

# Engineering materials datasheet

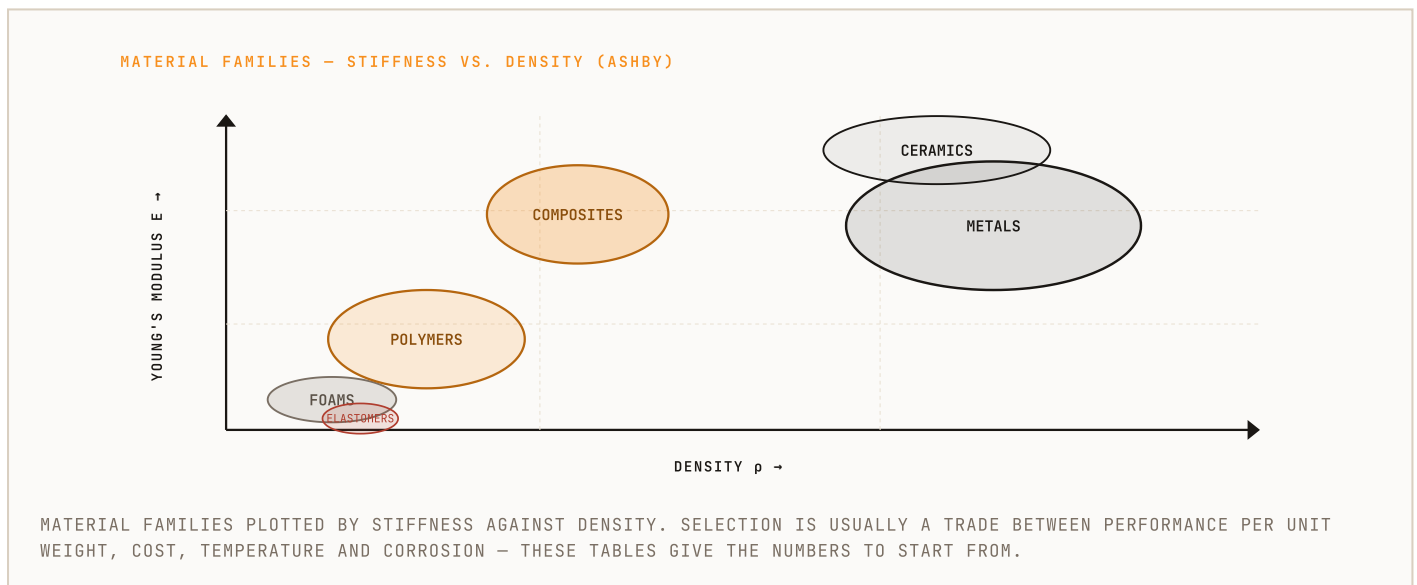
Typical mechanical properties of the metals and engineering plastics used in product development — density, stiffness, strength, thermal expansion and service temperature — with quick selection guidance.

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## ABSTRACT

A working reference of typical mechanical properties for the materials that show up most in electromechanical products: structural and sheet metals, and engineering plastics. Use it to size parts, compare candidates and sanity-check a supplier datasheet — then design to the supplier's certified values for the exact grade and temper.

Section 1 defines the properties and how to read them. Section 2 is metals. Section 3 is engineering plastics. Section 4 covers selection trade-offs (strength- and stiffness-to-weight, cost, CTE, temperature). Section 5 is quick "which material" guidance.



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## 1. Reading the tables

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The values below are **typical room-temperature properties** for a common grade/temper of each material. Real values vary with grade, temper, processing, fillers, moisture and temperature — always confirm against the supplier's certified datasheet for the exact material before final sizing.

### 1.1 Properties

Density $\rho$	Mass per volume ( $\text{g}/\text{cm}^3$ ). Drives part weight and shipping cost.
Young's modulus $E$	Stiffness (GPa) — resistance to elastic deflection, independent of strength.
Yield strength	Stress at the onset of permanent deformation (MPa) — the usual design limit for metals.
Tensile strength (UTS)	Stress at fracture (MPa).
Elongation	% stretch before fracture — a proxy for ductility/toughness.
CTE	Coefficient of thermal expansion ( $\mu\text{m}/\text{m}\cdot\text{K}$ ) — drives fit changes and thermal stress.
Max service temp	Rough continuous-use ceiling; mechanical properties fall well before melting.

## 2. Metals

METAL	P (G/CM <sup>3</sup> )	E (GPA)	YIELD (MPA)	UTS (MPA)	CTE (MM/M·K)	MAX °C	NOTES
Steel, low-carbon (1018)	7.87	200	350	440	12	~400	Cheap, weldable, rusts — the structural default
Steel, alloy (4140 Q&T)	7.85	205	655	1020	12	~425	Shafts, high-strength parts; heat-treatable
Stainless 304	8.00	193	215	505	17	~600	Corrosion resistant, non-magnetic, formable
Stainless 316	8.00	193	240	580	16	~600	Marine / chemical grade (Mo added)
Aluminium 6061- T6	2.70	69	276	310	23	~150	Machines & extrudes well; the all-rounder
Aluminium 7075- T6	2.81	72	503	572	23	~120	Aircraft-grade strength; poor weldability
Aluminium A380 (die-cast)	2.74	71	160	320	21	~150	High-volume cast housings
Titanium Ti-6Al-4V	4.43	114	880	950	8.6	~400	Best strength-to-weight; expensive, hard to machine
Magnesium AZ91D	1.81	45	160	230	26	~120	Lightest structural metal; die-cast
Brass C360	8.50	97	125	340	20	~200	Free-machining; connectors, fittings

### 3. Engineering plastics

PLASTIC	P (G/CM <sup>3</sup> )	E (GPA)	TENSILE (MPA)	MAX °C	NOTES
ABS	1.05	2.3	40	~80	Tough, cheap, easy to mould; not UV/chemical
PC (polycarbonate)	1.20	2.4	65	~120	High impact, transparent; scratches, notch-sensitive
PC/ABS	1.15	2.4	55	~110	Balance of impact + processability; enclosures
PA6 / PA66 (nylon)	1.14	2.7–3.0	80–85	~100–120	Tough, wear-resistant; absorbs water (dims shift)
POM (acetal)	1.41	2.8	65	~100	Low friction, stiff, dimensionally stable; gears
PP (polypropylene)	0.905	1.3	33	~100	Chemical resistant, living hinges; low stiffness
PE (HDPE)	0.95	1.0	28	~80	Chemical resistant, low cost; hard to bond
PET	1.38	3.0	75	~100	Stiff, good barrier; bottles, structural
PMMA (acrylic)	1.18	3.0	70	~80	Optically clear, rigid; brittle
PEEK	1.32	3.7	100	~250	High temp + chemical + wear; expensive
TPU (elastomer)	1.20	0.05–0.7	35	~80	Flexible, abrasion resistant; seals, bumpers

Glass-fibre fill (e.g. PA66-GF30) roughly **doubles modulus**, raises strength and service temperature, and lowers CTE — at the cost of toughness, surface finish and tool wear.

## 4. Selection trade-offs

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- **Stiffness-to-weight ( $E/\rho$ ) is similar for steel, aluminium and magnesium**  
so for a stiffness-limited part, the lighter metal usually wins on weight at equal stiffness. Composites (CFRP) beat all metals here.
- **Strength-to-weight favours titanium and 7075 aluminium; titanium also keeps it at temperature.**
- **Cost ranking (rough): mild steel < aluminium < stainless < titanium; commodity plastics (PP, ABS, PE) < engineering (PC, PA, POM) < high-performance (PEEK).**
- **CTE mismatch matters in mixed-material assemblies and press-fits**  
plastics expand 5–10× more than steel, so clearances and interference change a lot with temperature.
- **Temperature quietly caps plastics: most commodity plastics soften by 80–120 °C; reach for PEEK, PPS or metal above that.**
- **Corrosion / environment**  
stainless, aluminium (anodised) and most plastics resist corrosion; plain steel needs coating or plating.

## 5. Which material — quick guidance

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Pair this with the *Mass from volume* tool to turn a CAD volume into part weight across these materials, and design to certified supplier data for the final grade.