03/30/2021

HW16: Fracture Toughness and Stress Intensity Factor

Question 1

Explain the difference between fracture toughness (K_{IC}), and stress intensity factor (K_I), both quantitatively, and also how they can be used in engineering applications.

Question 2

$$2\gamma_F = \frac{K_{IC}^2}{E} \ . \qquad (1)$$

Note that $2\gamma_F$ for polymers is about the same as for metals, yet the fracture toughness is one to two orders of magnitude small. Please explain,

Question 3

In class we did the three dimensional problem of a penny shaped crack under remote loading, leading to the result expressed in Eq. (1)

Repeat this calculation for a body which is cylindrical (in two dimensions) where the crack is in the shape of a ribbon rather than a penny.

Show that essentially the same result as in (1) is obtained except for a geometrical factor in front.

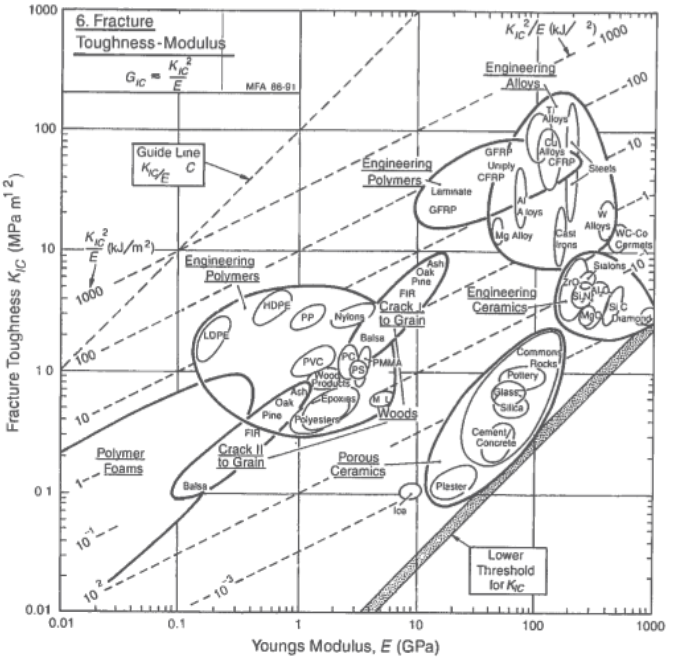

Fig. 4.8 Chart 6: Fracture toughness, K_{Ic}, plotted against Young's modulus, E. The family of lines are of constant K_{Ic}^2/E (approximately G_{Ic}, the fracture energy). These, and the guide line of constant K_{Ic}/E, help in design against fracture. The shaded band shows the 'necessary condition' for fracture. Fracture can, in fact, occur below this limit under conditions of corrosion, or cyclic loading.