BME341 Biomaterials

Lecture #6
Biomaterial Processing

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Objectives of this course

- To understand the molecular mechanisms behind strengthening techniques for metals and polymers
- To understand how thermal processing affects microstructure and bulk properties of metals and polymers
- To compare and contrast types of forming techniques for metals, ceramics and polymers
- To understand the need for, killing mechanisms of, and limitations of various sterilization techniques.
- Overview of biomaterial degradation behavior

Biomaterial Processing

- Formation of materials into shapes
- Processing of biomaterials is done to
  - Change the bulk or surface properties
  - Obtain a desired shape
  - Sterilize or improve the biocompatibility of the material

Processing to Improve Bulk Properties

Metals

Ceramics

Polymers

Metals

- Processing is a very efficient way of affecting mechanical properties in metals.
- Defects can be added to the crystal structure to prevent dislocation motion

Alloying

- Alloys are almost always stronger than pure metals.
- Alloys are a type of solid solution, and thus, alloying is like adding many substitutional point defects to the base metal.

Strain Hardening

- Just as adding point defects improves the strength of a material, additional line defects also create a stronger material.
- The metal becomes stronger as it is plastically deformed
- This phenomenon is known as strain hardening

Annealing

- Annealing occurs in 3 stages:
  - Heating to required T
  - Maintaining that T (soaking)
  - Controlled cooling (quenching)

Processing to Improve Bulk Properties

Metals

Ceramics

Polymers

Ceramics

- Due to the nature of the ionic bonds involved, dislocation motion in ceramics is difficult
- There is little use for techniques to further reduce dislocation movement
- On the contrary, a large problem in ceramic processing is how to increase the slip systems to improve ductility

Processing to Improve Bulk Properties

Metals

Ceramics

Polymers

Polymers

- As with ionic materials, dislocation motion is difficult in covalent crystals
- But many polymers are semicrystalline
- So it is possible to improve the strength of polymeric materials by increasing their % crystallinity