DESN2000 W5 Material Selection Exercise

Scenario

A large satellite telescope mirror needs to be optimised so that its mass is minimised. The mirror will be supported horizontally around its circumference (Figure 1).

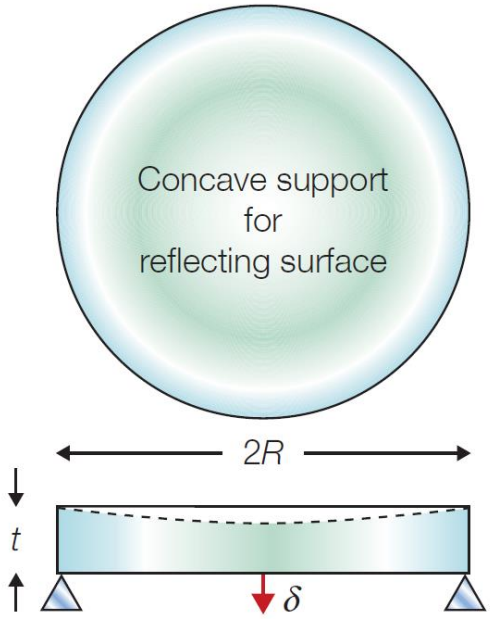

Figure 1: Top and side view of the mirror, showing key dimensions and how it will be supported.

This will cause the mirror to deflect at its centre with deflection δ. This mode of deflection can be described by the equation:

$$\delta = \frac{3}{4\pi}\frac{mgR^2}{Et^3} \quad (2)$$

The mass of the mirror can be described as $m = \pi R^2 t\rho$. The concavity of the mirror can be ignored. The mirror has the following constraints: Fixed mirror radius ($\boldsymbol{R}$), minimal deflection $\boldsymbol{\delta}$ under self-weight. High dimensional stability (retains shape well), low thermal expansion.

What might be an ideal material to make the mirror out of? The relevant Ashby chart is provided on the next page (Figure 2).

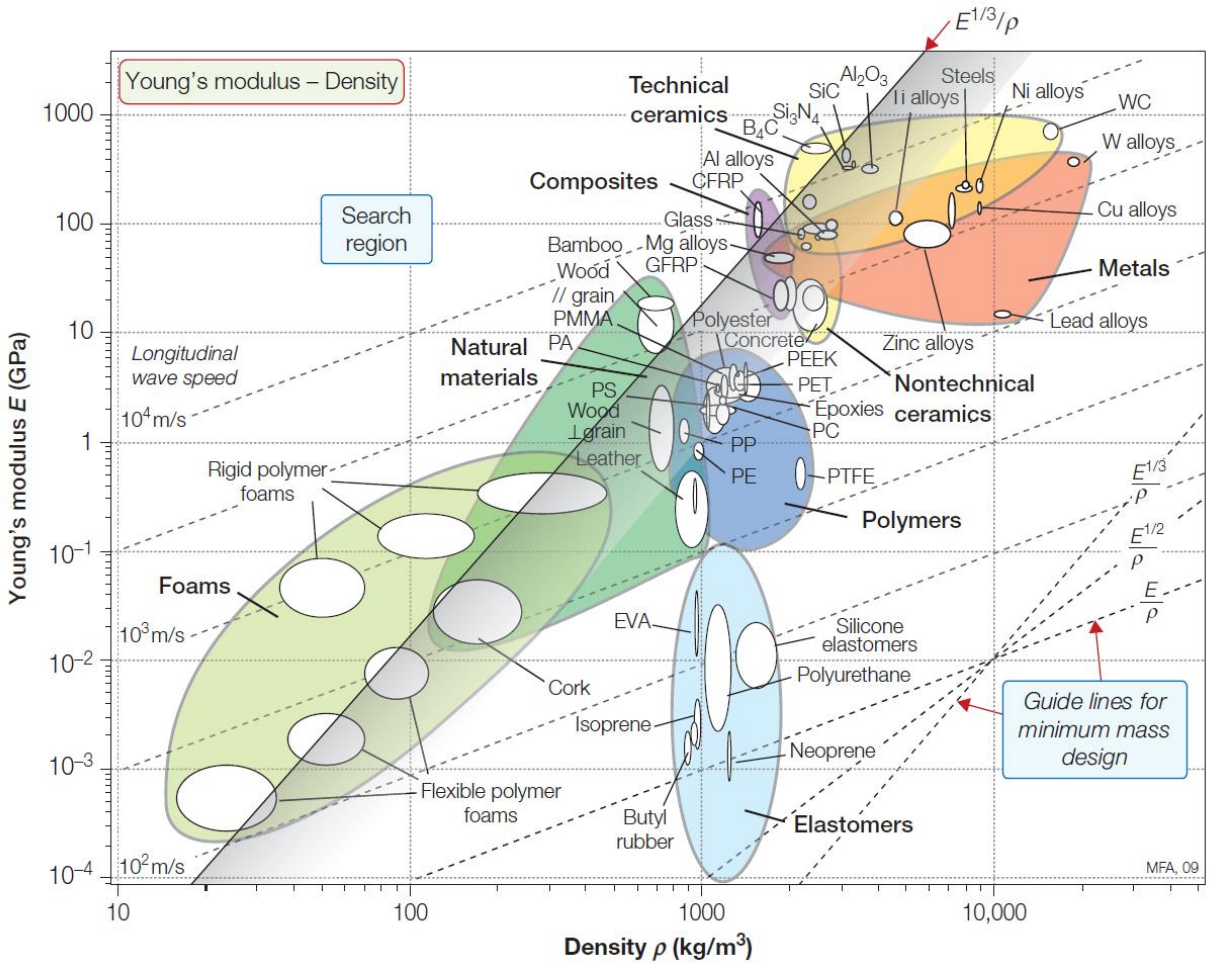

Figure 2:Ashby chart comparing Young's modulus and density.