Collaborative Engineering

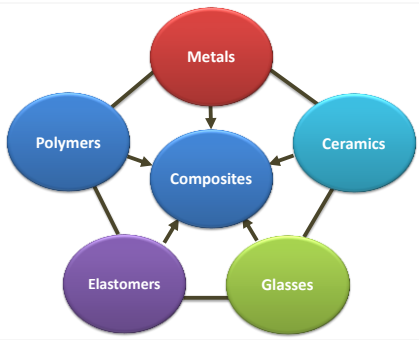
Materials Selection

- Engineering Materials
- Types and Applications
- Property Charts
- Materials Selection

OrthoCAD Lab, I.I.T. Bombay

Engineering Materials in Nature

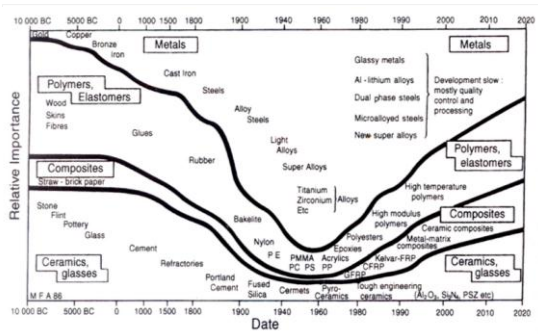
Engineering Materials – Broad Classification



Engineering Materials

- **Metals and Alloys:** Steels, alumimium, zinc, copper…
  - ✓ Good electrical and thermal conductivity
  - ✓ High tensile strength, stiffness, ductility, shock resistance
- **Ceramics and Glasses:** Silicon carbide, silica glass…
  - ✓ Poor thermal conductivity, strong and hard, but brittle
- **Polymers:** Thermoplastics, thermosets and elastomers
  - ✓ Good electrical and thermal resistivity (insulation)
  - ✓ Low strength, but good strength-to-weight ratio
- **Composites:** Concrete, fibreglass, carbon-fibre composite
  - ✓ Light+stiff, temperature+shock resistance, etc.

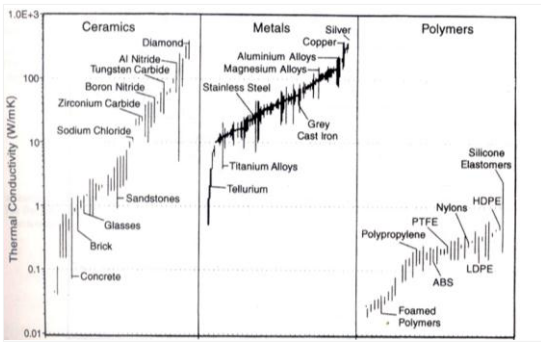
Materials Use – Historical



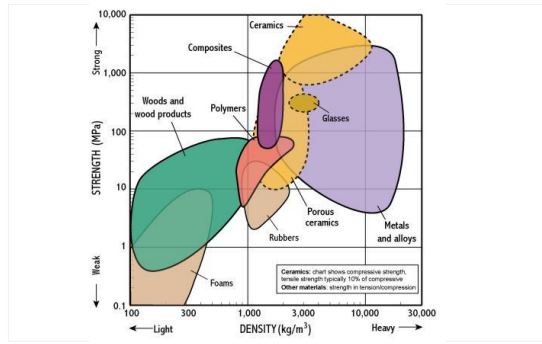
Material Properties

- **Physical:** Density, Melting temp., Thermal conductivity, Thermal expansion, Magnetic permeability, Elec. resistance.
- **Mechanical:** Strength- tensile, compressive, shear, impact; Elongation, Fatigue limit, Hardness, Wear resistance.
- **Chemical:** Resistance to Oxidation, Corrosion, Moisture; Inflammability, Toxicity.
- **Technological:** Castability, Formability, Machinability, Cost

Material Properties – Thermal Conductivity

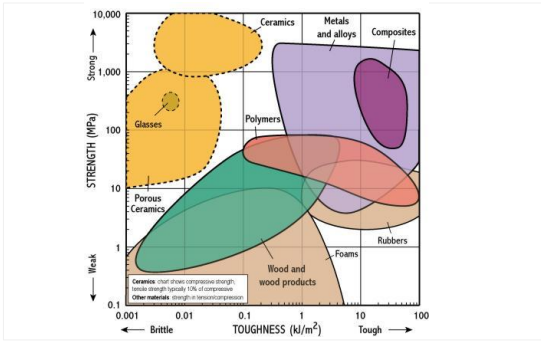


Strength versus Density



[http://www-materials.eng.cam.ac.uk]

Strength versus Toughness



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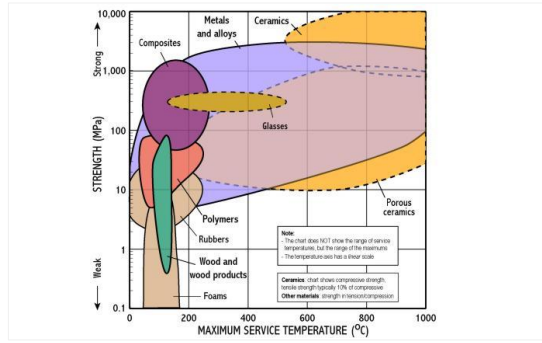
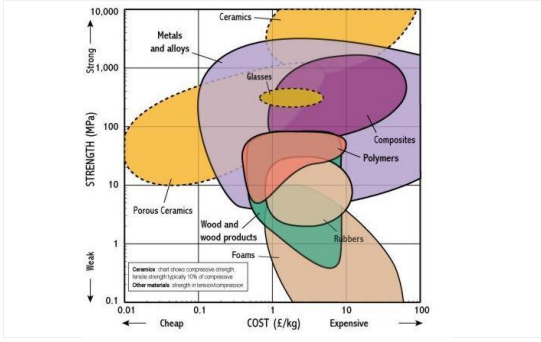
Strength versus Service Temperature



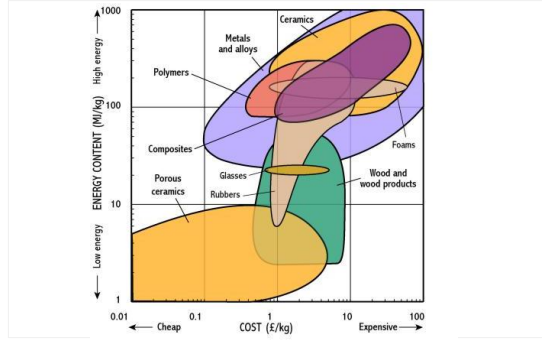
[http://www-materials.eng.cam.ac.uk]

Strength versus Cost



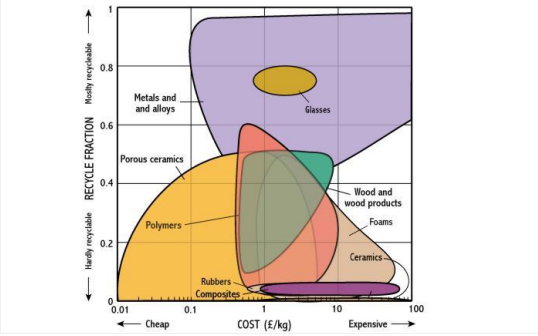
[http://www-materials.eng.cam.ac.uk]

Energy Content versus Cost



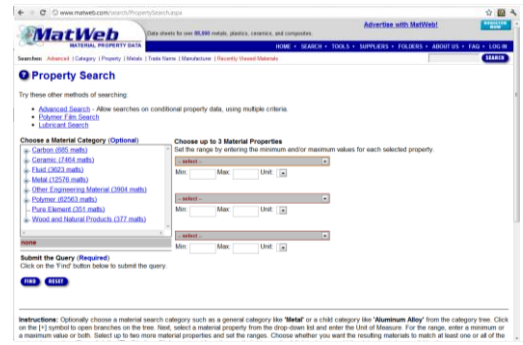
[http://www-materials.eng.cam.ac.uk]

Recyclability versus Cost



[http://www-materials.eng.cam.ac.uk]

Online Material Selection



[http://www.matweb.com]

Example Applications

- **Aerospace**: ex. Aluminium & Titanium alloys
- **Biomedical**: Co-Cr-Mo alloys, Hydroxy-Appatite
- **Electronic**: Copper, Tantalum oxide (capacitor)
- **Energy & Environment**: Si (Solar), Li-ion (battery)
- **Magnetic**: Co-Pt-Ta-Cr alloys (hard disk)
- **Optical**: Silica (optical fiber), Alumina (lasers)
- **Structural**: Steels, glasses (building)
- **Smart materials**: lead-zirconium-titanate (lighter)

SUMMARY

- A large variety of engineering materials are available
- For selection suitable for any given application
- Consider physical, mechanical and technological properties.