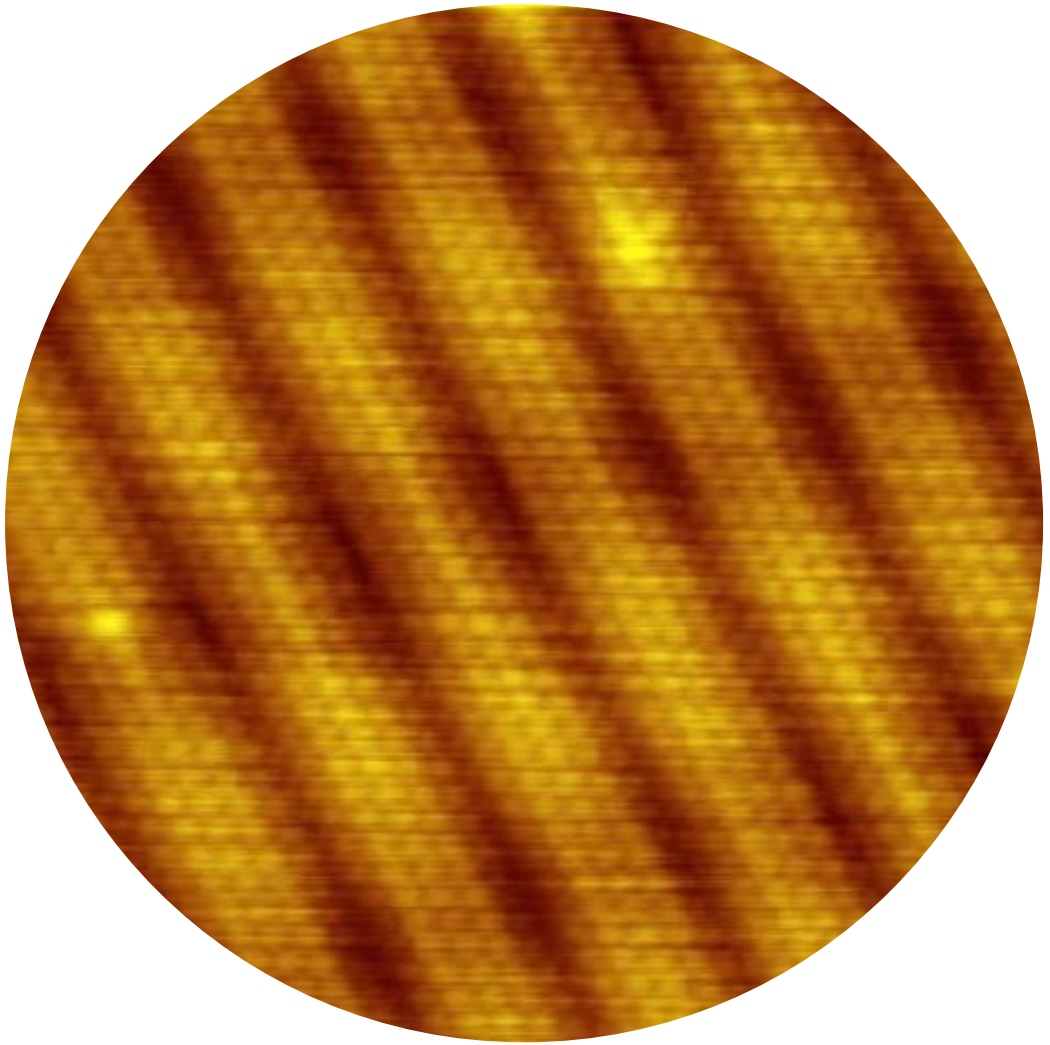
Scanning tunnelling microscopy (STM)



wikipedia.org

Si & Au as seen in STM





wikipedia.org

Scanning Tunneling Microscope (STM)

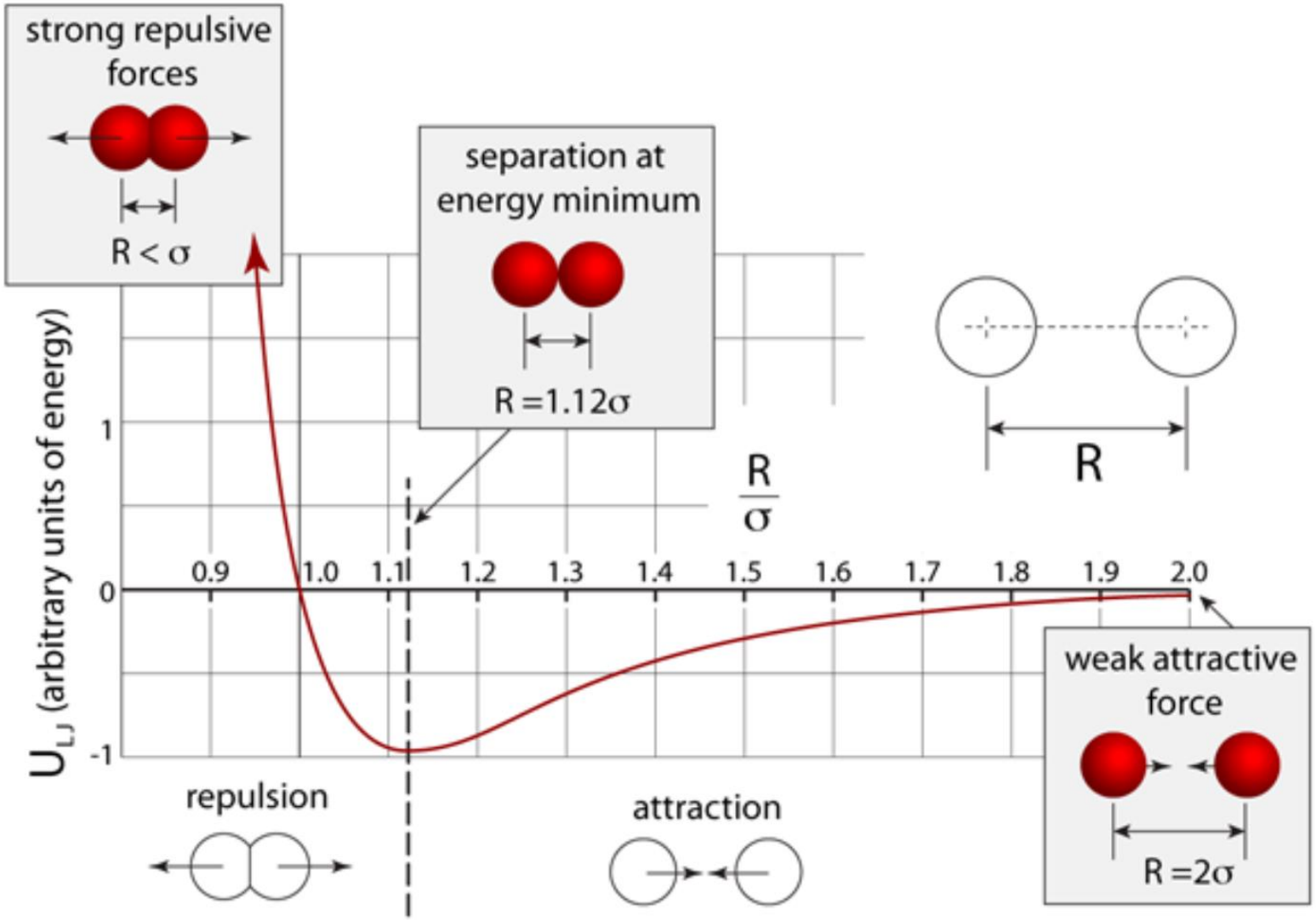
Quantum Tunnel Effect and Tunneling Microscope

www.youtube.com/watch?v=K64Tv2mK5h4

The Scanning Tunnelling Microscope : How it Works and Its Applications

www.youtube.com/watch?v=RftWp_3RZwA

Atomic Force Microscope (AFM)



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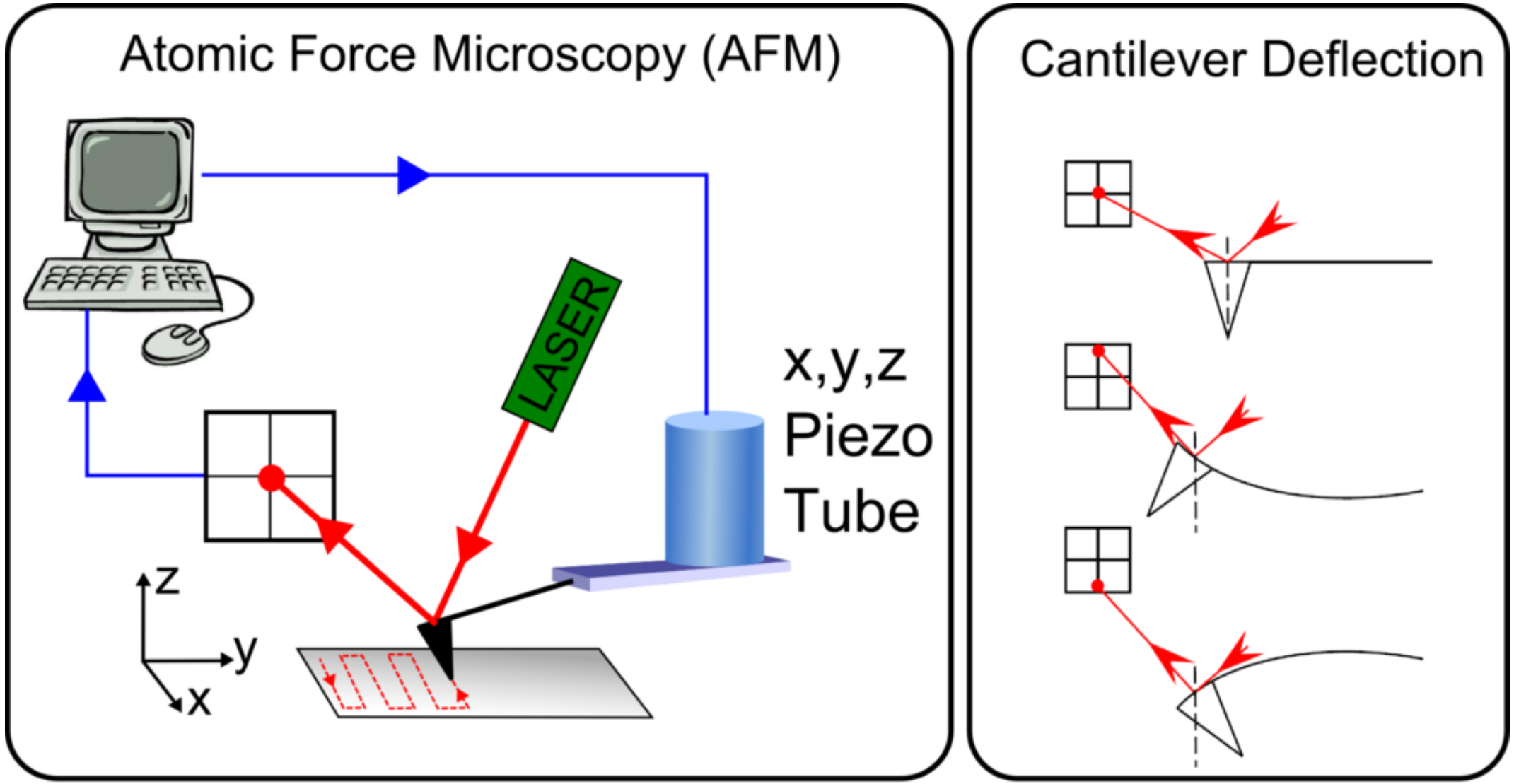

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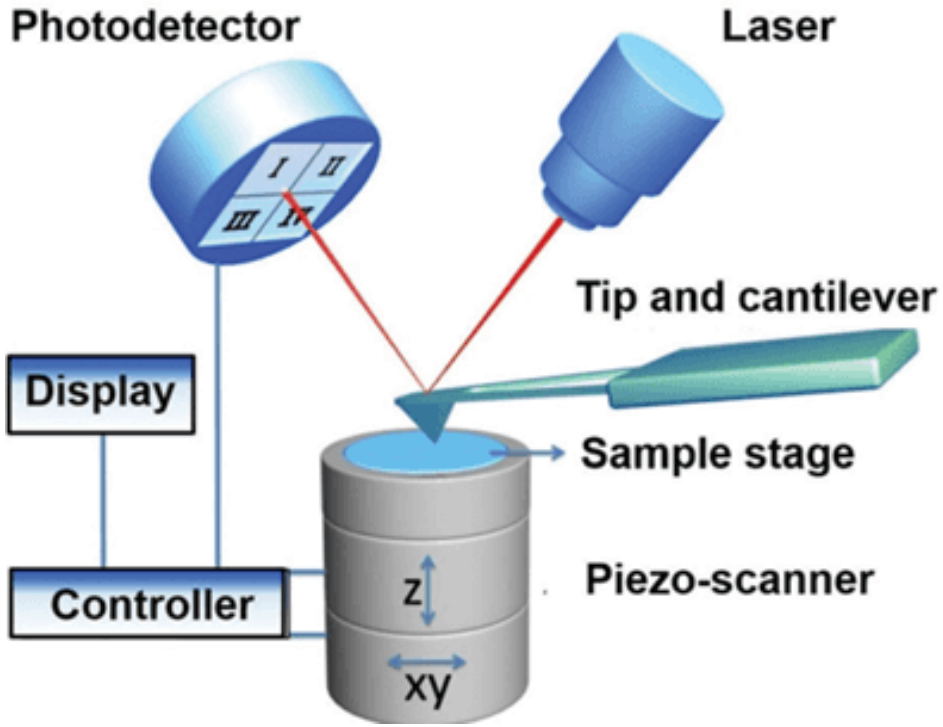
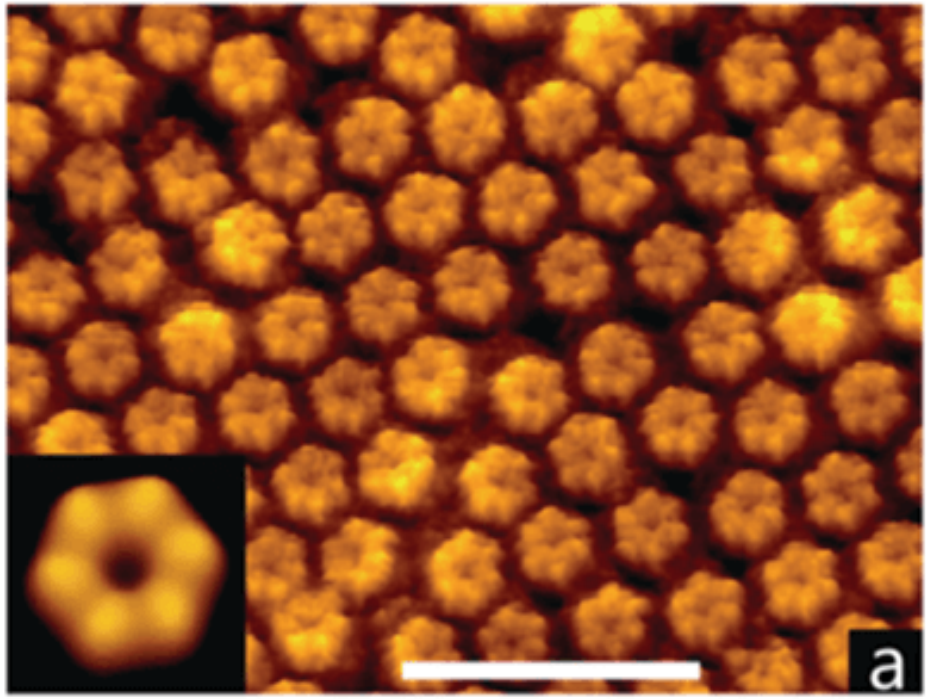
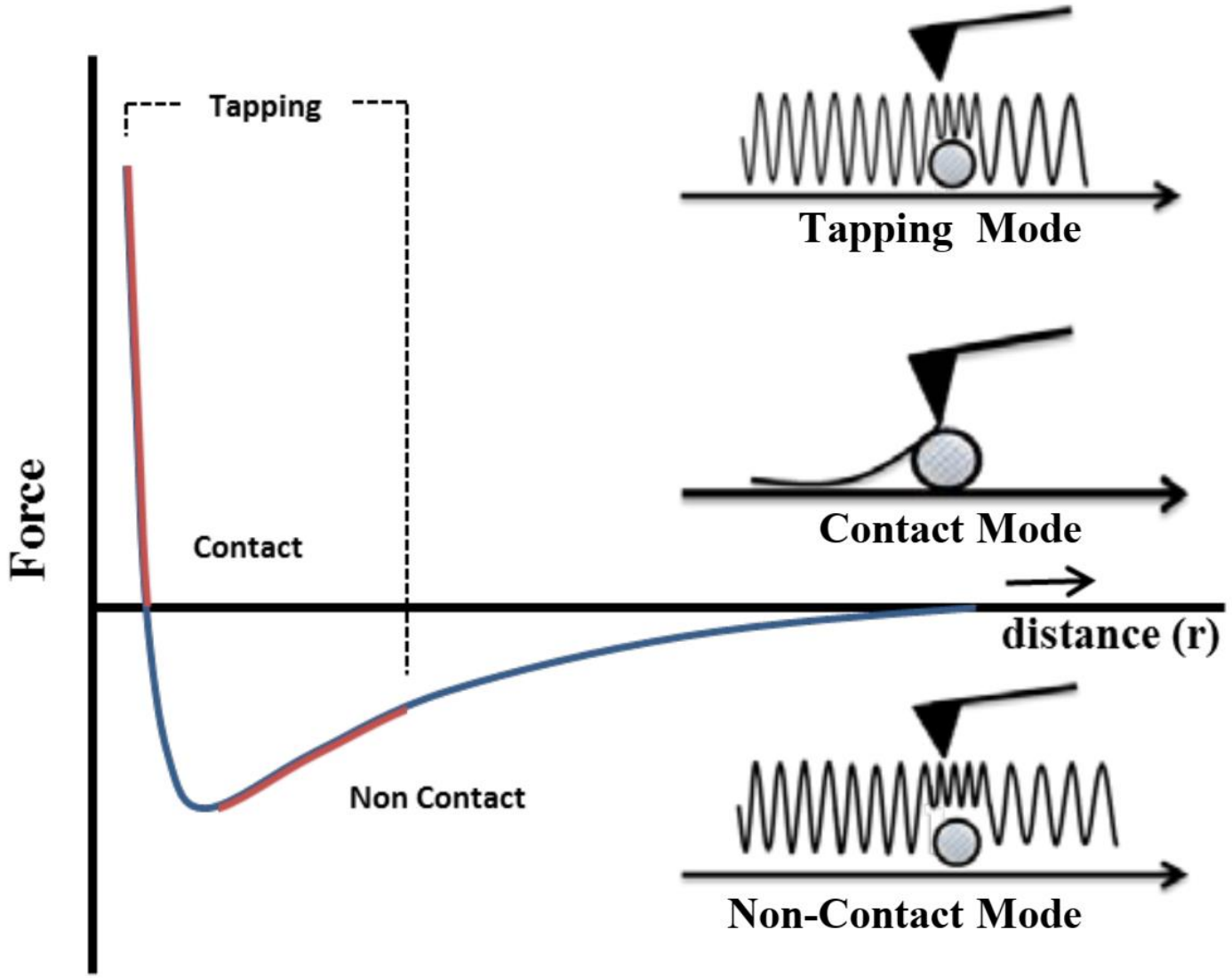


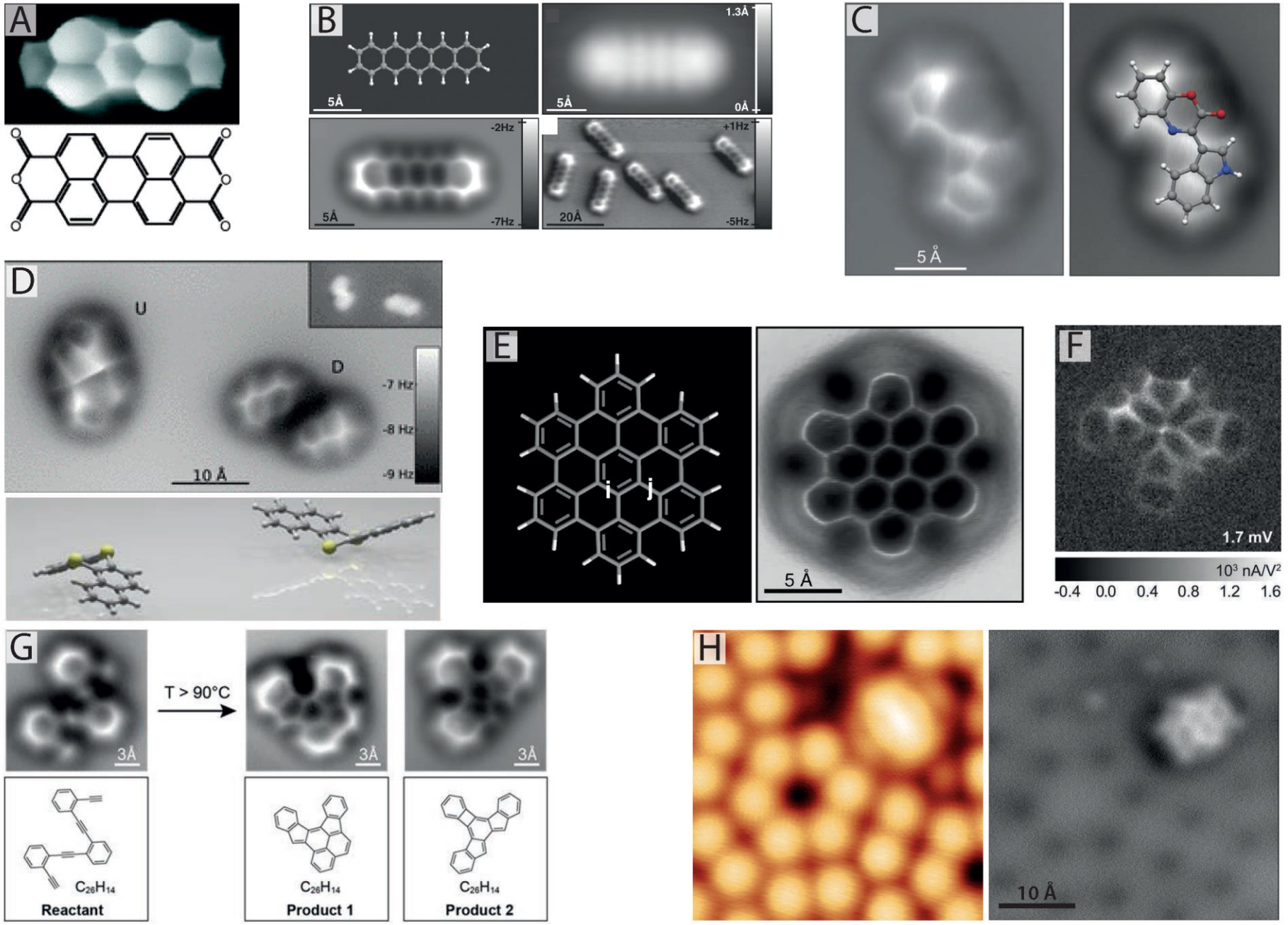


AFM Modes of Operation	Working Principle	Advantage	Disadvantage
Contact Mode	• Physical contact between the tip and the surface	• High scan speeds • High resolution	• Damage to soft sample • Later forces may produce image artefacts
Non-contact Mode	• No contact between the tip and the sample	• Low resolution • No damage to sample	• Slower scan speed if compared with both contact and tapping mode
Tapping Mode	• Intermittent and short contact between the sample and the tip	• High resolution • Minimal damage to sample	• Slower scan speed if compared with contact mode

Atomic Force Microscope (AFM)



Imaging internal bond structure with CO-mediated non-contact atomic force microscopy (NC-AFM)

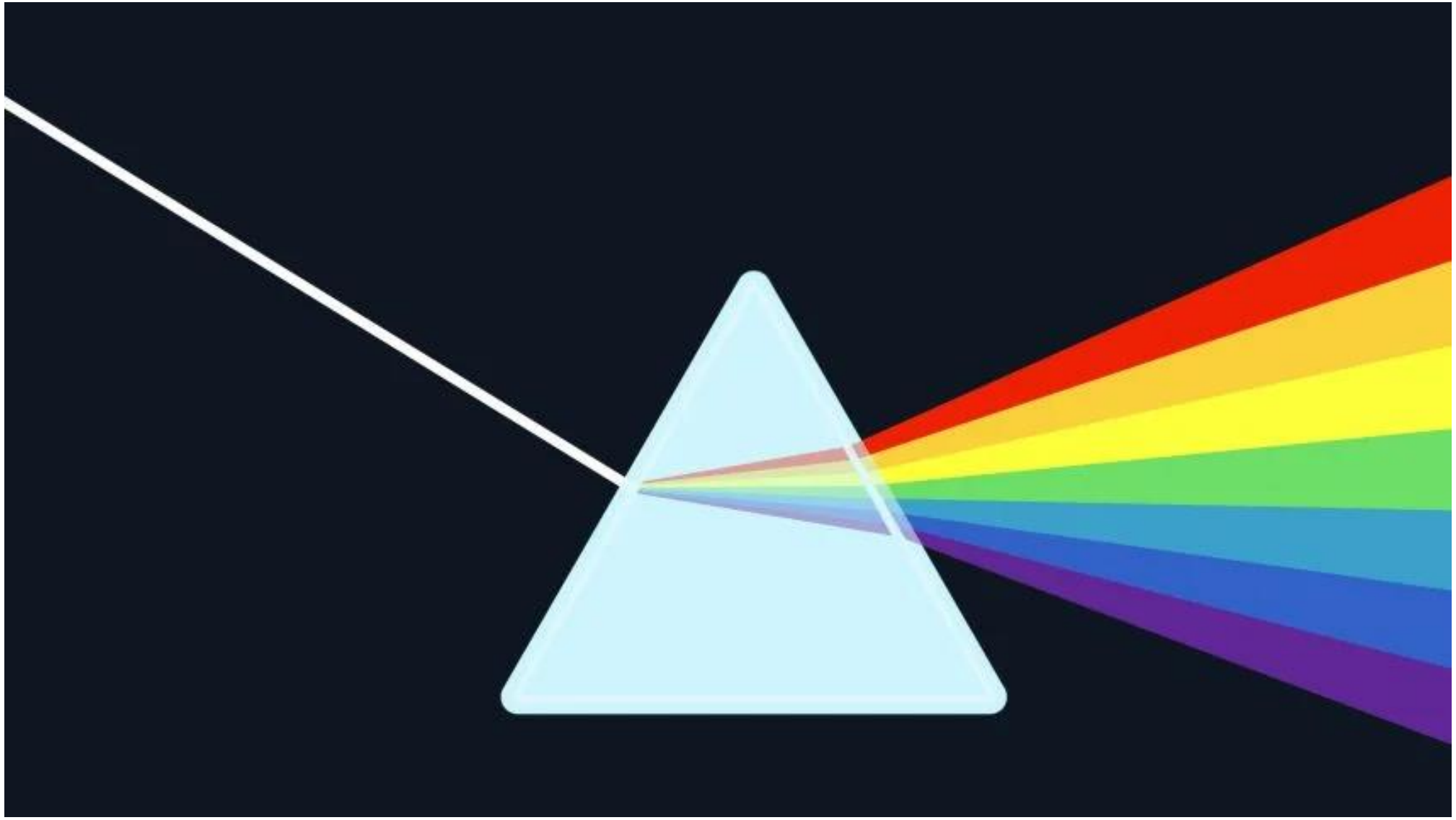


Atomic Force Microscope (AFM)

AFM Principle- Basic Training

www.youtube.com/watch?v=s6KqJS1GZNE

Electron Energy Loss Spectroscopy (EELS)



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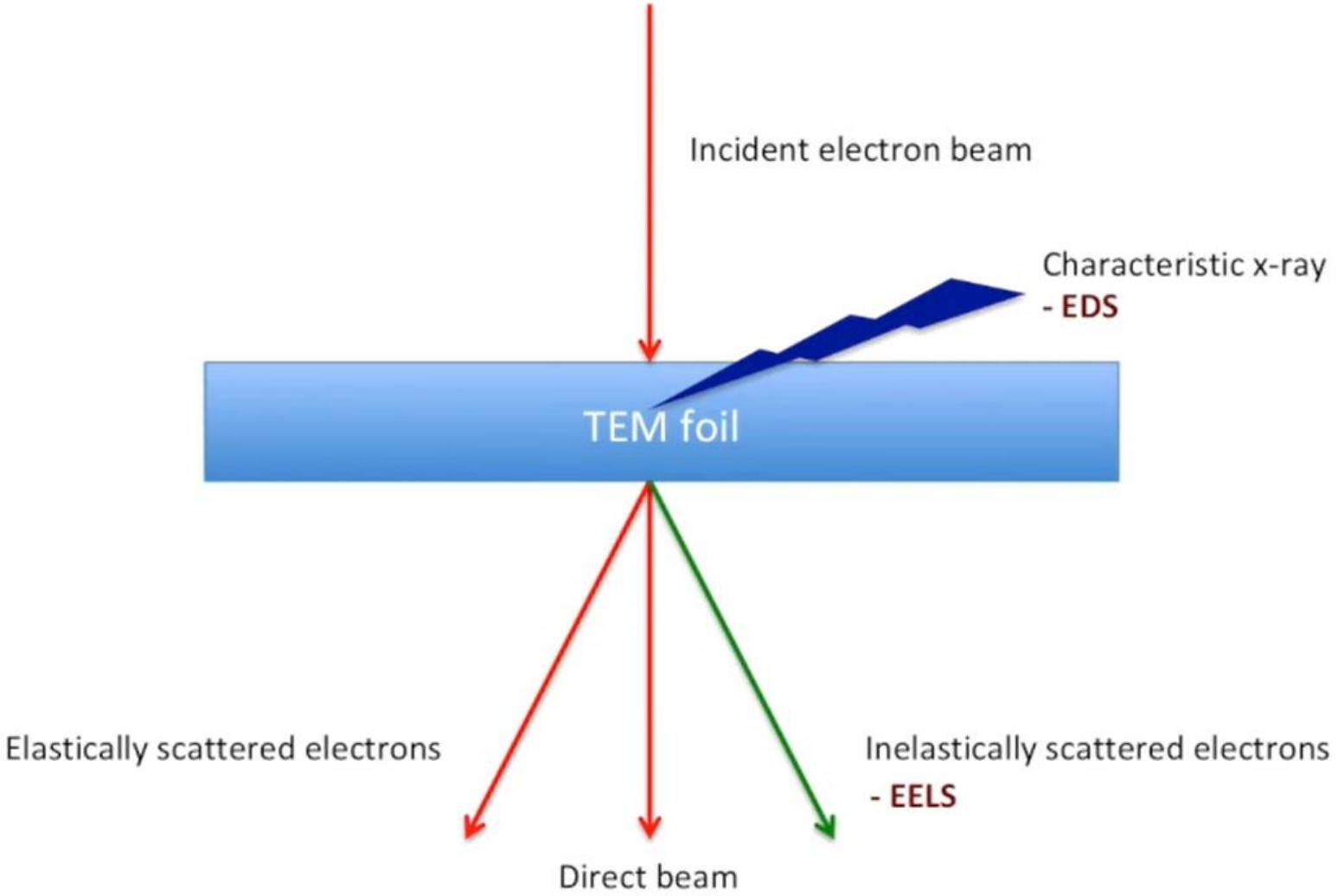

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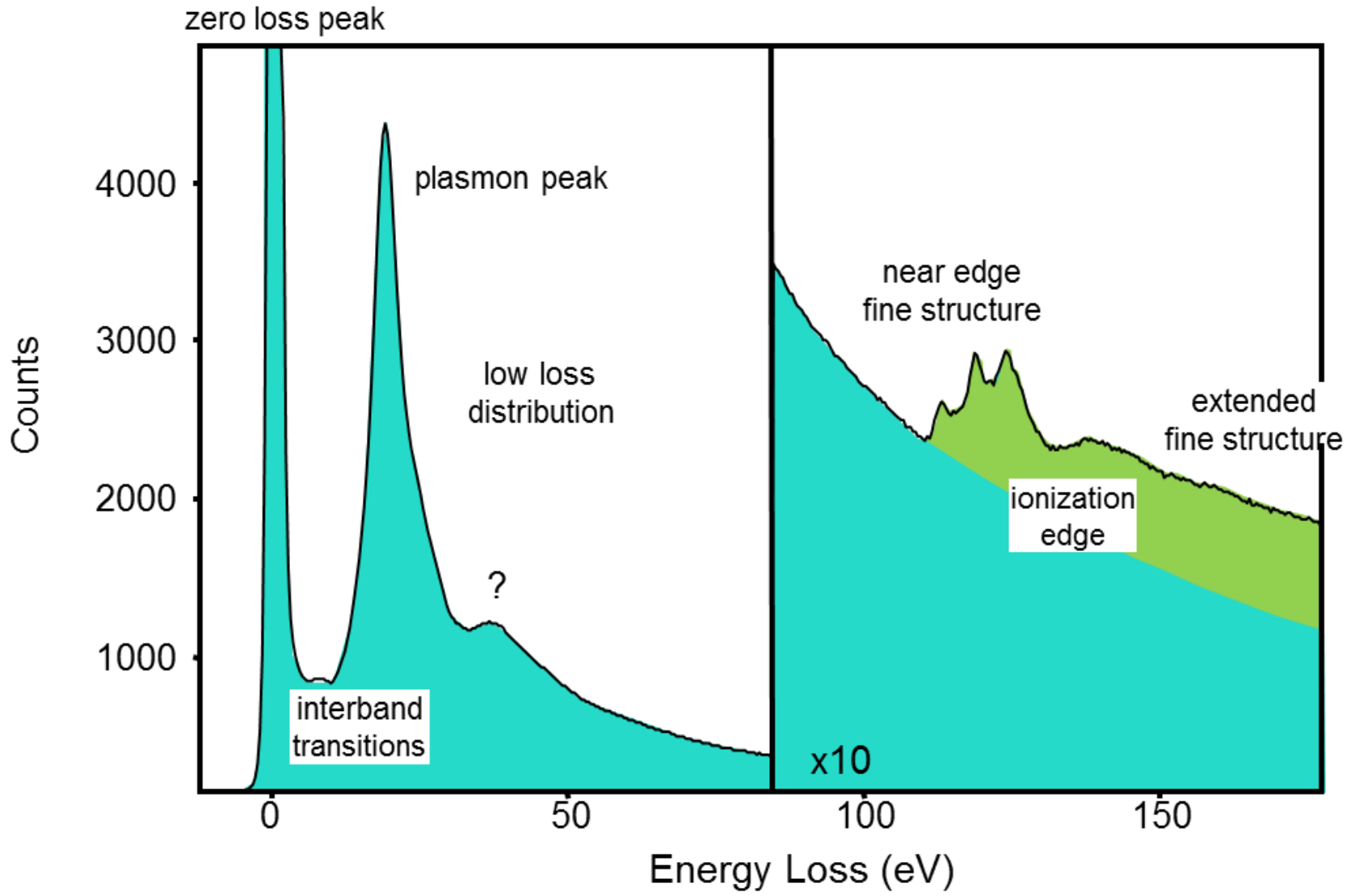
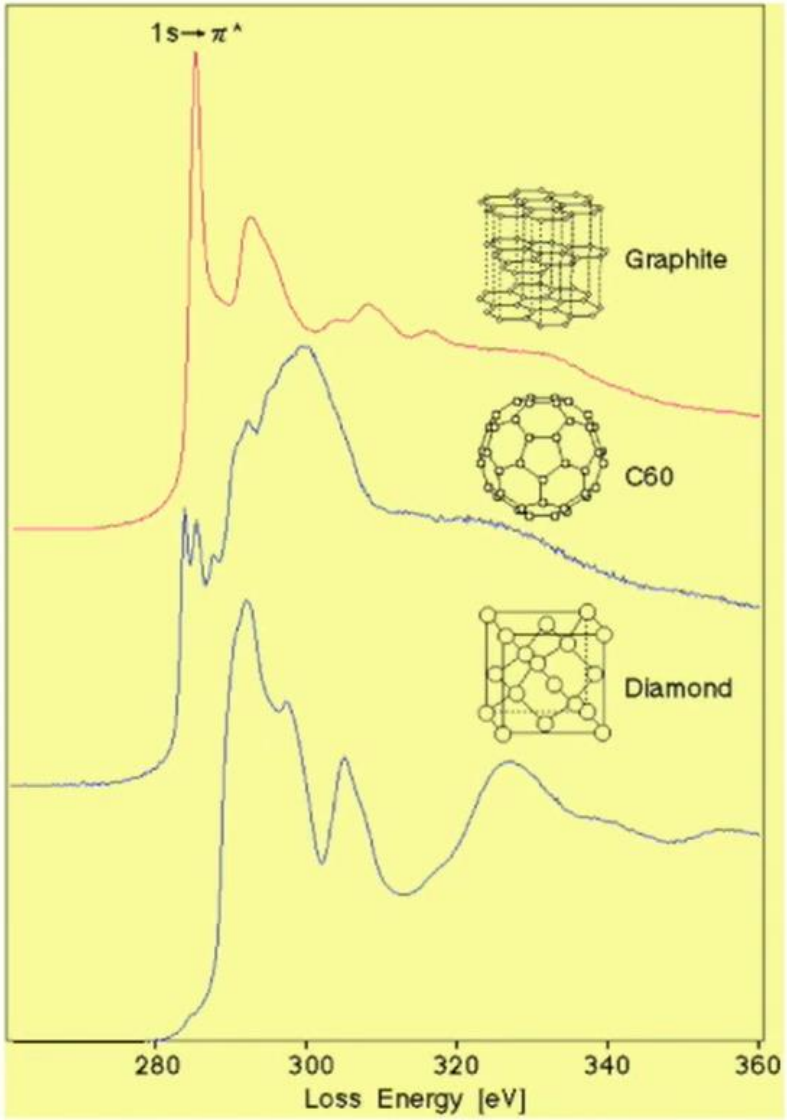


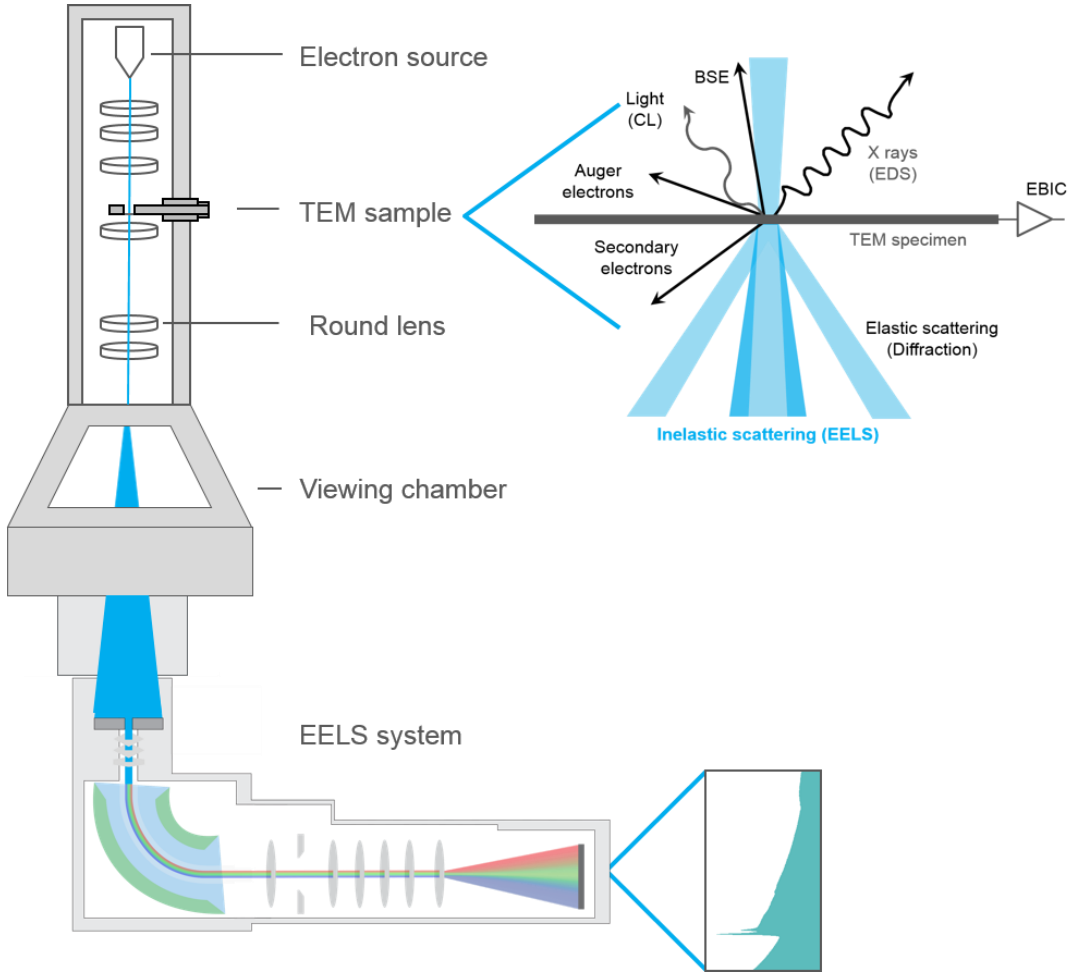
Electron Energy Loss Spectroscopy (EELS)

- Elemental information
  - Similar to EDS
  - Great for low-Z materials
- Bonding/valence state
- Nearest-neighbor atomic structure
- Dielectric response
- Free-electron density
- Band gap
- Specimen thickness



Electron Energy Loss Spectroscopy (EELS)

- When electron interacts with specimen, it loses energy in different ways.
- This loses energy contains information about the sample.
- So, It can be separated by magnetic prism and analyzed to find the details of their bonding/valence state, the nearest-neighbor atomic structure, their dielectric response, the free electron density, the band gap , and the specimen thickness.



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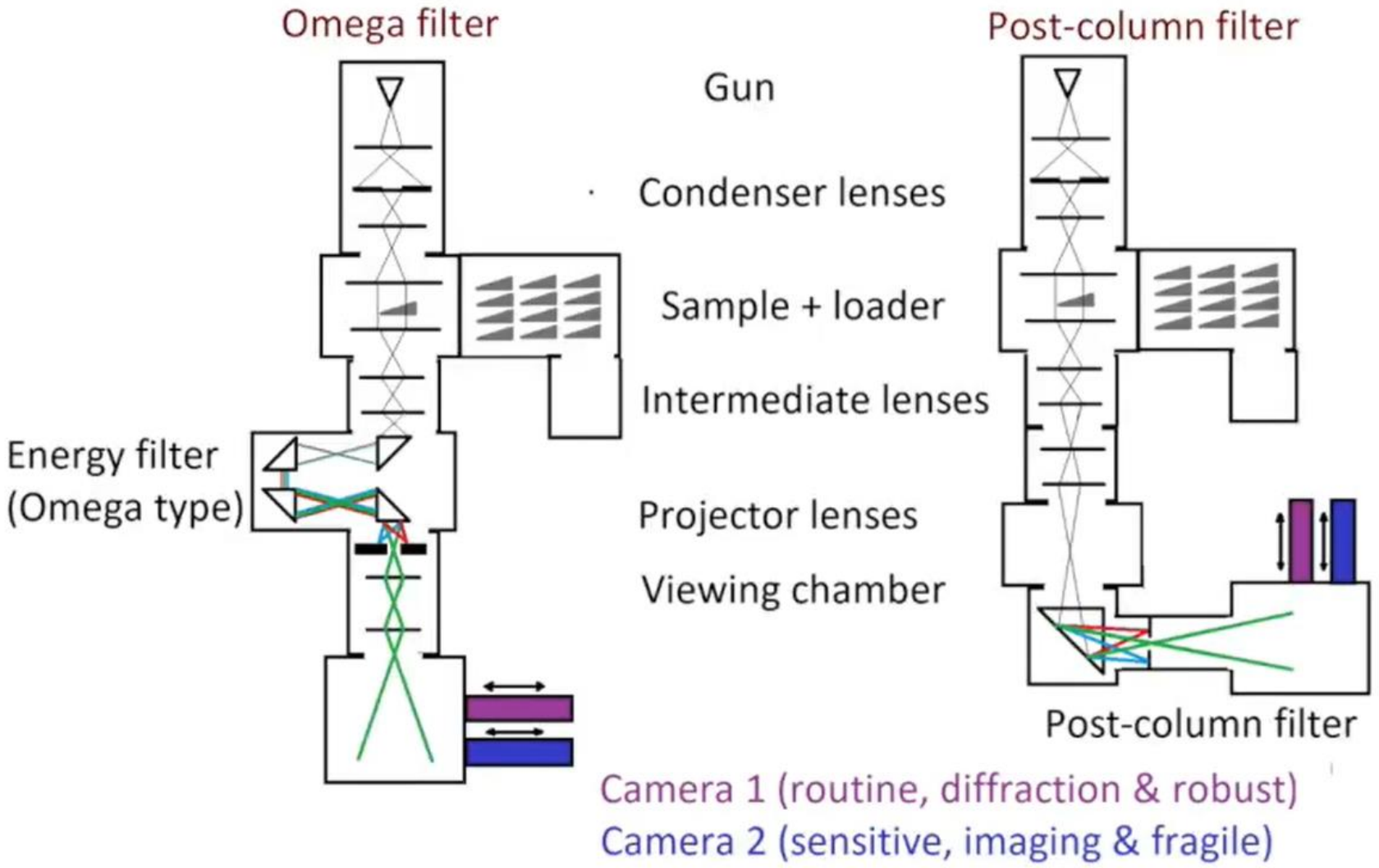

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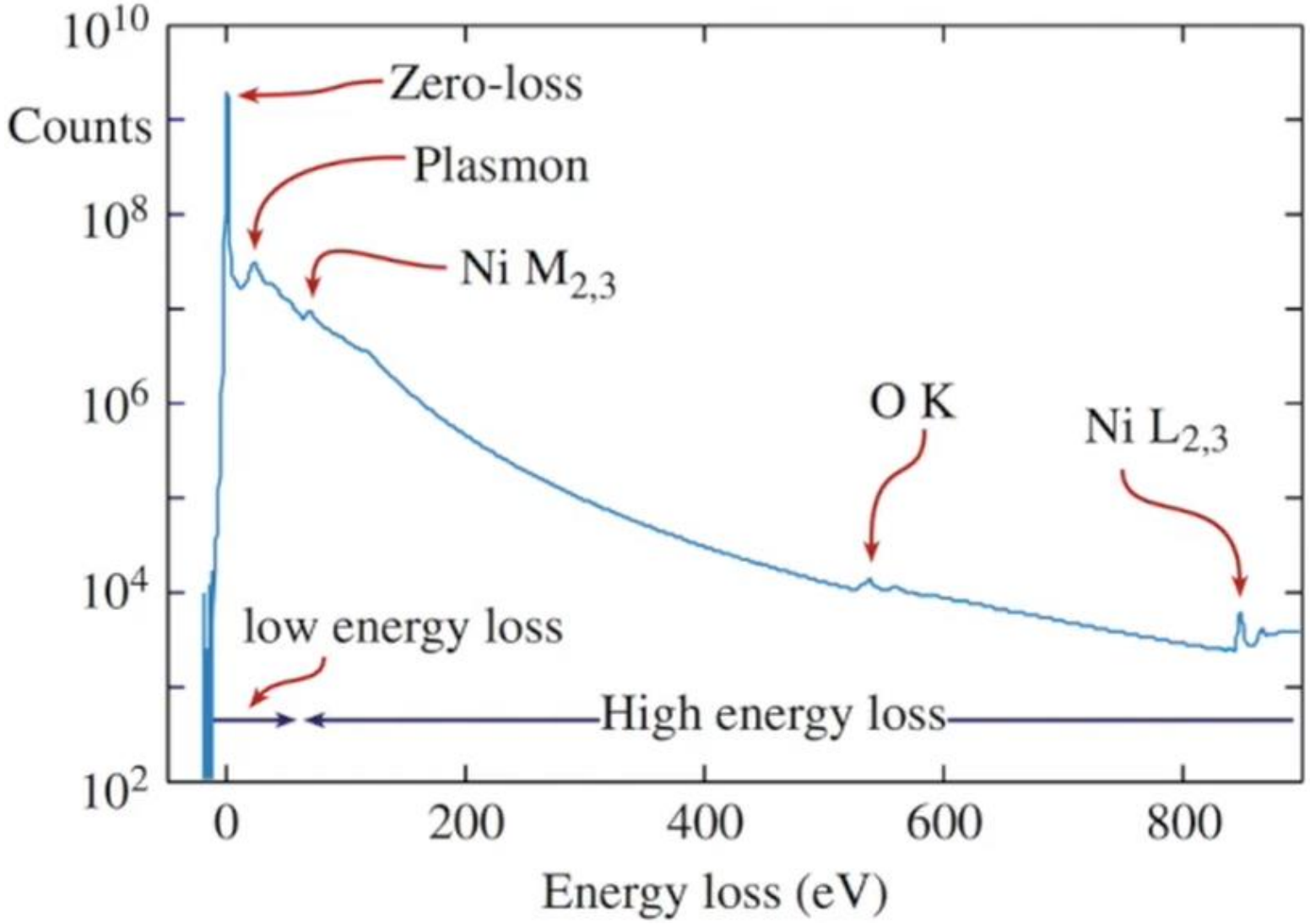

Electron Energy Loss Spectroscopy (EELS)

eels.info

Introduction to electron energy-loss spectroscopy

www.youtube.com/watch?v=wBz6csZN4Jc

There are more

- Auger Electron Spectroscopy(AESO)
- X-ray Photoemission Spectroscopy (XPS)
- Low Energy Electron Diffraction (LEED)
- Reflection High Energy Electron Diffraction (RHEED)