Commentary

With elastic stiffness, we find a greater spread among the major classes than with density. We see four orders of magnitude difference, with plastics being the most flexible.

Metals

Steels	E =	200 GPa
Titanium alloys	E =	120 GPa
Aluminum alloys	E =	70 GPa
Magnesium alloys	E =	45 GPa

The ranking is the same as with density. That is, the densest metals are also the stiffest. The stiffest common metal is tungsten, with a modulus of 410 GPa. However, tungsten is too brittle for most applications. The least stiff common metal is lead, with a modulus of only 20 GPa. Lead is too soft for most applications.

Polymers

PVC	E =	3.3 – 3.4 GPa
PS	E =	3.0 – 3.5 GPa
PC	E =	2.0 – 2.6 GPa
PMMA	E =	1.8 – 3.2 GPa
PP	E =	1.3 – 2.0 GPa
PE	E =	0.2 – 0.8 GPa

With these common engineering plastics, the elastic modulus values are quite close, with those at the top of the list only two to three times stiffer than those at the bottom. As shown in the comparison table, elastomers and foamed polymers are orders of magnitude more flexible.

Ceramics – Engineering Ceramics

C	E =	1000 GPa
WC	E =	500 GPa
SiC	E =	450 GPa
Al_2O_3	E =	390 GPa
ZrO_2	E =	200 GPa

These engineering ceramics are approximately ten times stiffer than most metals. As brittle materials, they deform very little elastically before failing by fast fracture.

Ceramics – Porous Ceramics and Glasses

The glasses (70–75 GPa) are comparable to aluminum alloys, while the porous ceramics (30–50 GPa) are in the range of magnesium alloys.

Composites

Engineering composites have a range of values because of the different manufacturing techniques of layering fibers into epoxies. Roughly, the glass GFRPs are less stiff (20–40 GPa) and the carbon fiber CPRPs are a little stiffer than steel (200–300 GPa). Wood, as expected, is very dependent on direction, with approximately (9–16 GPa) parallel to the grain and (0.6–1.0 GPa) perpendicular to the grain.