Transmission Electron Microscopy

Corban Swain | 20.109 | **Module 3, Day 4** | November 29, 2018

Only three 20.109 class days are left!

Key Assignments

Research Proposal (20 %) — **1 PM Dec 6**
- → Upload slides to Stellar
- → Bring 1 print-out of slides to 16-336

Blog Post — 10 PM Dec 8

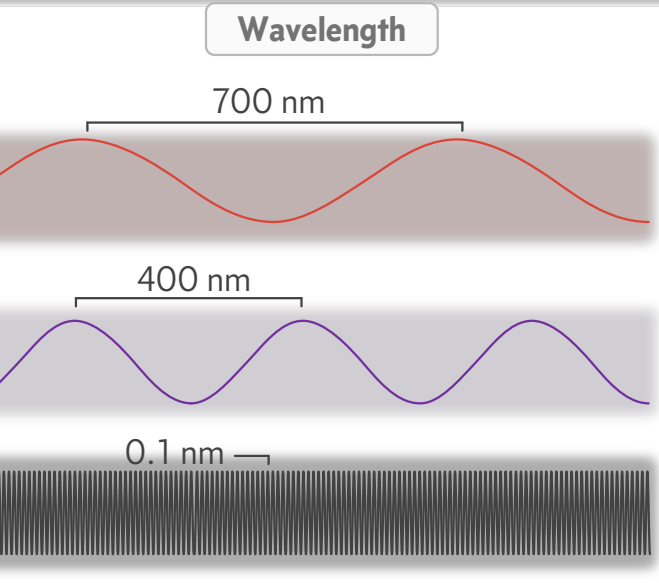
Mini-report (5 %) — **10 PM Dec 10**
- → No abstract nor methods section
- → Background + Figures + Results/Discussion

Extra Office Hours

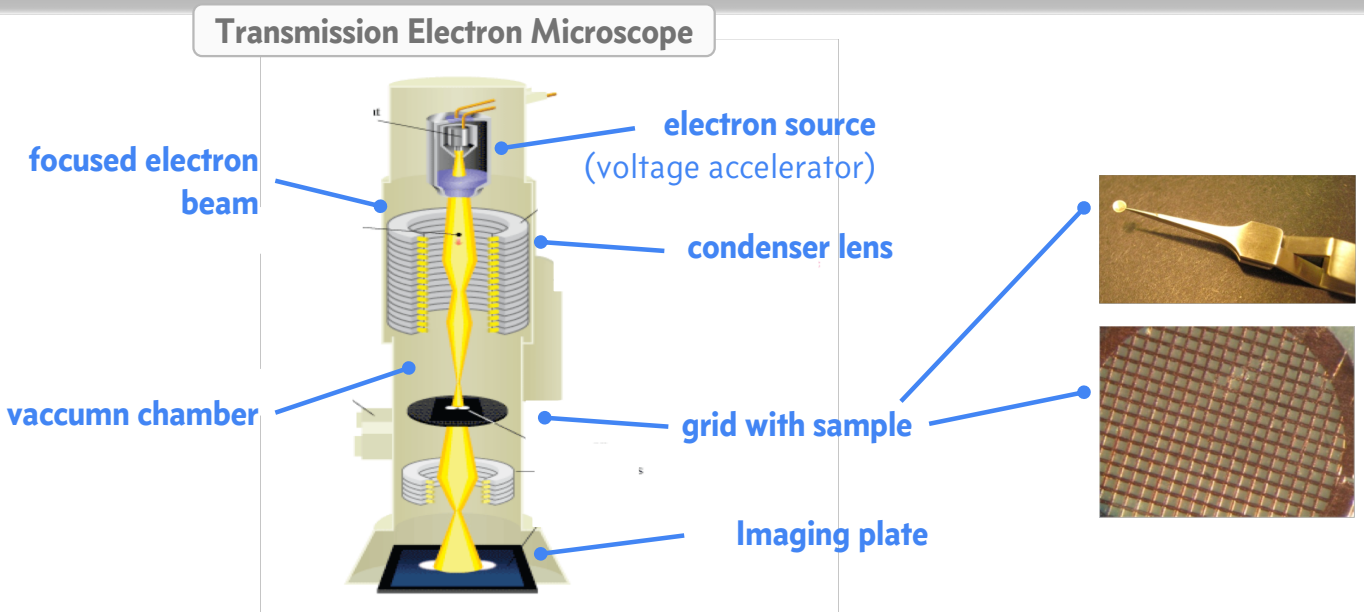
- **Sat and Sun (12/1 & 2):** *Leslie is willing to meet in the afternoon for 1 hour time slots, by appointment only (email her if interested)*
- **M 2-5pm** Noreen
- **Tu 10-11am** Josephine
- **W 11am-1pm** Josephine
- **W 3-5pm** Noreen
- **Th 2-3pm** Leslie
- **Th 3-5pm** Noreen

No Lecture on Thursday

Electron microscopy pushes past a fundamental limit of light microscopy



How does transmission EM create an image of a sample?



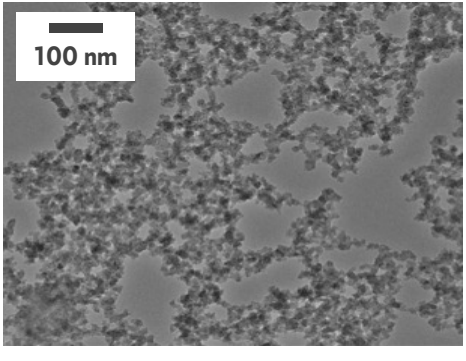
TEM Fundamentals Summary

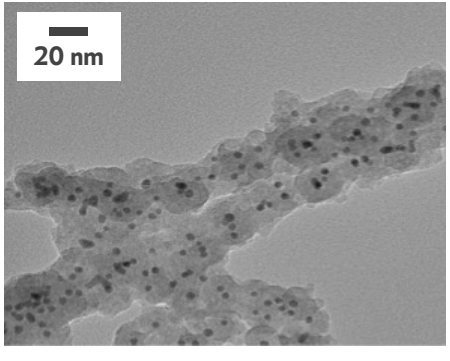
- Resolution
  - $\lambda_{blue\ light}$ = 400 nm
  - $\lambda_{high\ E\ electrons}$ = 0.1 nm
  - Diffraction Limit, d = $\frac{\lambda}{2.8}$
- Electron Beam
  - Source is from thermionic emission by tungsten
  - Acceleration by voltage differences
  - Beam focusing by electro magnets
  - Vacuum to prevent collisions w/ air
- Sample preparation
  - Grid material is Cu
  - Grid conductivity is important for dispersing ions
  - Biologic samples must be coated by e⁻ dense material
- Image Generation
  - Contrast is produced by e⁻ density
  - For bright field, darker means more e⁻ density
  - Must convert electrons to photons
    - by eye use a phosphor screen
    - For digital image use YAG CCD

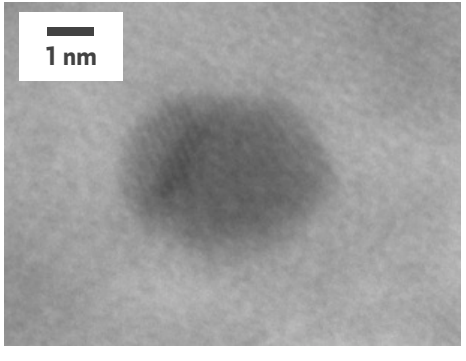
TEM micrographs can provide visual support for nanomaterial structure

What will you learn …

- At low resolution? density, # of wires, # of particles, length of wires
- At high resolution? lattice, atomic arrangement







TEM micrographs can provide visual support for nanomaterial structure

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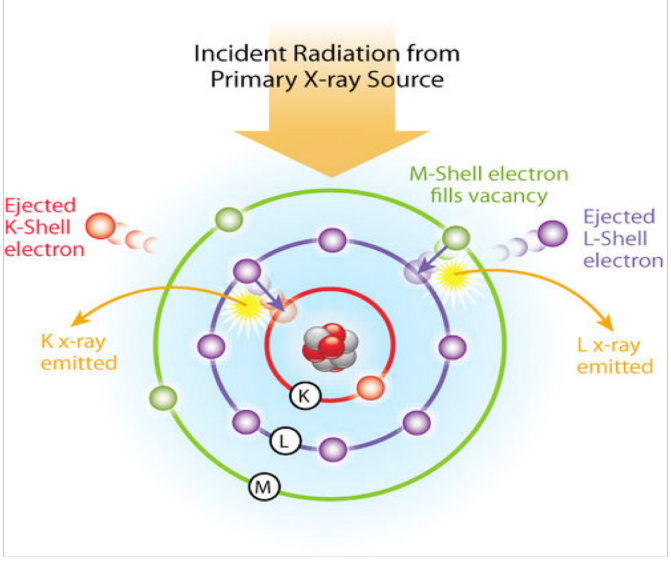
X-ray emissions are produced by electron collisions; why do we care?



elemental fingerprint

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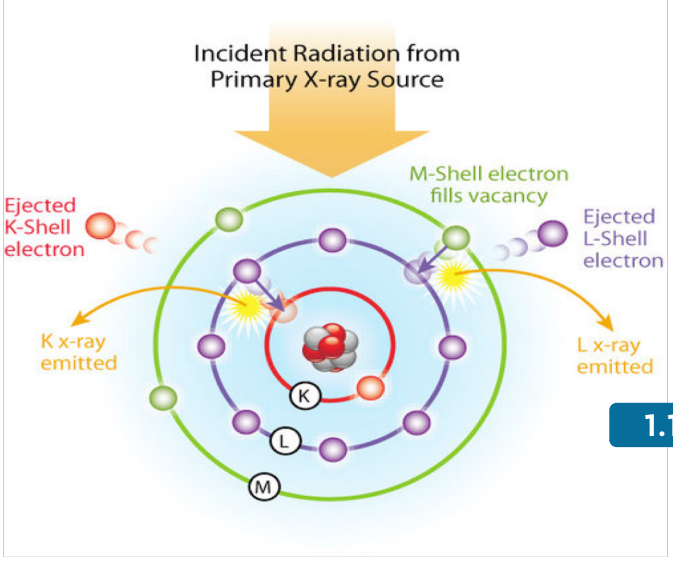
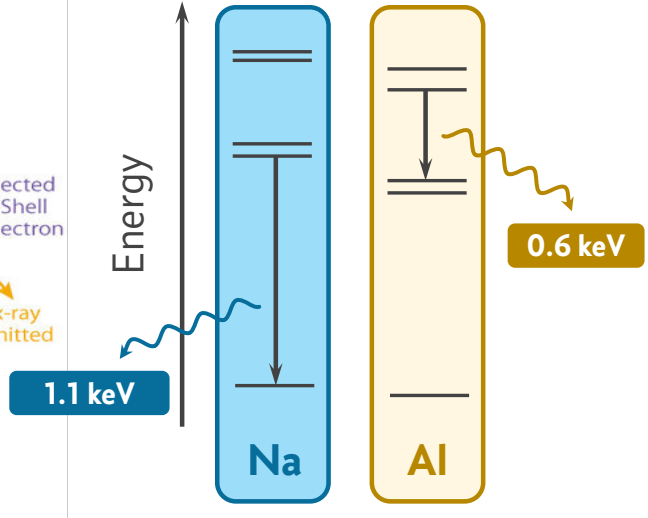
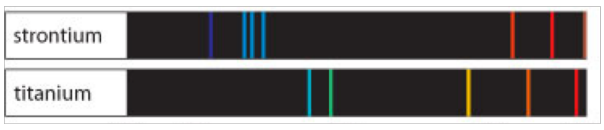


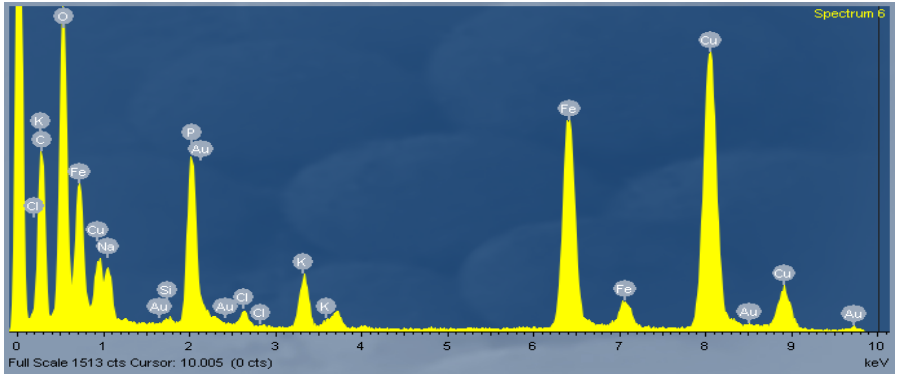


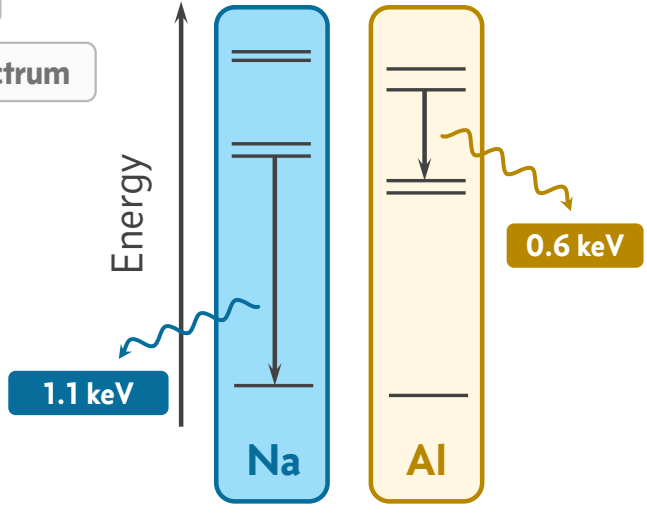
X-ray emission spectra are specific to elemental energy transitions



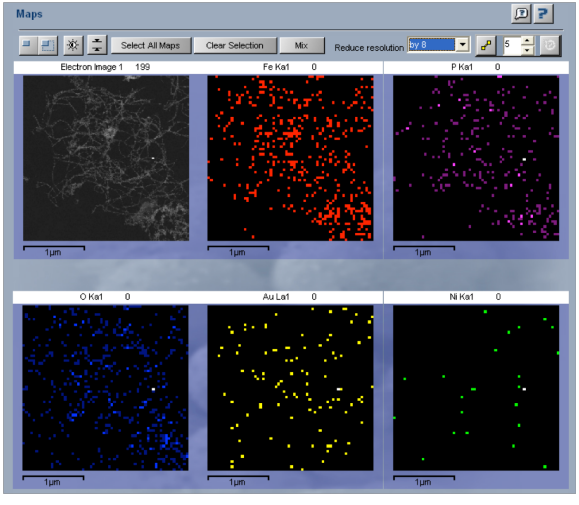
← Visible Spectrum

↓ X-Ray Spectrum





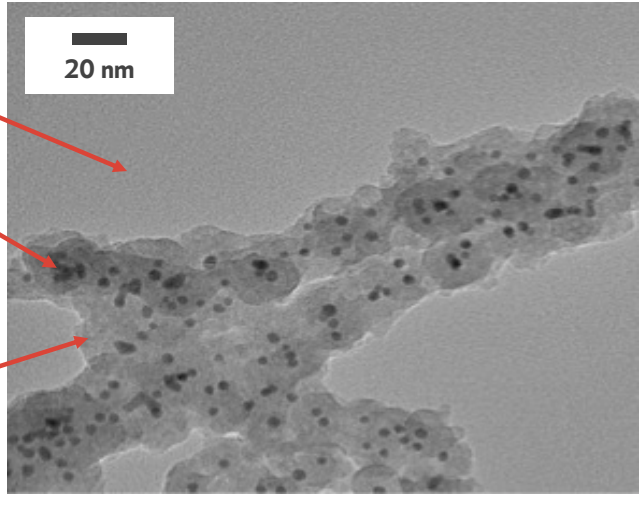
X-ray emission spectra can be used for elemental mapping, EDX



C, Cu

Au

Fe, P



Imaging & EDX Fundamentals Summary

- TEM Images
  - At low resolution we can visualize:
  - At high resolution we can see:
- EDX = energy dispersive X-ray spectroscopy
  - X-rays are produced by _____
  - Energy gap differences is unique to each element
- Biomineralized phage samples
  - We expect to see what elements:
  - Contamination from what elements?
  - Where do contaminants come from?

Today in lab …

- TEM in Koch basement
  - What can your TEM images suggest about the phage biomineralization and AuNP binding? Are the NP the size expected?
- *Use your time wisely:*
  - draft your research proposal slides
  - discuss how the presentation speaking parts will be shared
  - draft talking point notes for presentation
  - **Review rubric** on wiki to make sure you are including all components necessary
- M3D5HW: Calculate mA needed to discharge your experimental battery (choose 1 cathode weight) battery in 10 hrs, handwritten or emailed calculations are fine, turn **in individually**
- Reminder: Quiz M3D5 on ~~Wednesday~~ TUESDAY

1. GREEN
2. PURPLE
3. PINK
4. ORANGE
5. RED

assignments tab