3.5 Properties, Measurements and Characterization

3.5.1 More Properties

List of Properties to be Measured

- What are "**general properties**" and how do we measure them?
  - In a first approximation we take all the properties where a measurement produced just a single number. This always means that we measure some *average* property. What do we have - let's make a quick list:
- **Geometry and Topology**.
  - Under this heading we may list:
    - **Thickness and roughness**.
    - **Density and porosity.**
    - Bravais lattice type.
- **Mechanical properties**
  - Under this heading we may list:
    - **Elastic moduli**.
    - **Plastic deformation**. parameters like ***critical yield strength***, ultimate tensile strength, dislocation density, other defect densities.
    - **Fracture** parameters.
    - **Internal stress and strain**
- **Thermal properties**
  - What comes to mind is
    - **Thermal expansion coefficient**.
    - **Thermal conductivity**.
    - **Specific heat**.
    - **Thermoelectric coefficients**.
- **Chemical properties**
  - Things like
    - **Corrosion resistance** in various ambients.
    - Solid-state **reactivity** between substrate and top layers.
    - ???
- **Defect properties**
  - We have, outside of structural concerns, some simple numbers for, e.g.:
    - Formation and migration enthalpies of point defects.
    - Solubilities for impurities.
    - Stacking fault and surface energies.
    - Precipitate formation parameters.
- **Optical properties**
  - Not too much here on first sight. We have
    - **Index of refraction**.
    - **Absorption coefficient**.
    - **Non-linear optical properties**.
- **Electrical properties**
  - The list includes
    - **Conductivity**.
    - **Carrier mobility**.
    - **Hall coefficient**.
    - **Carrier type and concentration**.
    - **Work function**.
    - **Dielectric breakdown field strength**.
    - **Critical current density**.

- **Dielectric function.**

OK - you are right: This is getting ridiculous. Some of the properties listed you have never heard of before (which doesn't mean that they might not be crucial in some applications). Obviously, the list can be expanded to provide a short enumeration of everything dear to Material Scientists.

Well - yes. But the fact remains: All those properties (and more) are there and *need to be measured* if you either

- Really need to know them, and
- Have some reason to expect that they might be different from the (hopefully) known bulk values.

With that practical restriction in mind, we can cut out a lot of measurements contained in the list above. If we focus on the most essential general properties you almost always need to know *and* must measure, we are left with

- Film thickness.
- Density / porosity / uniformity.
- Conductivity.
- Special properties.

Let's discuss this list a bit in the next module and give some hints about methods of measurement (more will be found in the links provided)