

Engineering Materials

- Metals (carbon steel, stainless, tool, cast iron, aluminium, nickel, etc.)
- Polymers (thermoplastics, thermosets, elastomers, naturals, foams, etc.)
- Ceramics (glasses, cement, brick, graphite, diamond, alumina, silicon-carbide, etc.)
- Composites (reinforced plastics, GFRP, CFRP, concrete, honeycomb structure, etc.)

Metals

- Metals are inorganic substances
- They have crystalline structure (BCC: Body Centered Cubic, FCC: Face Centered Cubic, Hexagonal, ...)
- Main properties:
 - Reflectivity of light
 - Transmission of heat
 - Conduction of electric current
 - Ability to be deformed without breaking (ductility)
 - Good strength and toughness
- Metals can form alloys with alloying elements and non-metals (C, N, O, S, ...)

Polymers

- Polymers are composed of large number of molecules, joined together in a chain-like fashion
- Two groups: thermo-setting and thermo-plastic polymers
- Base material: natural (wood, rubber) and synthetic (polyetilen, PVC, ...)
- Main properties:
 - Resistance to corrosion
 - Low density (like water), low thermal resistance
 - Low strength, but excellent strength/density ratio
 - Good isolator (resistance to the conduction of electrical current)

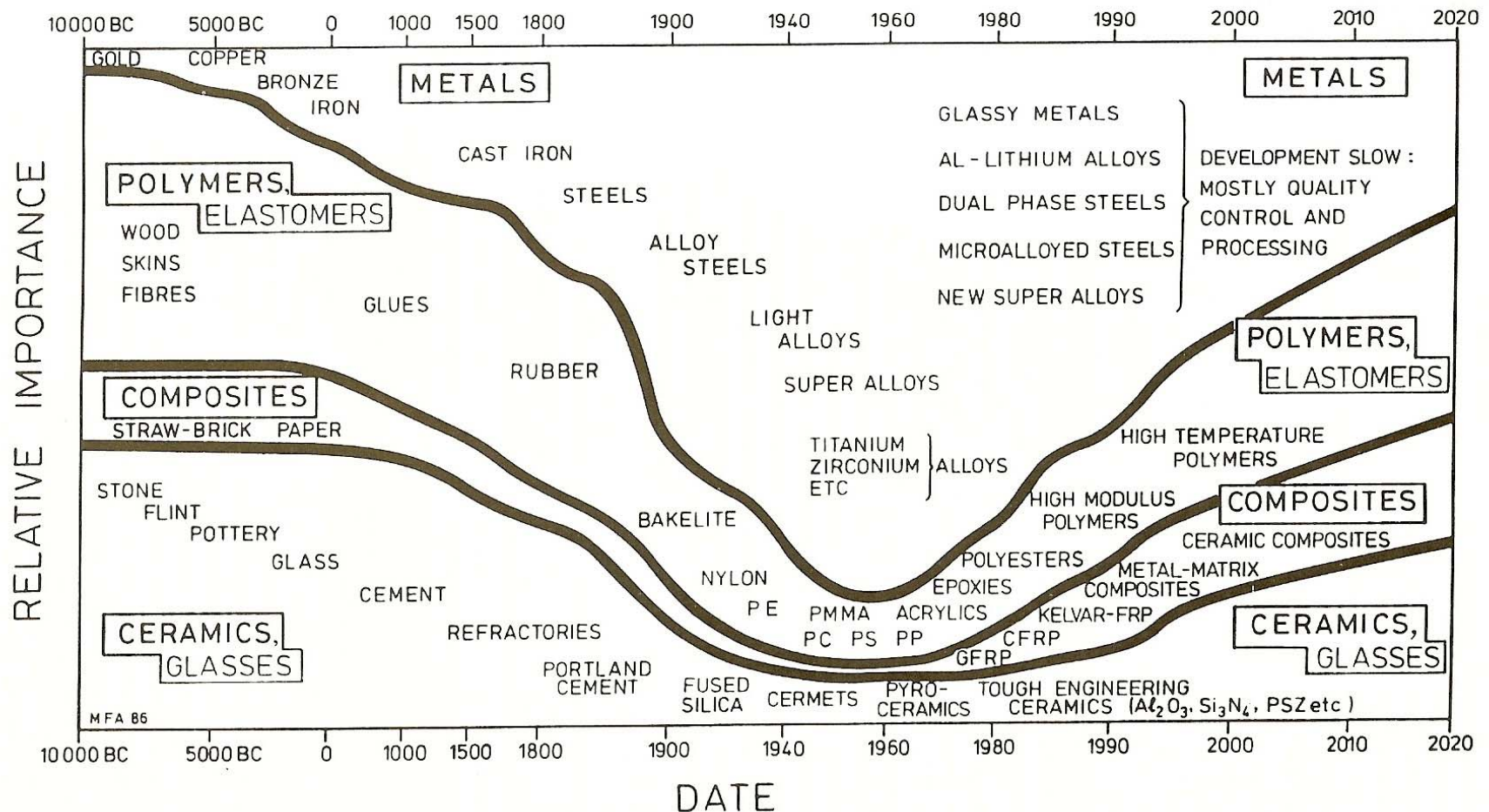
Ceramics

- Ceramics are hard and brittle objects
- Classification:
 - Traditional ceramics (brick, porcelain, ...)
 - Engineering ceramics (magnets, semiconductors, high strength and hard materials, eg. tool inserts)
- Main properties:
 - High strength and hardness, high hot strength
 - Brittleness and crack sensitivity
 - Low thermal expansion
 - Wide variety of electrical and magnetic properties
 - Good thermal and chemical resistance

Composites

- Composites consist of combinations of other materials discussed above
- Fibers or particles are dispersed in a matrix. Examples:
 - Ceramic fibers in metal matrix, glass or carbon fibers in polymers
 - GFRP: Glass Fiber Reinforced Polymer, CFRP ...
- Main properties:
 - Wide variety of strength properties, excellent strength-to-weight ratio
 - Corrosion resistance, creep resistance
 - Properties may be tailored to satisfy given demands

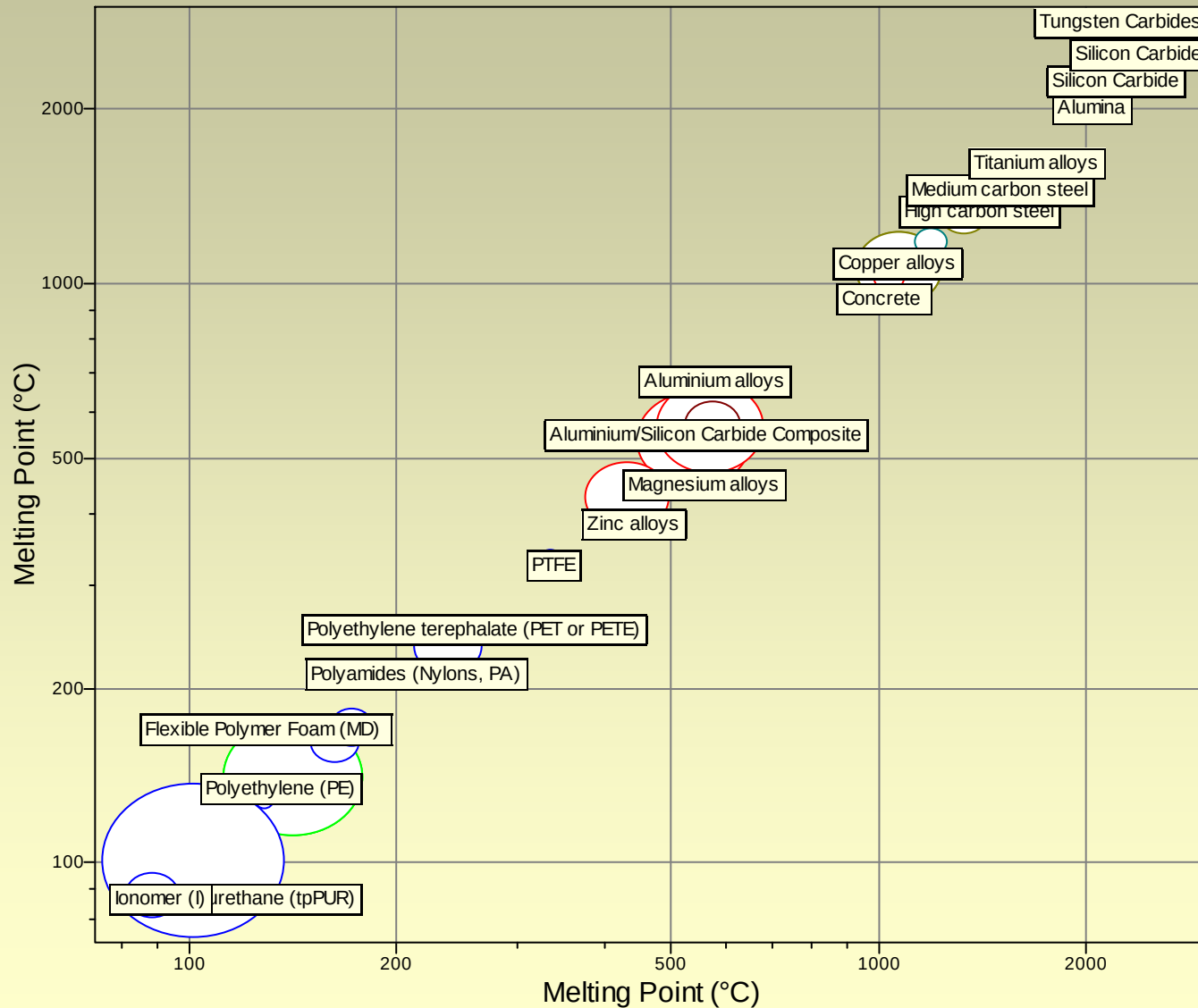
The evolution of engineering materials



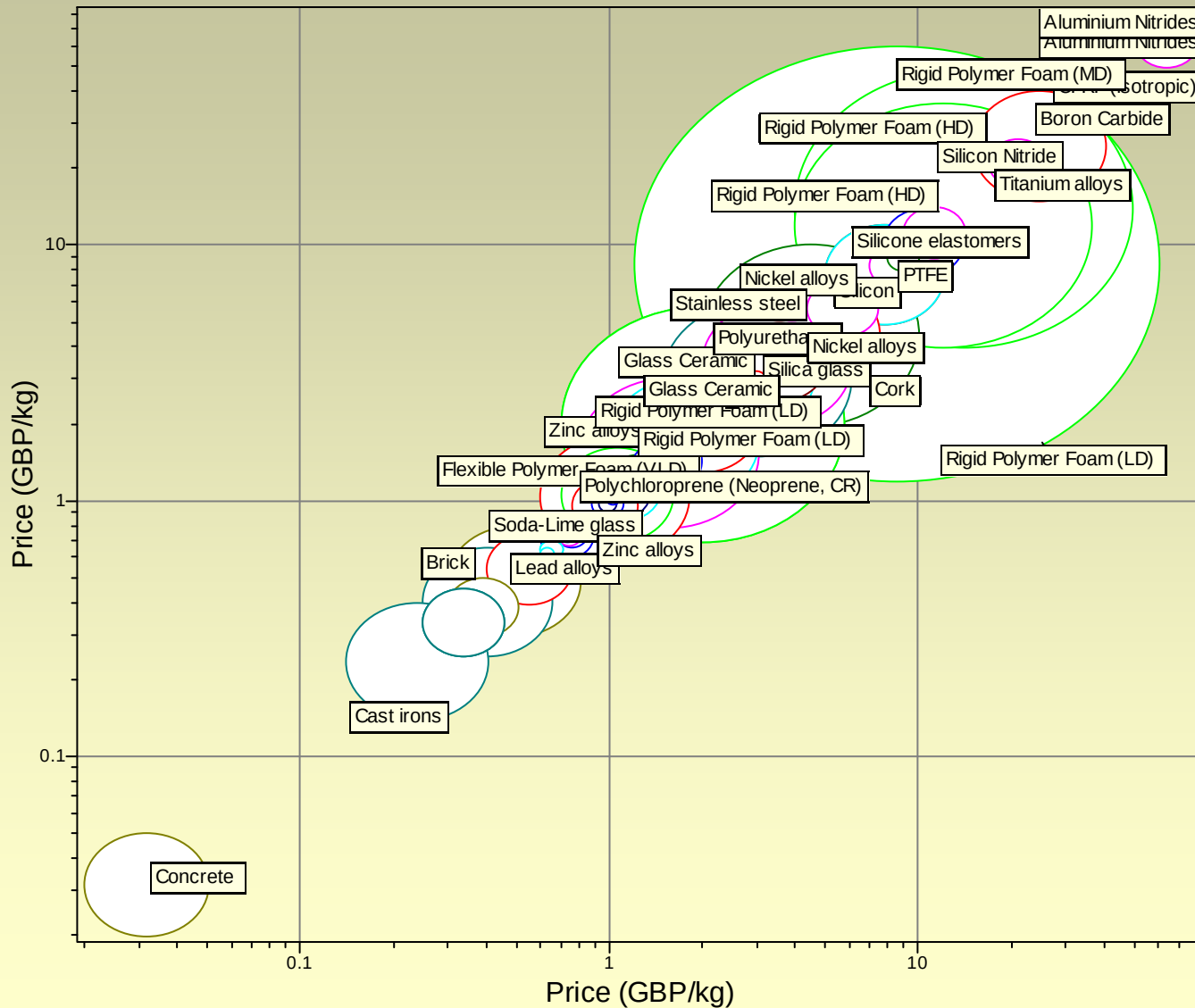
General parameters, selection

- **Mechanical**: strength, toughness, ductility, hardness, fatigue, creep, elasticity, etc.
- **Physical**: density, specific heat, thermal expansion, melting point, conductivity, etc.
- **Chemical**: environmental behaviour, oxidation, flammability, corrosion, toxicity, etc.
- **Manufacturing**: castability, weldability, formability (rolling, forging), etc.
- **Availability and cost**
- **Recycling**

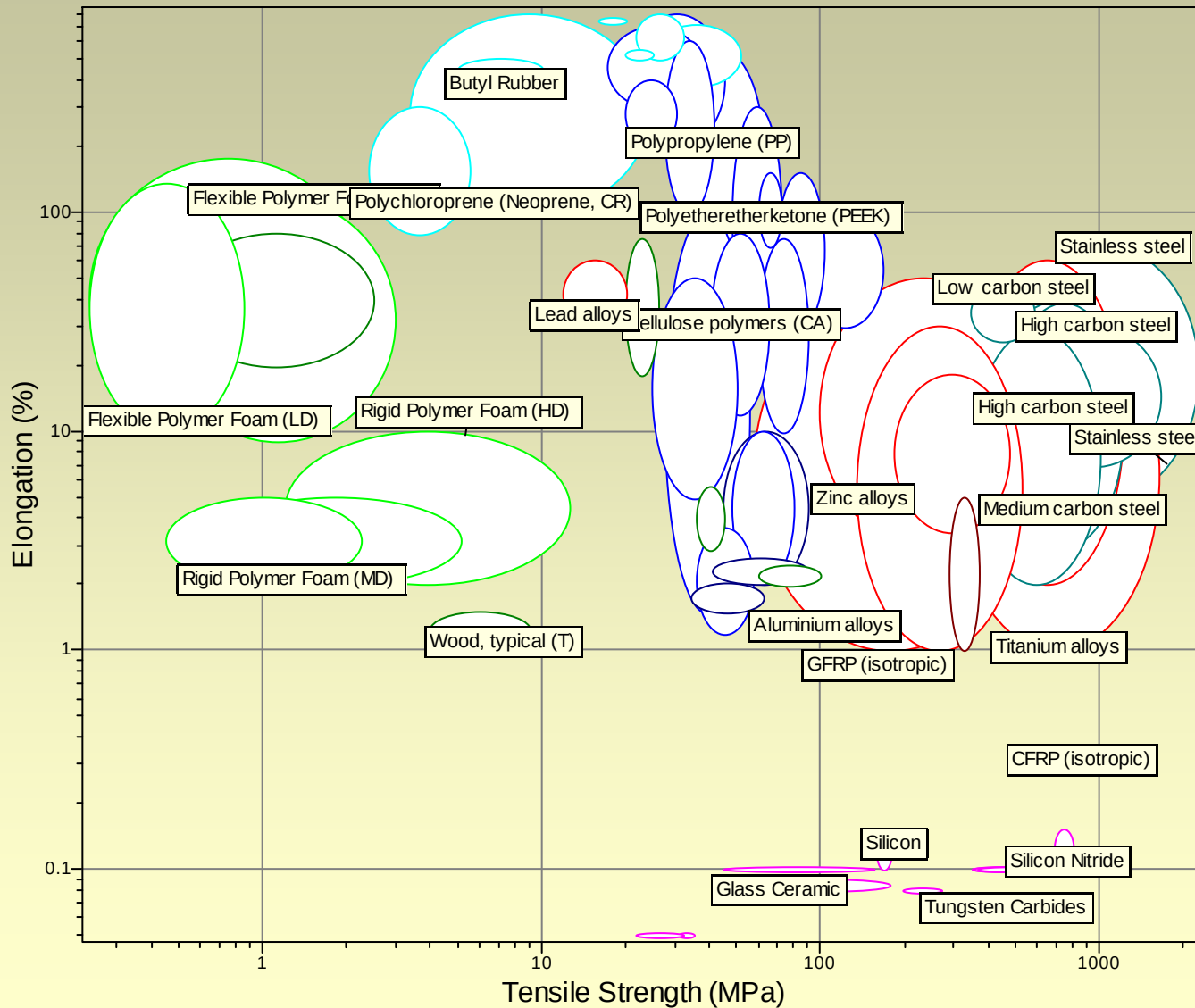
Comparison of material properties



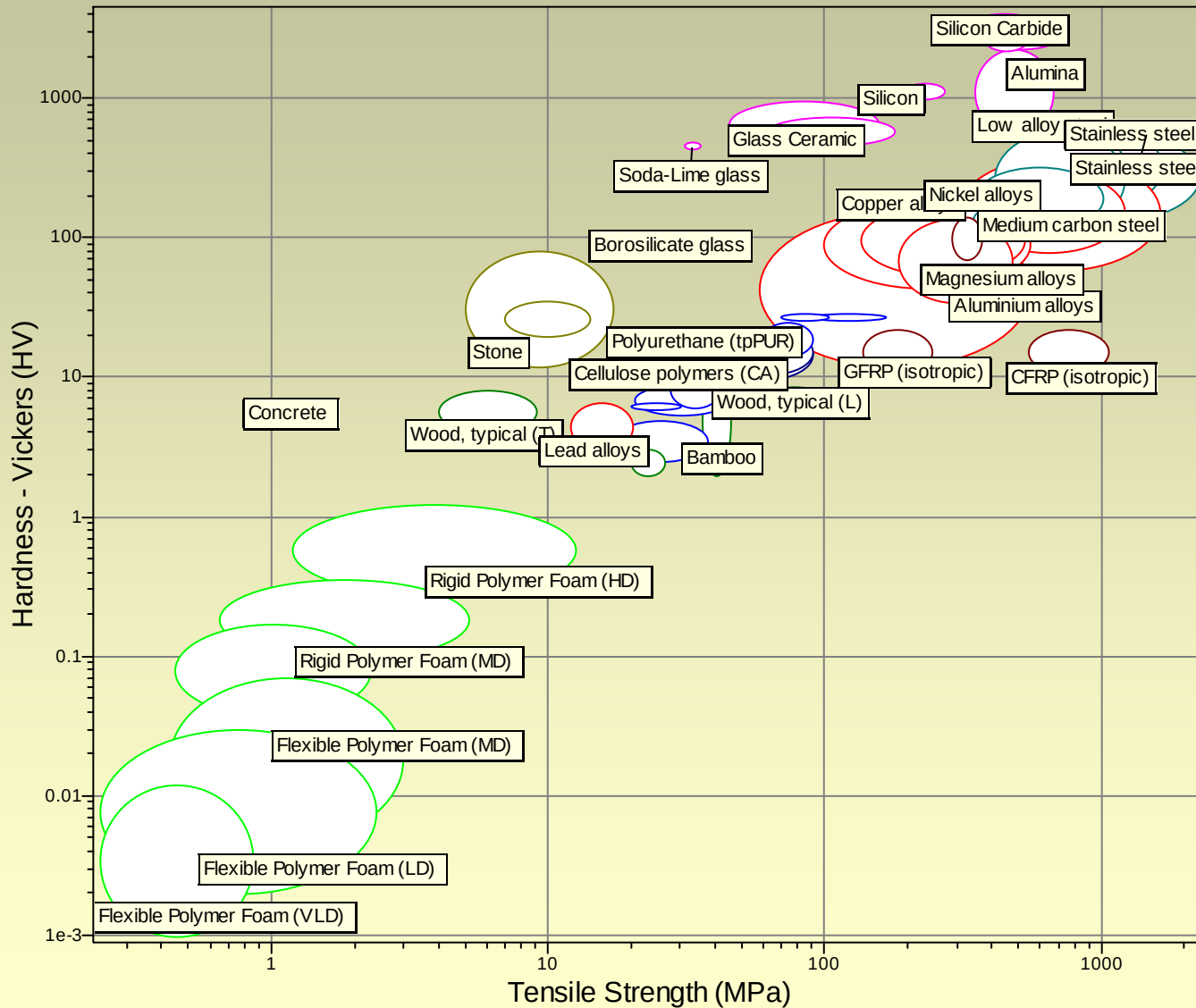
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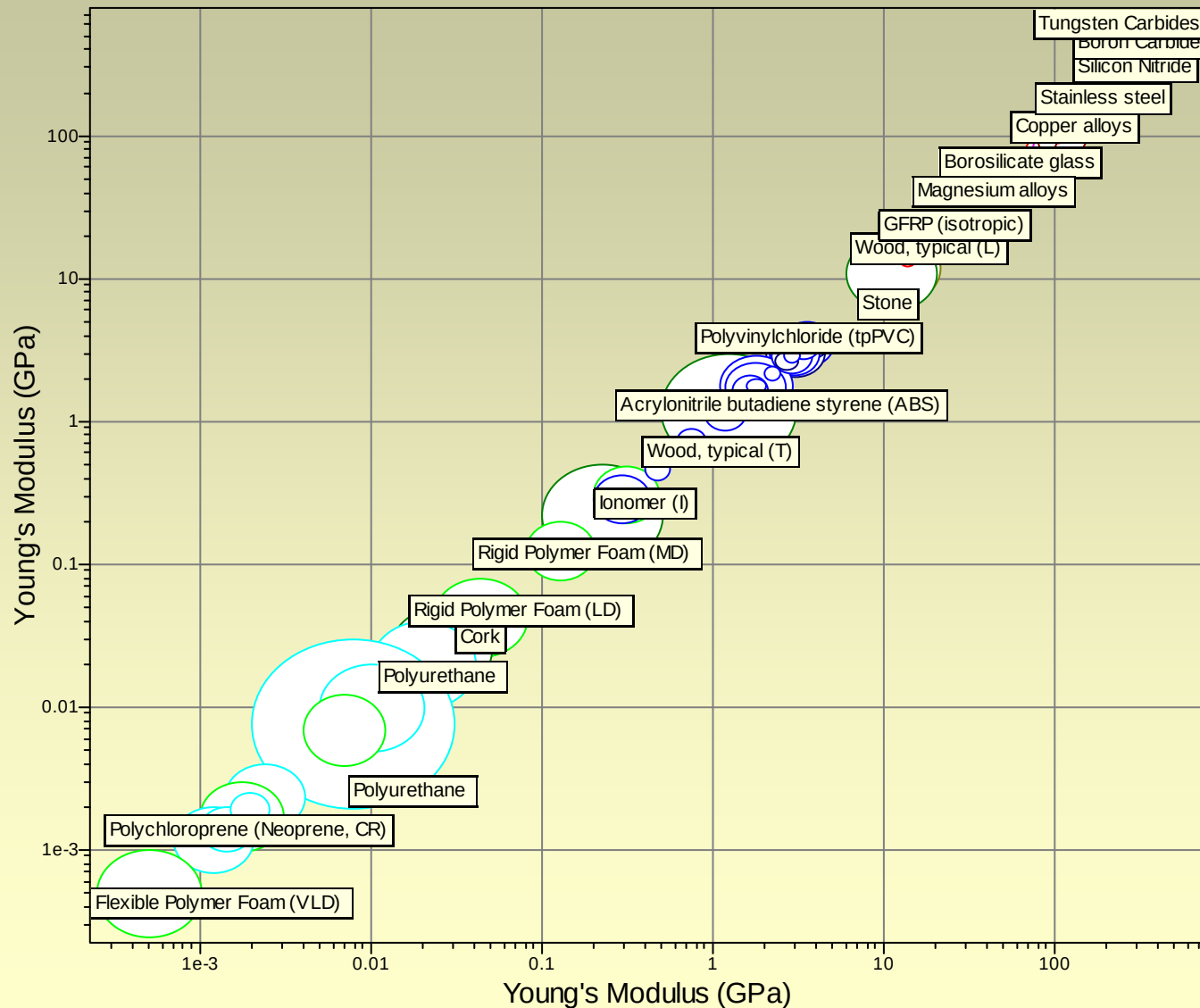
Comparison of material properties



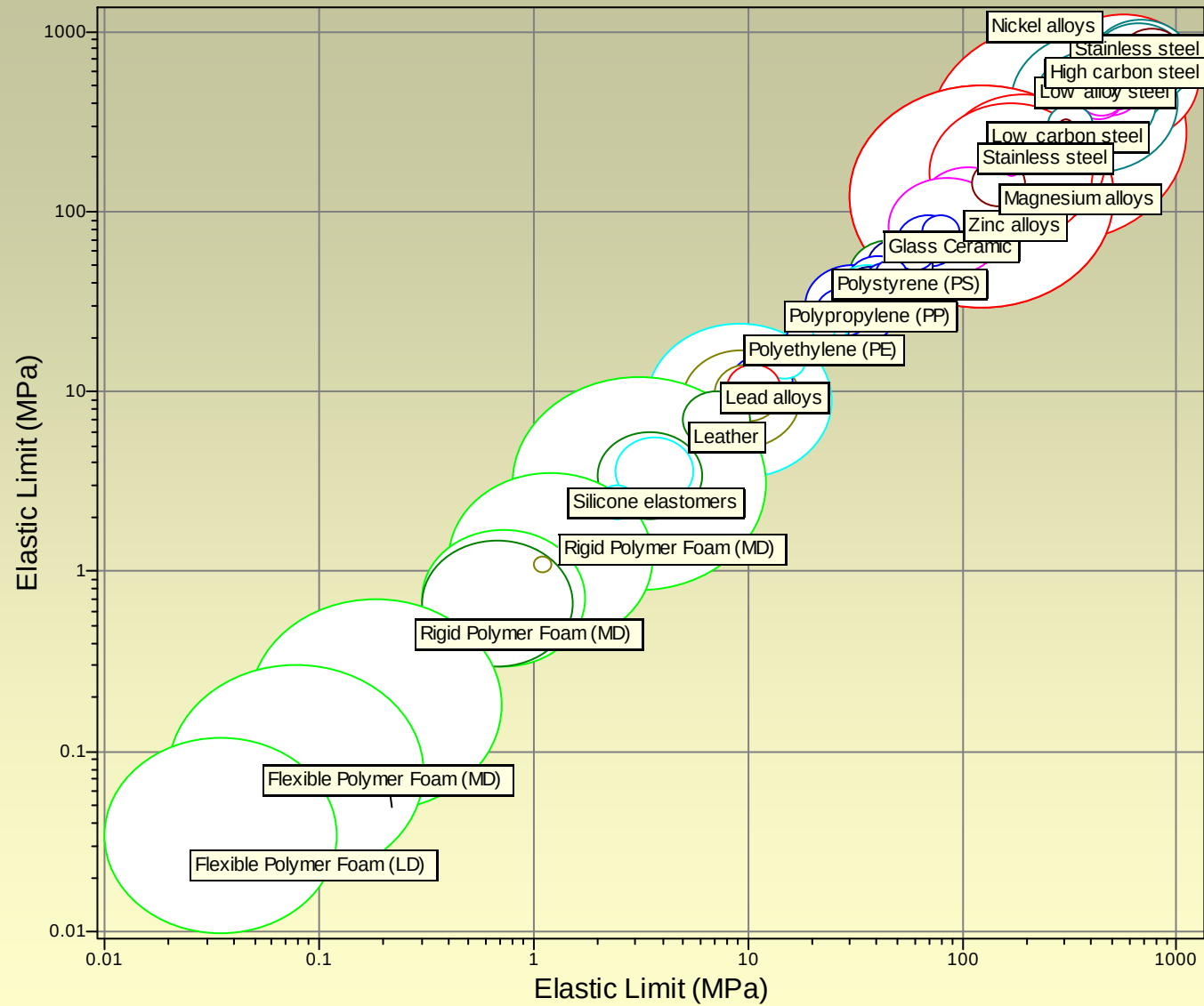
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