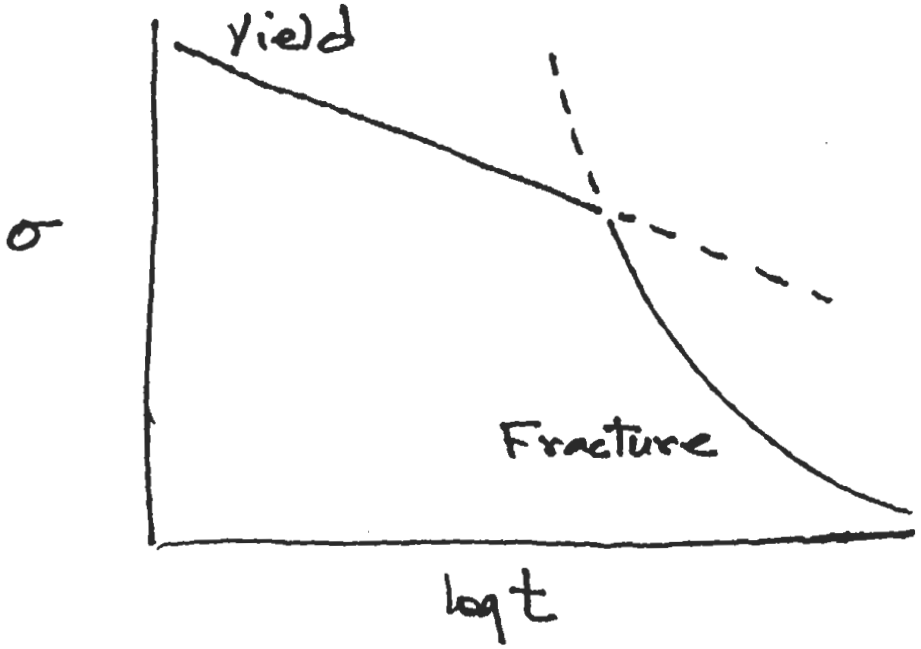
See Figure 5.17, graph of "Crack Length vs. Failure Stress" (p. 218) in McCrum N.G. *Principles of Polymer Engineering.* New York: Oxford University Press, 1997.

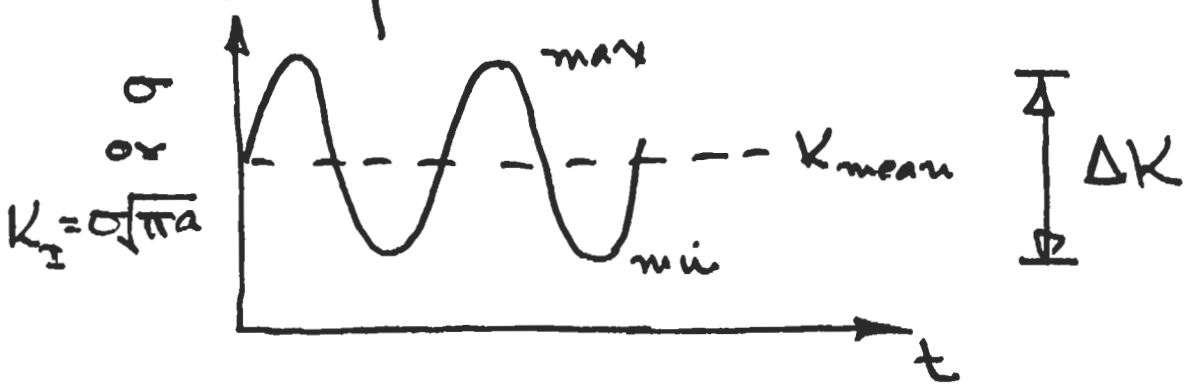
Crack growth

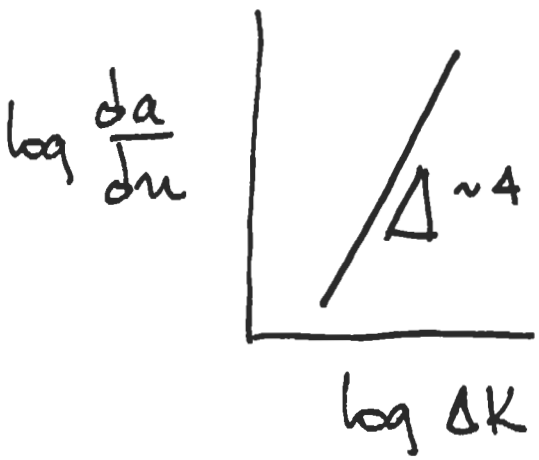
$$\frac{da}{dt} = AK^m = A\left(Y\sigma\sqrt{\pi a}\right)^m$$

fracture when $a = a_c = \frac{1}{\pi}\left(\frac{K_{Ic}}{\sigma}\right)^2$



- Fatigue





volume of plastic zone
$\propto (r_p)^2 \propto K_I^4$

Cycles to failure

Paris law:

$$\frac{da}{dN} = A \cdot \Delta K^{m}$$

Stress intensity factor:

$$\Delta K = \Delta\sigma \cdot \sqrt{\pi a}$$

$$\rightarrow \quad \frac{da}{dN} = A\left[\Delta\sigma\sqrt{\pi a}\right]^{m}$$

$$\int_{a_0}^{a_f} \frac{da}{a^{m/2}} = \int_{0}^{N_f} A \cdot \Delta\sigma^{m} \pi^{m/2} \, dN$$

$$N_f = \frac{2m}{2-m}\left| a_f^{1-\frac{m}{2}} - a_0^{1-\frac{m}{2}} \right| \cdot \frac{1}{A \cdot \Delta\sigma^{m} \pi^{m/2}}$$

See Figure 5.21, electron micrograph of HIPS crazing, in McCrum N.G. *Principles of Polymer Engineering.* New York: Oxford University Press, 1997.