



UNIVERSITY OF
ILLINOIS
URBANA-CHAMPAIGN

ME 330: Engineering Materials

Lab - 7

Impact & Fracture



**Grainger College
of Engineering**

UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

1. What is impact?

- Force with high magnitude but low duration

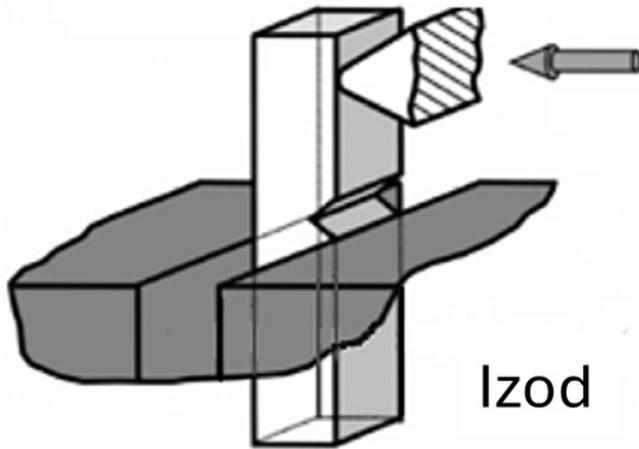
2. What parameter can be used to represent impact strength?

- Energy directly

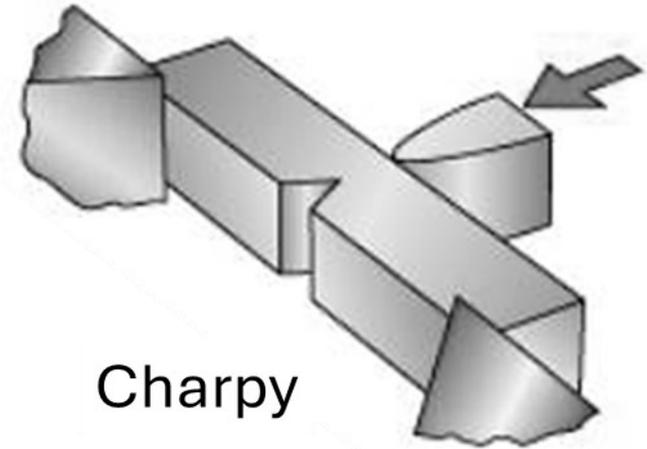
3. How impact test is different than tension test?

- Need to measure energy

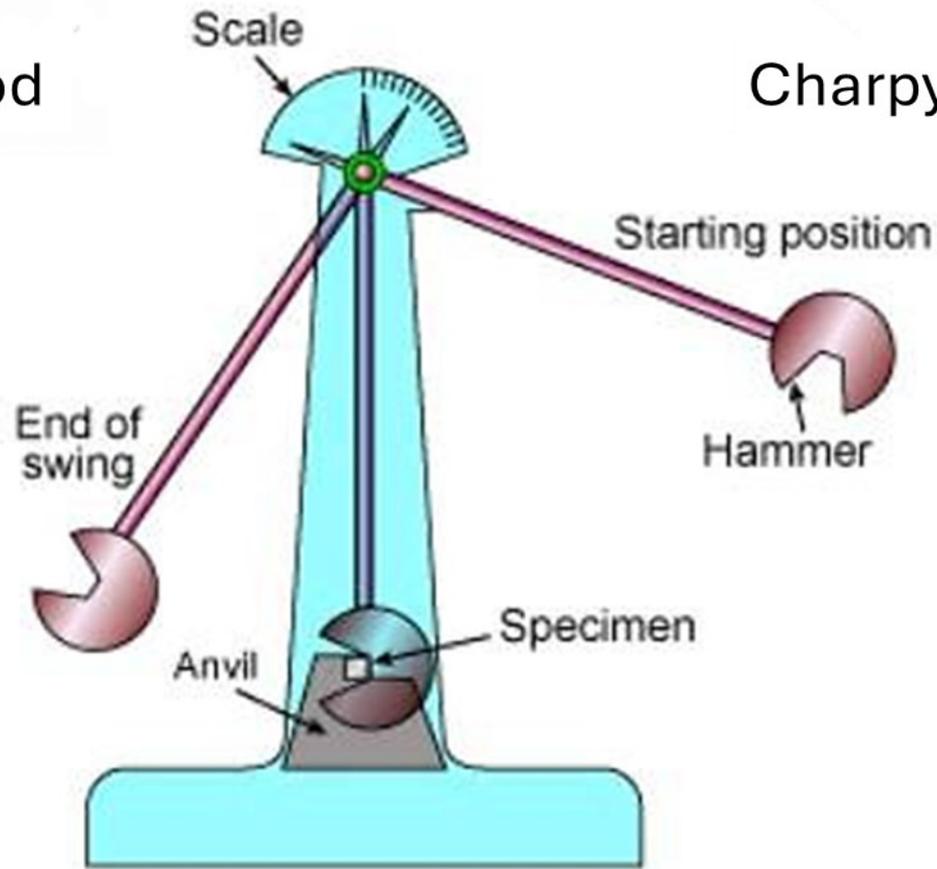
Impact test (The concept)



Izod

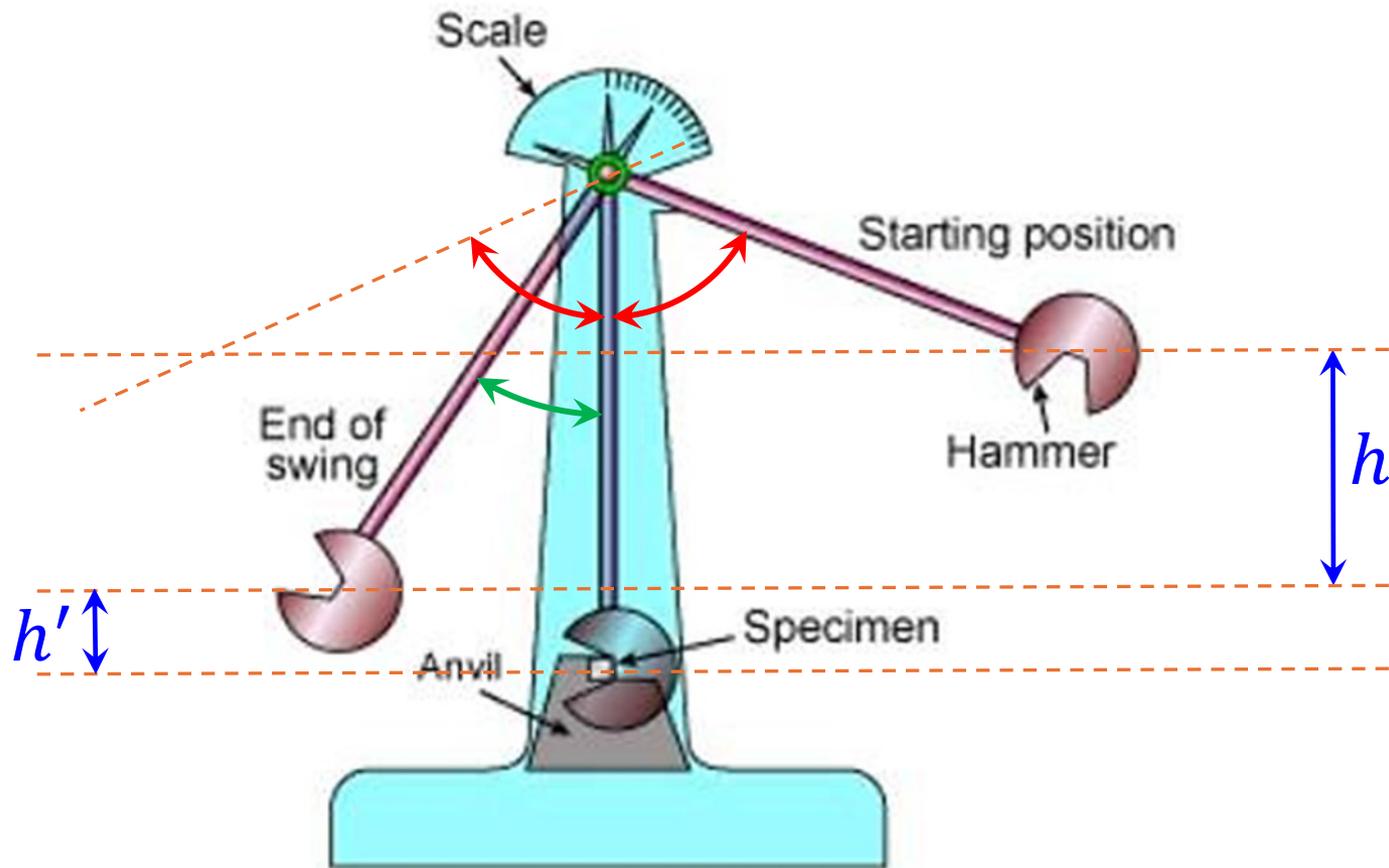


Charpy



Energy conservation

$$U_{\text{specimen}} = mg(h - h')$$



Drop-weight impact test apparatus



Weight
Height of fall

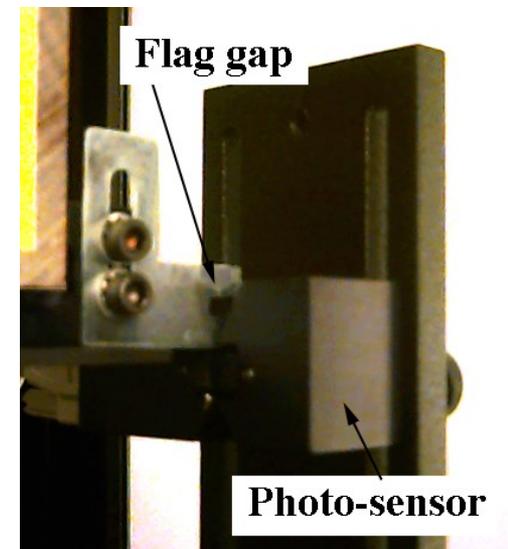


Potential energy

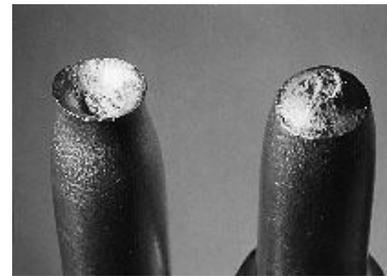
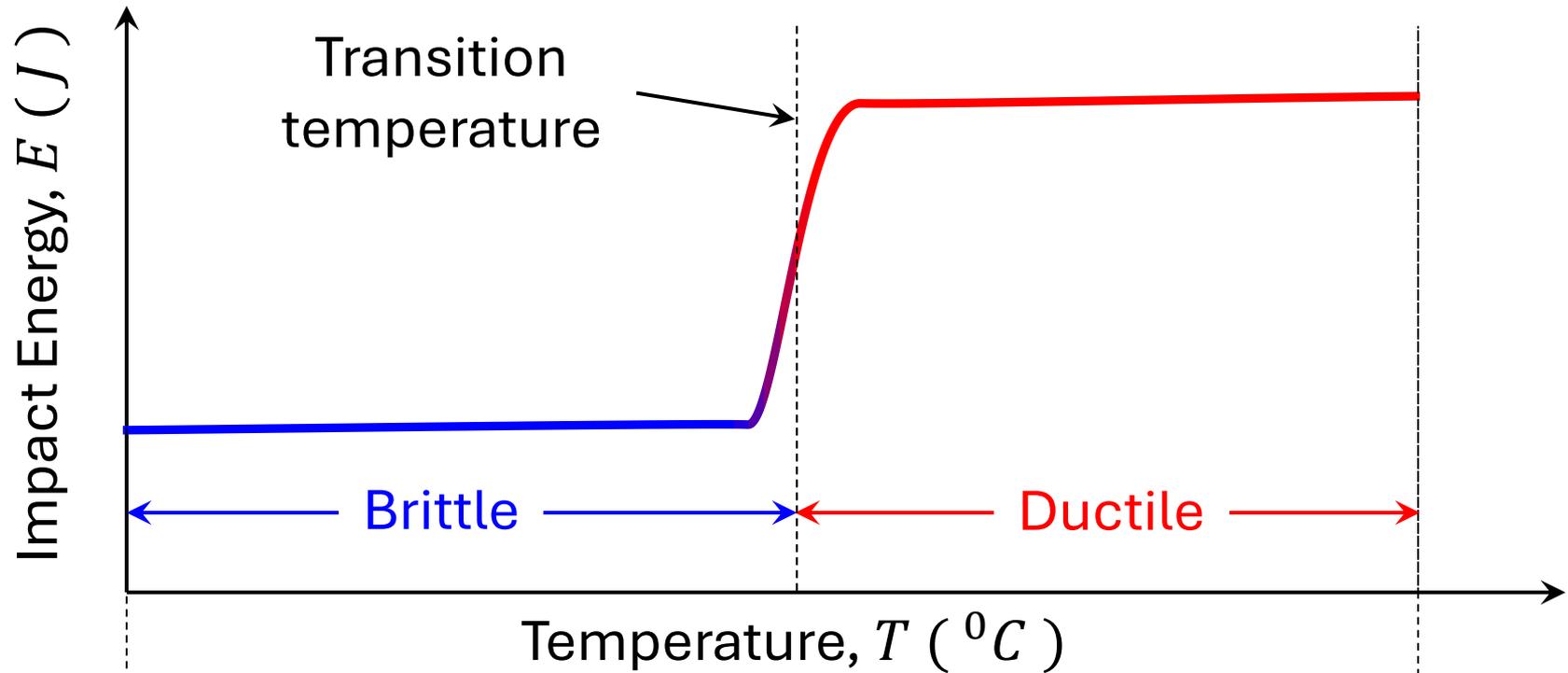
Mass
Velocity



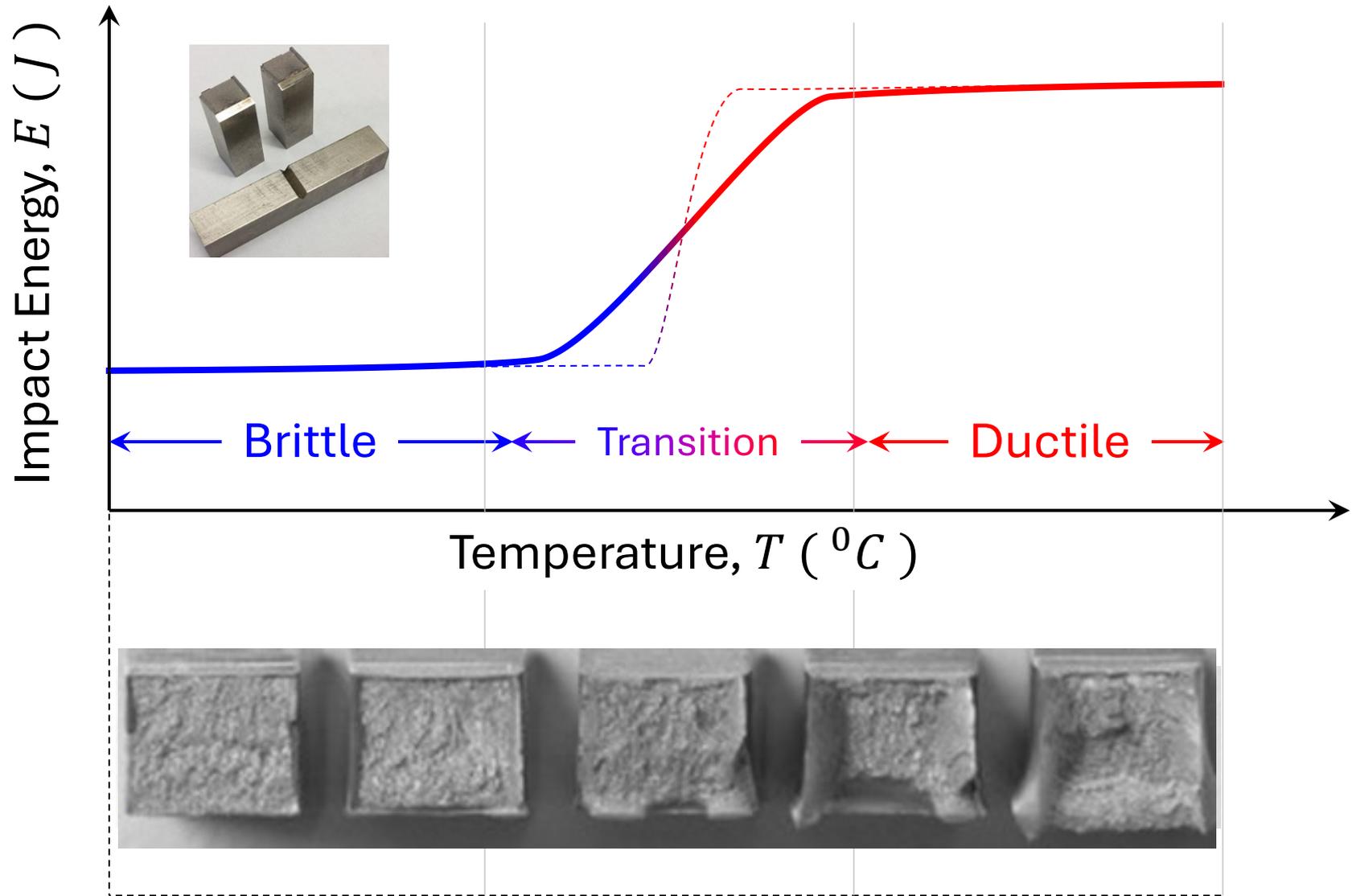
Kinetic energy



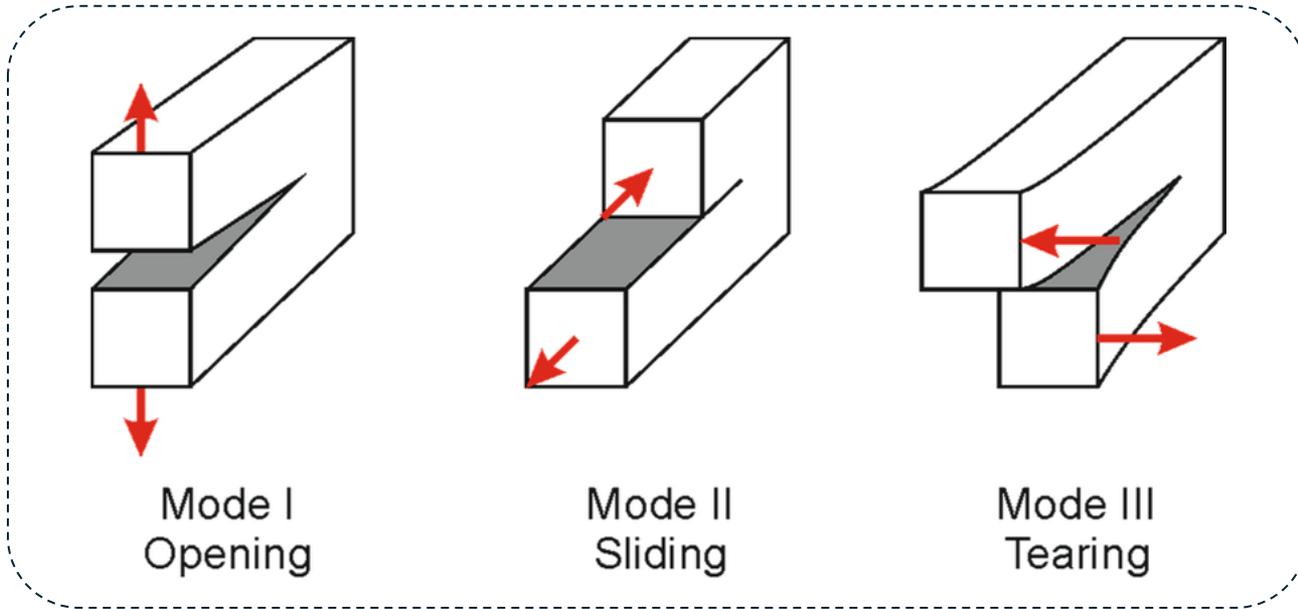
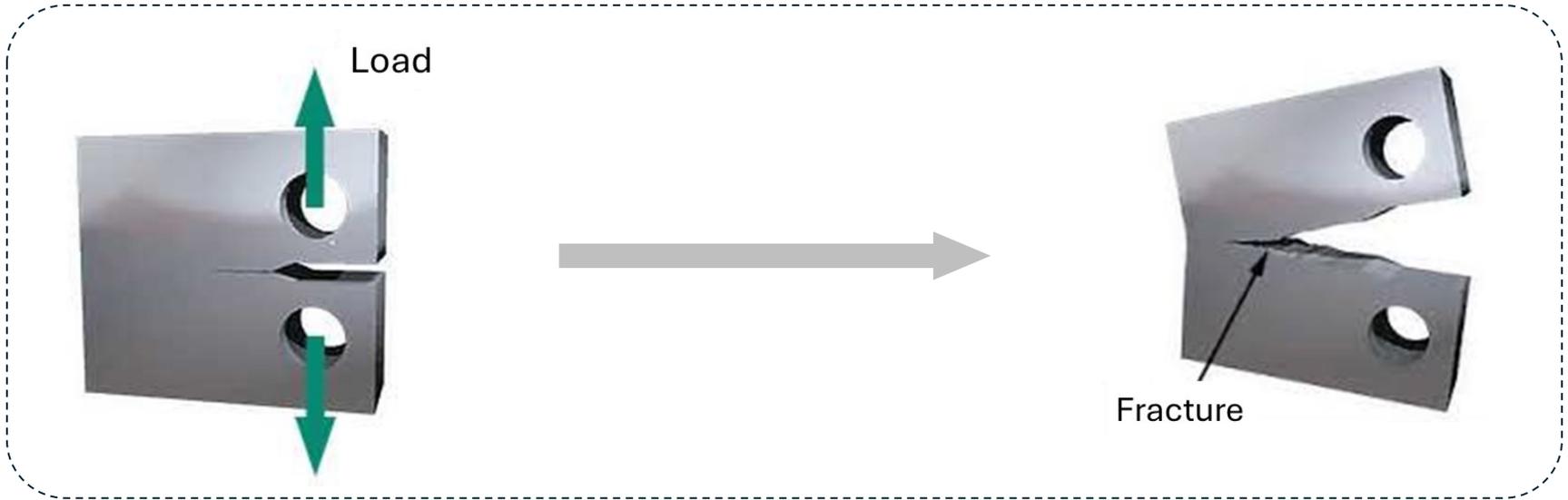
Brittle to ductile transition of “Metals”



Brittle to ductile transition of “Metals”



Toughness testing



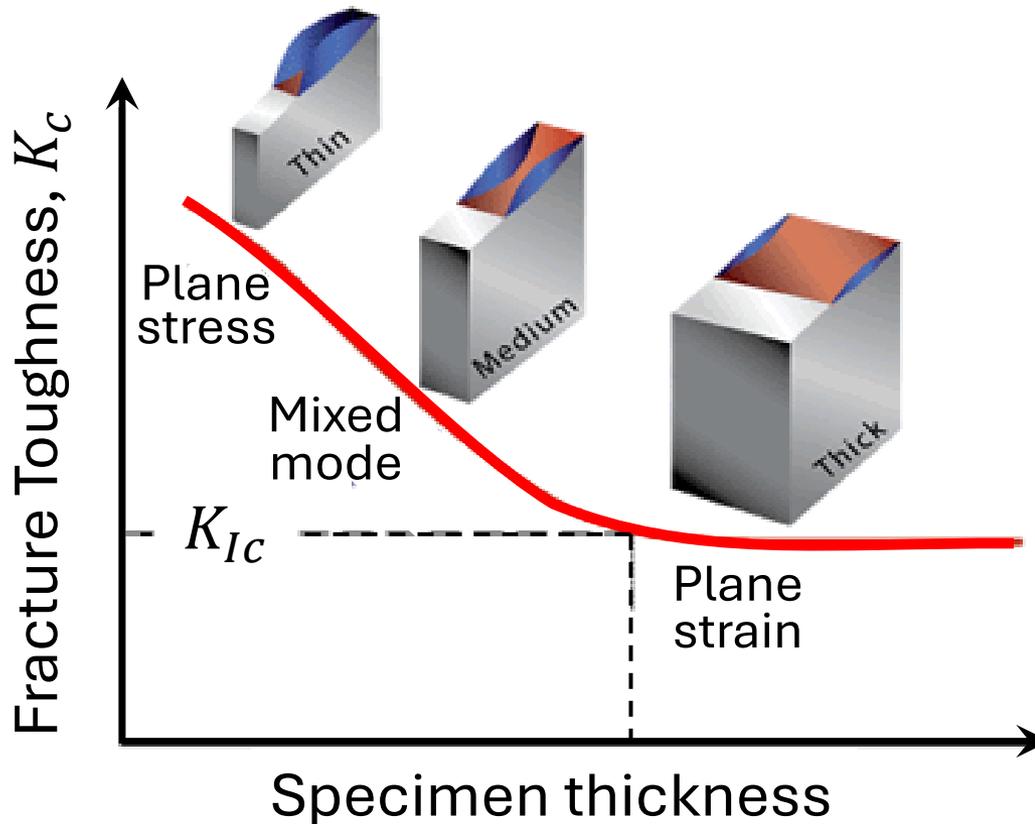
Effect of specimen size (width)

$$K_{Ic} = \sigma \sqrt{\pi a} Y$$

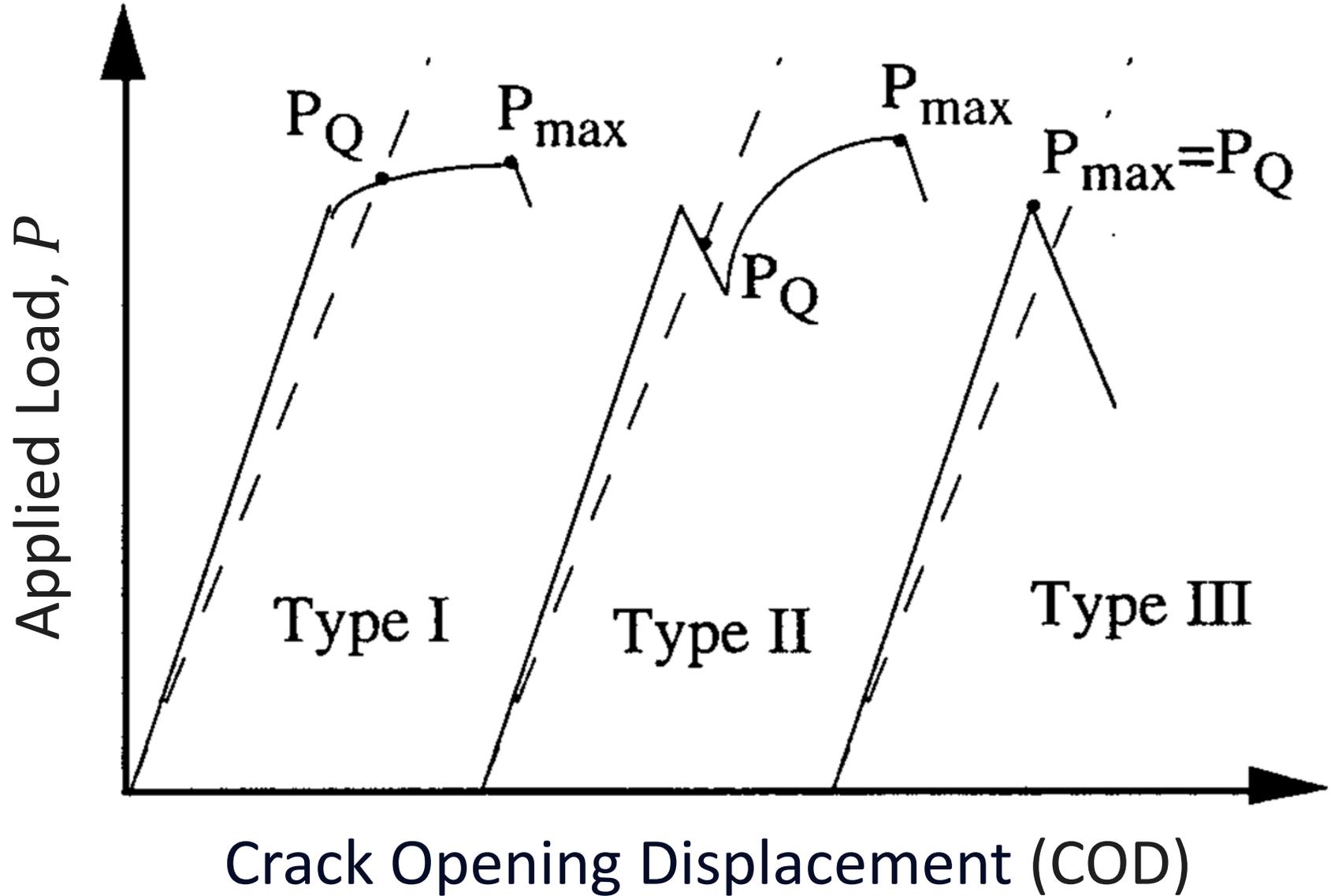
σ – Operating stress

a – flaw size

Y – Specimen geometry



K_{Ic} is material property
if some conditions are
satisfied



$$K_Q = \frac{P_Q}{B\sqrt{W}} f\left(\frac{a}{W}\right)$$

The following four criteria must be satisfied:

Ensures fatigue plastic zone is small

→ (i)

$$P_{precrack} < 0.6 P_Q$$

Ensures low strain hardening at crack tip

→ (ii)

$$P_{max} < 1.1 P_Q$$

Ensures crack tip plastic zone size is small

→ (iii)

$$a, W - a, t > 2.5 \left(\frac{K_Q}{\sigma_{yd}} \right)^2 \approx 50 r_p$$

Ensures validity of the geometric factor

→ (iv)

$$0.45 \geq \frac{a}{W} \geq 0.55$$

If these conditions are satisfied, then:

$$K_{IC} = K_Q$$

$P_{precrack}$ is the max load required to form the sharp fatigue pre-crack

$$f\left(\frac{a}{W}\right) = \left(\frac{2 + \left(\frac{a}{W}\right)}{\sqrt{1 - \left(\frac{a}{W}\right)^3}} \right) \left(0.886 + 4.64 \left(\frac{a}{W}\right) - 13.32 \left(\frac{a}{W}\right)^2 + 14.72 \left(\frac{a}{W}\right)^3 - 5.6 \left(\frac{a}{W}\right)^4 \right) \longrightarrow \text{Geometric correction factor}$$

