September 14, 2022

APS110 – Lecture 3

See hand written notes for drawings.

Last class…

- **Stress = (force)/(initial cross sectional area)**
  - Initial cross sectional area is important, because this area can change when an object is stretched (think of a spring)
  - We consider the stress from this eqn as 'engineering stress', as it's not the true stress
- **Stress and strain are <u>independent</u> of sample size**
  - Because we've divided by cross sectional area, we've normalized for size
  - Between different materials (ex. large diameter rope vs. small diameter rope), they would handle the same load (force) differently, even though they experience the *same stress*
    - This is why we have to *normalize* for sample size

- **Strain = (change in length)/(initial length)**
  - Strain is change in length normalized to the length of the sample
  - Large object and small object of the same material property will experience the same strain, even though the change in length differs

- Hooke's Law allows us to determine the elastic response of a material to an applied load

How do we determine Stress and Strain?

- We can't use a cylinder in real life
- In order to control where the deformation happens so that we can measure it, we create a **tensile specimen** (aka tensile coupon, dogbone specimen)
  - There are larger regions at the end (large cross sectional area), where we can hold onto the specimen – **grip region**
    - Occasionally, this region is threaded
  - The interesting stuff is going to happen in a narrowed section, with reduced cross sectional area – **reduced section**
    - The stress is the highest in this section
    - When the specimen is going to ultimately deform and break, it will happen in this reduced section
    - Linear elastic region
    - Somewhere in this reduced section, we have to define our initial length (l_0) → this is called the **gauge length**
  - This whole process would be used for a **tensile test**

Elastic → returns to original form (geometrically and atomically)

- *Caveat, at the atomic level, some atoms may move around slightly, but most of them return to their original position*

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- The simplified model that we use for atoms works well for our application
- With our model of atoms connected by a spring, we can apply a force
- There are two forces:
    - Attractive force – attracting the nuclei together
    - Repulsive force – like-charges of the electrons repel the atoms apart
        - This force dominates at short distances
- What we are interested in is the sum of these two forces, which gives us the net force
    - This is going to be what determines the behaviour of those two atoms
- At some distance between the two atoms, the forces will be in equilibrium, therefore the net force will be 0
    - This distance is denoted **r_0 – equilibrium interatomic spacing** (or, separation)
- We are most interested in applying [...]
- Elastic strain on this net force curve is very small, and close to $r = r_0$
    - When we're discussing Young's modulus, we are most interested close to where $r = r_0$
    - The Young's modulus is directly proportional to this slope – it is related to the slope of F vs. r at $r = r_0$
- Provided that you're not changing the type of atoms, then the Young's modulus shouldn't change
    - Young's modulus is a material property (differs for different materials)
    - **E depends <u>only</u> on type of atom**
        - **It is STRUCTURE INDEPENDENT** (we mean **<u>microstructure</u>**, which are features close to the atomic scale)
        - Atomic scale ~10^{-10}m