

Learning Objectives:

1. Students will compare and contrast different types of fracture behavior (ductile/brittle).
2. Students will understand how to characterize fracture properties.
3. Students will apply their knowledge of fracture to predict how different cheeses will fail.
4. Students will discuss how geometry plays a role in fracture behavior.

Topics covered:

- Lecture
 1. Causes of fracture
 2. Stress concentrators
 3. Types of fracture (ductile failure, cleavage, intergranular fracture)
 4. Mechanical testing to characterize fracture properties
- Lab
 1. Mechanical testing to characterize fracture properties
 2. Stress concentrators
 3. Simulations of stress (computational materials science)

Estimated Time for Activity:

Lecture: 30 minutes

Lab: 1 hour

Supplies Needed:

- Lecture
 - Computer with Powerpoint
 - Projector
 - Optional: iClicker/Polling software
- Lab
 - Computer lab with internet access (Nanohub) or with pre-installation of OOF2
 - Variety of cheeses (pre-notched bars)
 - Gloves (optional for students)
 - Paper plates

Recommended Prior Knowledge for Instructors:

- Stress and strain behavior for different material classes
- Tensile testing and 3-point bend testing
- Fracture mechanisms
- Working knowledge of OOF2 software

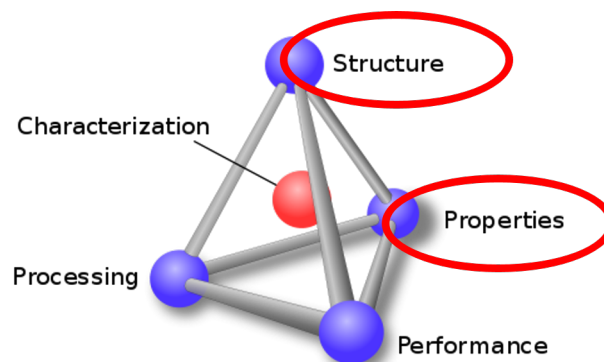
Recommended Prior Knowledge for Students:

- Types of bonding in solids

Discussion Points for Instructors:

- Lecture
 - Will a material with a surface crack be more likely to fracture than one with no flaws?
 - What class of material is most likely to fail through brittle fracture? Ductile failure?
- Lab
 - What does your fracture surface look like? Did all of your samples fail the same way? Can you rationalize why or why not?
 - What type of fracture do you think your cheese will exhibit and why?

Aspects of Materials Science Tetrahedron Covered in Module:



Complimentary Modules

- Composites
- The Materials Science of Chocolate

Files Needed

- Fracture Lecture (PPT or pdf)
- Fracture Instructor Lab Handout
- Fracture Student Lab Handout - Cheese
- Fracture Student Lab Handout - Computer
- Zipped files for OOF2
 - .png files
 - * blunt_crack.png
 - * no_crack.png
 - * center_crack.png
 - * narrow_crack.png
 - Script files
 - * blunt_crack_script.py
 - * no_crack_script.py
 - * center_crack_script.py
 - * narrow_crack_script.py
 - Video of cheese sample prep
 - Video of cheese sample fracture

For K-12 Instructors:

Assessment Ideas

- Lecture
 - Utilize a word cloud through PollEverywhere – ask “What was the most interesting thing you learned?”
 - Use Think, Pair, Share to discuss which sample is more likely to fracture. Give options of a material with and without a pre-crack.
- Lab
 - Think, Pair, Share for discussion on different fracture simulations. Each group simulates a different sample geometry. Have students compare/contrast different samples and how they fracture.

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