

Due in class, Thursday, 11 February 2010

5. The Griffith condition reinterpreted

The condition for fracture is given by

$$\frac{\pi \sigma^2 a}{E} = \Gamma.$$

- Describe the geometry of the specimen for which this formula is valid. Give the physical significance of every quantity in the equation.
- Discuss the difference between the fracture energy and the surface energy.
- Describe an experimental procedure to determine Γ .
- An aluminum alloy has Young's modulus 70 GPa, fracture energy 1000 J/m², and yield strength 350 MPa. When a large plate of the aluminum alloy was tested under an increasing tensile stress, it fractured at stress 200 MPa. Estimate the flaw size in the plate.
- A 0.1 mm crack is found in another plate of the same aluminum alloy. When the plate is subject to an increasing tensile load, will the plate fail by fast fracture or general yielding?

6. Energy release rate

Energy release rate can be calculated by solving boundary-value problem. As an example, consider a crack in an infinite plate. The boundary-value problem was solved by Inglis (1913). In particular, the crack opens to the shape of an ellipse, and the opening displacement is

$$\delta(x) = \frac{4\sigma}{E} \sqrt{a^2 - x^2}.$$

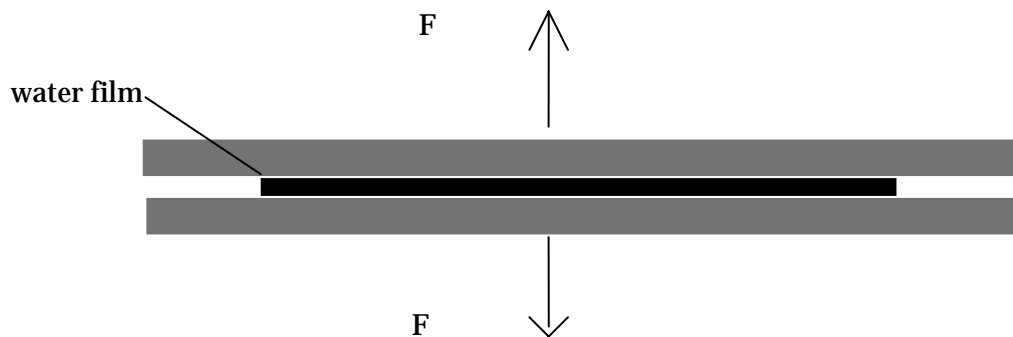
Use this result to show that the energy release rate is

$$G = \frac{\pi \sigma^2 a}{E}.$$

7. Sticking glass slides

It is a common experience that, when wet, two plates of glass stick. It takes some force to separate them.

- Use the following picture to explain the phenomena.
- Compute the force per unit area needed to maintain equilibrium using an energy method
- The edge of the water film is actually curved. This implies that pressure inside water differs from the atmospheric pressure. Calculate the pressure difference. Compare the result with (b).



8. Crack and compliance increase

The presence of a crack increases the compliance of an elastic sample.

- (a) Derive the relation between the energy release rate and the compliance.
- (b) In a handout, the energy release rate of a strip with two edge cracks under remote tensile load is given. Calculate the increase in the compliance as a function of the length of the crack. Plot your result in a dimensionless form.