IME 100 Interdisciplinary Design and Manufacturing

Introduction to Materials Selection

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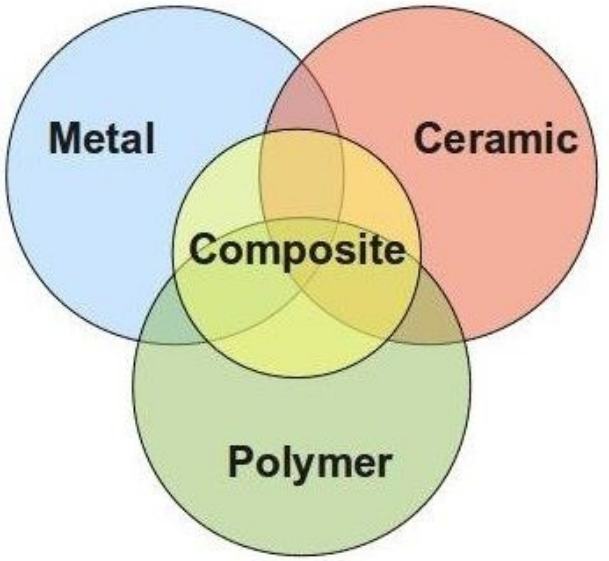
Kettering University

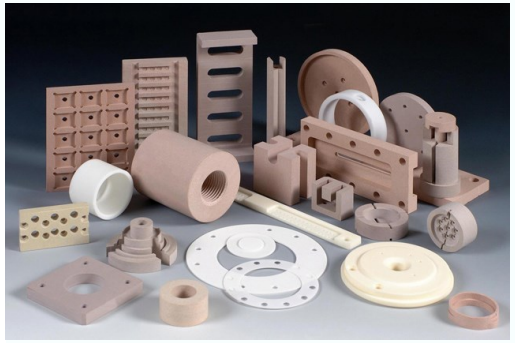
Announcements

- Coasters are due in 1 week
  - Drawings
  - Group submission (Upto 8 files)
- Toys are due in 4 Weeks
- Mock robot competition in Week 6

3 little Pigs!

Material Classifications





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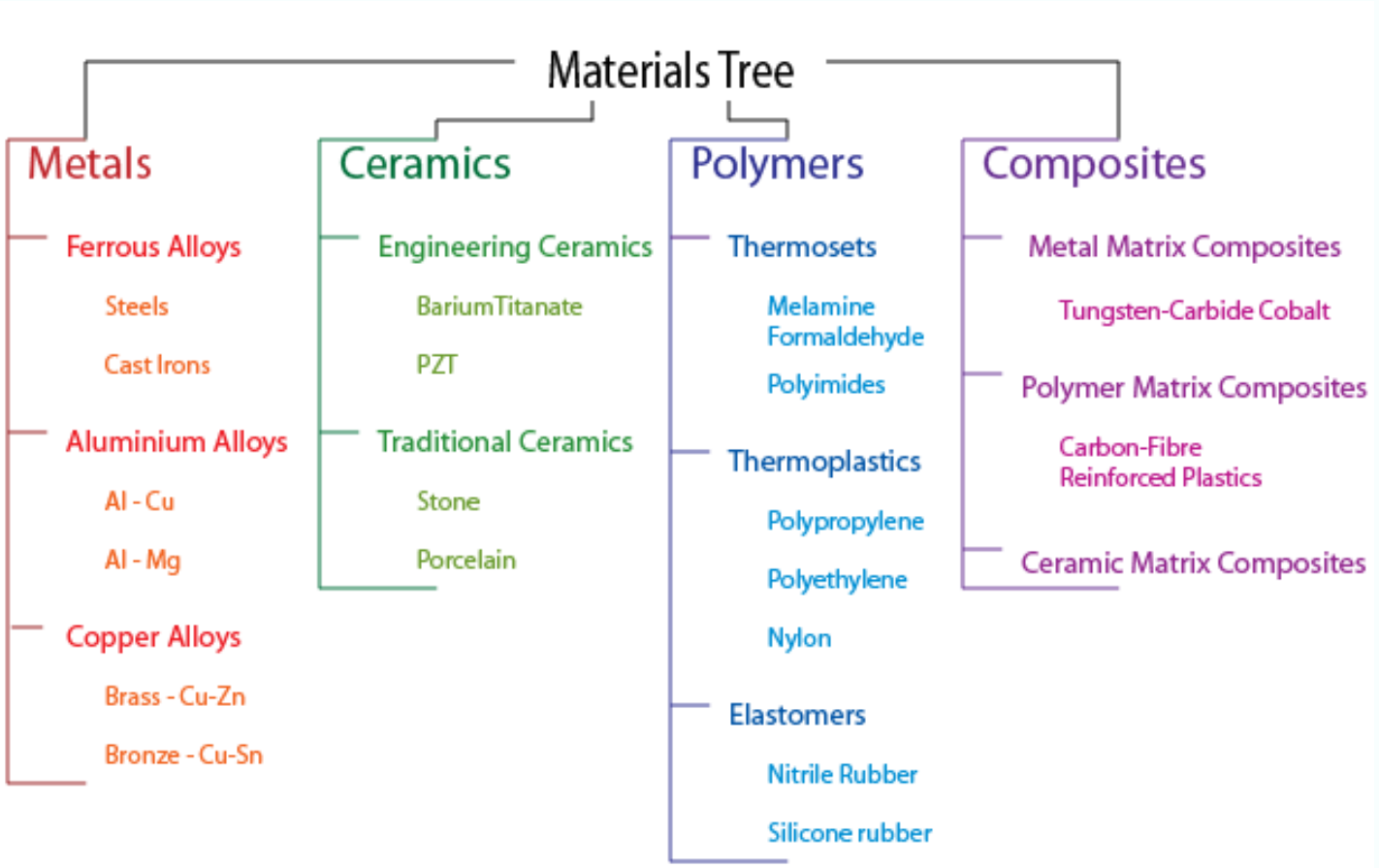


Factors Affecting Material Selection

1. Functional Requirements

- Structural
- Dynamic
- Flexible
- Cyclic loading
- Durable
- Lightweight
- Etc.

2. Manufacturing Process

- Plasticity
- Malleability
- Ductility
- Machinability
- Heat
- Surface finish
- Etc.

3. Operating Parameters

- Pressure
- Temperature
- Flow
- Environment
- Corrosion
- Biocompatibility
- Etc.

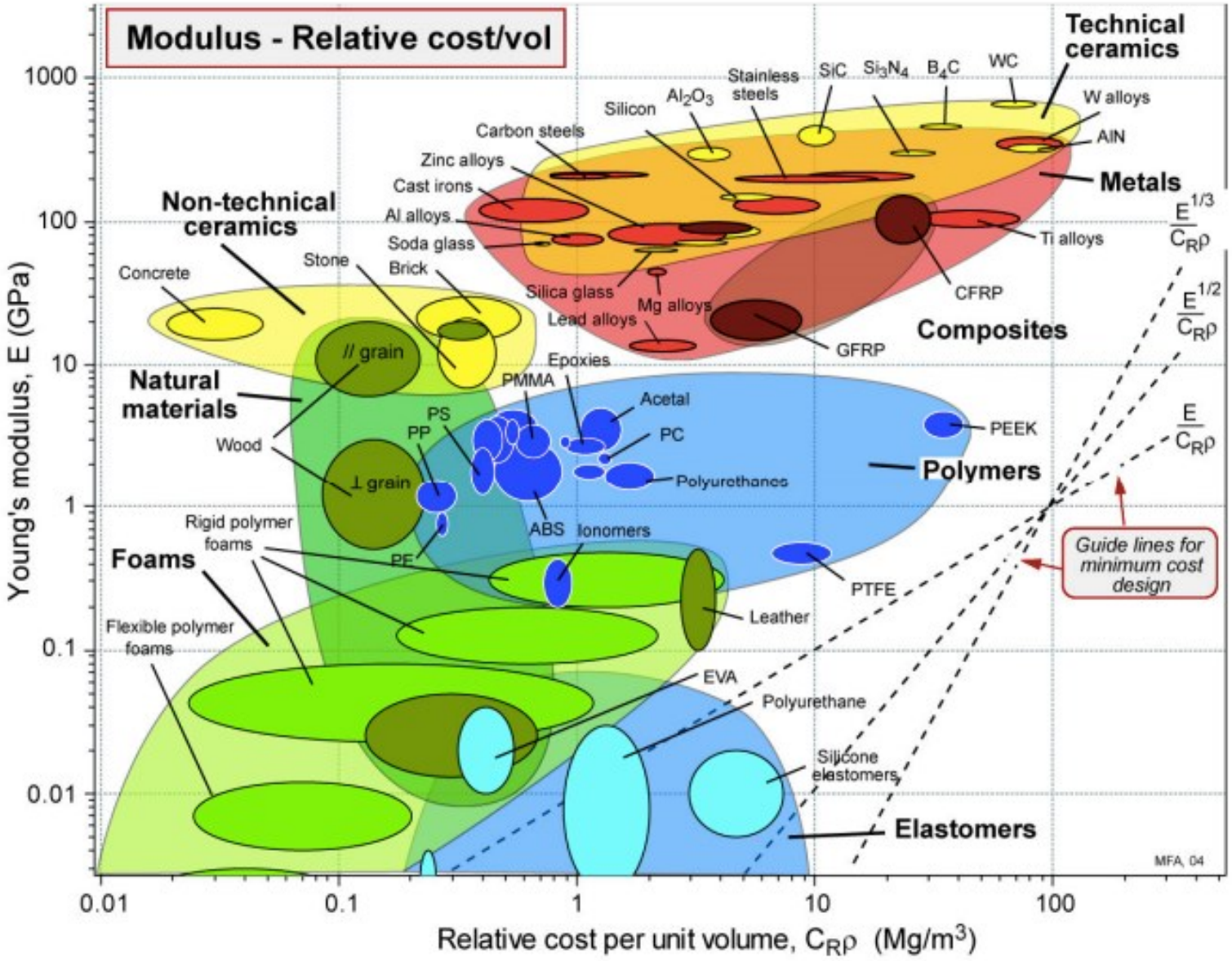
4. Cost Considerations

- Raw materials
- Processing
- Storage
- Labor
- Inspection
- Inventory
- Etc.

Material Properties

Class	Property	Symbol and Units
General	Density	ρ (kg/m^3 or Mg/m^3)
	Price	C_m ($/kg)
Mechanical	Elastic moduli (Young's, Shear, Bulk)	E,G,K (GPa)
	Yield strength	σ_y (MPa)
	Ultimate strength	σ_u (MPa)
	Compressive strength	σ_c (MPa)
	Failure strength	σ_f (MPa)
	Hardness	H (Vickers)
	Elongation	ε (--)
	Fatigue endurance limit	σ_e (MPa)
	Fracture toughness	K_{Ic} (MPa.m$^{1/2}$)
	Toughness	G_{Ic} (kJ/m^2)
	Loss coefficient (damping capacity)	η (--)
Thermal	Melting point	T_m (C or K)
	Glass temperature	T_g (C or K)
	Maximum service temperature	T_{max} (C or K)
	Thermal conductivity	λ (W/m.K)
	Specific heat	C_p (J/kg.K)
	Thermal expansion coefficient	α ($^\circ$K^{-1})
	Thermal shock resistance	ΔT_s (C or K)
Electrical	Electrical resistivity	ρ_e ($\Omega.m$ or $\mu\Omega$.cm))
	Dielectric constant	ε_d (--)
Eco-properties	Energy/kg to extract material	E_f (MJ/kg)
Environmental resistance	Wear rate constant	K_A MPa^{-1}

Ashby Diagrams



Summary of Material Properties by Class

	Ceramic	Metal	Polymer
Hardness	↑	↓	↓
Elastic modulus	↑	↑	↓
High temperature strength	↑	↓	↓
Thermal expansion	↓	↑	↑
Ductility	↓	↑	↑
Corrosion resistance	↑	↓	↓
Resistance to wear	↑	↓	↓
Electrical conductivity	↕	↑	↓
Density	↓	↑	↓
Thermal conductivity	↕	↑	↓
↑ Tendency to high values		↓ Tendency to low values	

Ashby Activity

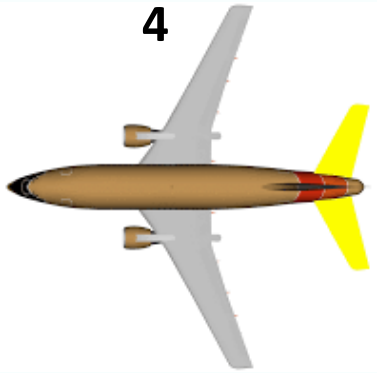
- Please split up into your toy group
- **Consider the following product/part and fill out the worksheet based on your group's product/part…**

1

2

3

4



5

6

Breakout Session

- Complete the Ashby material selection activity as a toy group
  - This will be your class participation grade for the day
  - We will discuss the material choice in 20 minutes

Toy Project Begin Design

- Safety
  - Drop Test
  - Chocking Hazard
- Use both wood and 3D printing options unless you have a very compelling reason

Acknowledgements

- Cincinnati State Additive Manufacturing Technician Program
- Prof. Ashley Paz y Puente; University of Cincinnati