

MSE250 – Materials Selection

Updated 16 December, 2011

Approach

This document aims to give an overview of all materials (synthesis, structure) and all characteristics (properties) discussed in the course. From these two categories, one can then determine what kinds of applications a particular material may be suitable for (performance). A chart has been provided. It may be useful for you to circle the property boxes in each column that are most useful for a particular material. Take your time to carefully consider each property on the list for each material. Not all properties may be important or defined for all materials, but you may find certain relationships that you did not think of before.

It is imperative that you are very clear and precise in your definitions of each of the property terms. Also, there are many more materials than properties. If I'm missing some, please let me know.

Materials

Metals

Metals in general
BCC metals (e.g. Fe, steel)
FCC/HCP metals (e.g. Al)
Cold-worked metals
Solid-solution metals (alloys) in general
Metals with small grain size
Metals with large grain size
Fully recrystallized metals
Polished metals
Case-hardened metals
Shot-peened metals
Noble metals (e.g. Au, Pt, Ti)
Reactive metals (e.g. Zn, Mg)
Pure austenite
Pure ferrite (v. low C content)
Fine/coarse pearlite, bainite, martensite, spheroidite, tempered martensite
Stainless steels (bone plates)
Cobalt-based alloys
Ti/Ti alloys

Ceramics

Ceramics in general
Polished ceramics
Ionic ceramics (e.g. salt, Al_2O_3)
Covalent ceramics (e.g. silicates/glasses, diamond, graphite)
Fused porous silica fibers (shuttle tiles)
Tempered glass
Zirconia (orthopedics)
Alumina (orthopedics)

Polymers

Thermoplasts in general
Amorphous thermoplasts
Semi-crystalline thermoplasts
Thermosets
Phenol-formaldehyde (Bakelite®; billiard balls)
Polypropylene (ice cube tray)
Polystyrene (coffee cup)
Lightly-crosslinked elastomers (rubber band)
Heavily-crosslinked elastomers (car tire)
PVC (piping)
Ultra-high molecular weight PE (UHMWPE; cartilage, spine, ankle, knee replacements)
PMMA (Plexiglass; bone cement, eye lenses)
PDMS (silicone; elastomer; ligament joints; blood vessels; facial implants)

Composites

Concrete (reinforced, prestressed)
Cermets (metal-cutting tools; machining)
Carbon black (ceramic in rubber; tires; running shoes)
Dispersion strengthened composites (metal-matrix composites)
Epoxy-glass fiber composite (e.g. fiberglass; pole vault)
Epoxy-aramid fiber composite (e.g. non-tear, vests, cases)
Epoxy-carbon fiber composite (e.g. aircraft, structural)
Pyrolytic carbon (heart valve)

Material Characteristics

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Mechanical properties

Strength / hardness					
Stiffness / modulus of elasticity, E					
Ductility / brittleness					
Toughness / modulus of resilience					
Viscoelasticity					
Anisotropy					
Density					
Specific strength					
Specific stiffness					
Porosity					

Fatigue/failure characteristics

Fracture characteristics / toughness					
Wear resistance (scratching, friction)					
Cyclic loading behavior					
Creep					
Corrosion resistance					

Thermal properties

Effect of heating on microstructure					
Thermal expansion					
Thermal conductivity					
Effect on mech. properties (above)					
T_g / T_m					

Other

Biocompatibility					
Chemical reactivity (inertness)					
Electrical characteristics					
Cost					