MT 256 January 3:0

Fracture

Instructor

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Teaching Assistant

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Department: Materials Engineering

Course Time: Mon, Wed, Fri 9:00 - 10:00

Lecture venue: Materials Engineering Multi Media Class Room

Detailed Course Page:

Announcements

Brief description of the course

This course is primarily directed towards students from a materials background. Following a brief review of mechanical behaviour, it develops the concepts of fracture from the ideas of theoretical strength through linear elastic fracture mechanics to the link between energy and stress methods. It then discusses how flaws nuclleate or arrive as pre-existing features, toughening mechanisms in practical systems ranging from process zones, bridging and plasticity. Thermal stress effects are then discussed to illustrate the difference between external loads and residual stresses, while contact loading approaches using Hertzian and point loading approximations present the value of fracture measurements in localised regions and also the link with adhesion. Finally, stress corrosion effects and the effects of cyclic fatigue are introduced. The course has about 6-8 assignments and evaluation based on a mix of mid-term exams and an orally delivered term paper on a topic of the student's choice.

Prerequisites

Basic mechanical properties is essential, some background in materials is helpful.

Syllabus

Review of elastic and plastic deformation

Historical development of fracture mechanics

Thermodynamics of fracture including Griffith theory

Linear elastic fracture mechanics, Irwin and Dugdale extensions

Stability of cracks, Crack resistance curves and toughening of brittle materials

Ductile failure, J-integral

Indentation failure, Environmental aspects of failure, thermal shock, Weibull statistics

Methods to measure toughness

Cyclic Fatigue

Special topics as time permits: Compression failure, Fracture in thin films and interfaces, Toughening in hierarchical structures

Course outcomes

Understanding of the factors that govern failure in systems ranging from structural metals to functional materials, knowledge of external factors that affect reliability and how to anticipate and quantify them, methods of measuring toughness quantitatively with 3 demonstrations in the laboratory that cover contact loading, adhesion and plane strain fracture toughness

Grading policy

50% for a total of 2 mid terms, 50% for the final which could be either a term paper or a written exam.

Assignments

Review of mechanical behaviour

Bonding and theoretical strength

Crack stability, stress intensity factor, Williams solution

Calculations of K1c in practical situations

Elastic-plastic fracture, finite size effects

Indentation and stress corrosion cracking

J-integral and COD calculations

Resources

Fracture of Brittle Solids, B.R.Lawn, Cambridge University Press (1993)

Mechanical Behaviour of Materials, Thomas H. Courtney, McGraw Hill (1990)

Engineering Fracture Mechanics, David Broek, Sijthoff and Nordhoff, The Netherlands (1978)

Deformation & Fracture of Engineering Materials, Richard Hertzberg, John Wiley (1996)

Anderson, Fracture Mechanics