# Lecture-6. Microscopy. TEM

Bouncing electrons off a sample is only one technique; you can also shoot electrons through the sample and watch what happens. That's the principle behind a transmission electron microscope (TEM). In effect, it's a kind of nanoscale slide projector: Instead of shining a light through a photographic image (which allows certain parts of the light through), the TEM sends a beam of electrons through a sample. The electrons that get through then strike a phosphor screen, producing a projected image: Darker areas indicate that fewer electrons got through (hence that portion of the sample was denser); lighter areas are where more electrons got through (that's where the sample was less dense). A TEM can achieve a resolution of approximately 0.2 nanometers, roughly the size of many atoms. Because most atoms have diameters of at least 0.2 nanometers, a TEM can produce images that show you just how the atoms are arranged in a material. Although a TEM can achieve much greater resolution than an SEM, the instrument itself is costlier — and much more work is required to prepare a sample for a TEM than for an SEM. That's why computer-chip manufacturers use SEMs as everyday workhorses and only fire up the TEMs for more specialized measurements. Typically, you'd use TEMs to analyze the morphology, crystallographic structure (arrangement of atoms in a crystal lattice), and composition of a sample.

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