Fracture Behavior with Cheese

You Will Be Able To:

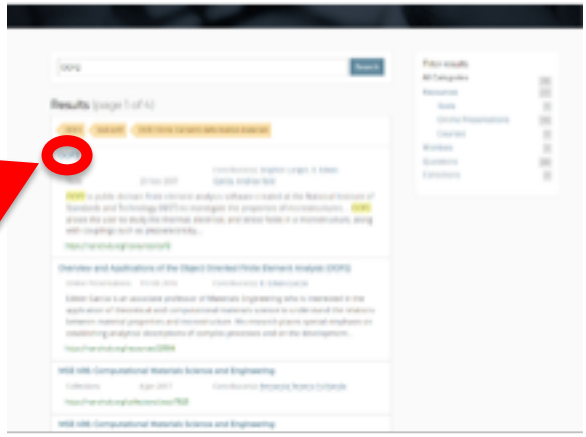
Explain why geometry of a material is important to understanding how it fractures

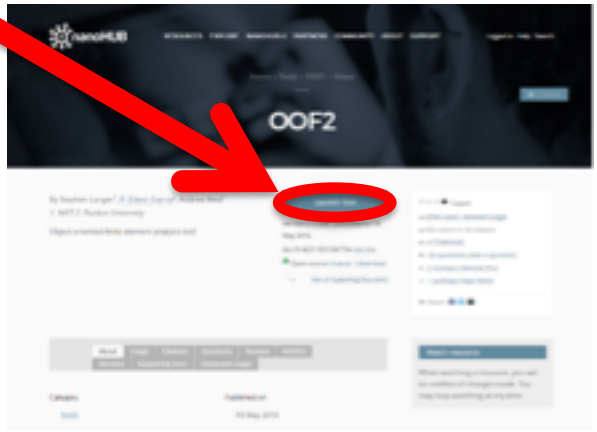
Simulations of Stress in Cheese

When a material breaks, there are engineers who will figure out why it broke. Instead of breaking a bunch of objects to see why they failed, engineers use different kinds of computer programs to digitally model how a material would fail. You will use one of these programs, called OOF2, to understand why the geometry of a material can concentrate physical stress in a particular location in the material. Each group will be assigned to simulate a different initial fracture geometry (due to time constraints), which you will present at the end. What you will see once you have finished the simulation is a visual representation of where stress builds up in the cheese as it is initially strained.

Getting Started:

- Log in to nanohub.org
- Go to the search bar and type in "oof2"
- Click on the first search result
- Then click "launch tool"

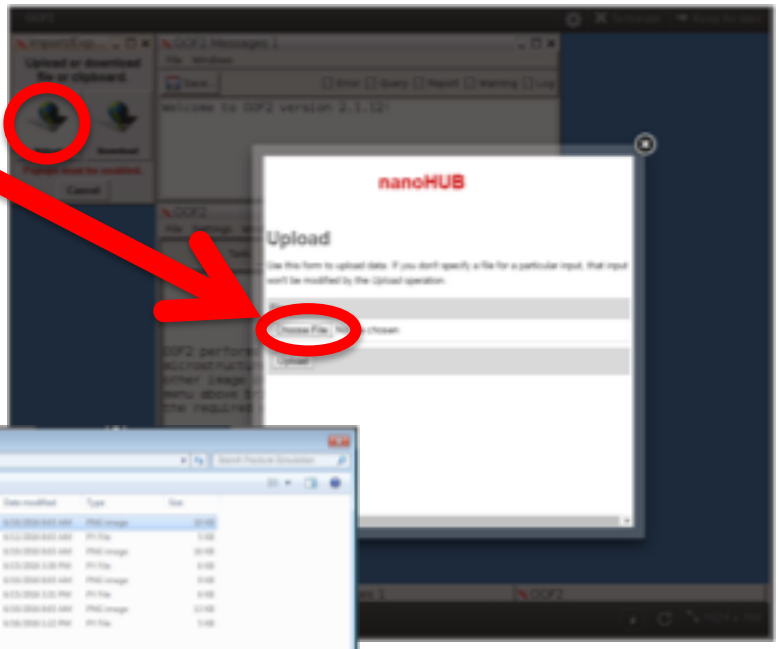


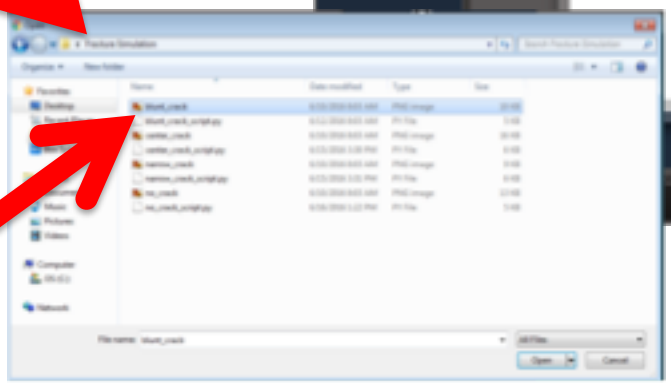


Fracture Behavior with Cheese

Loading the Simulation Data and Script:

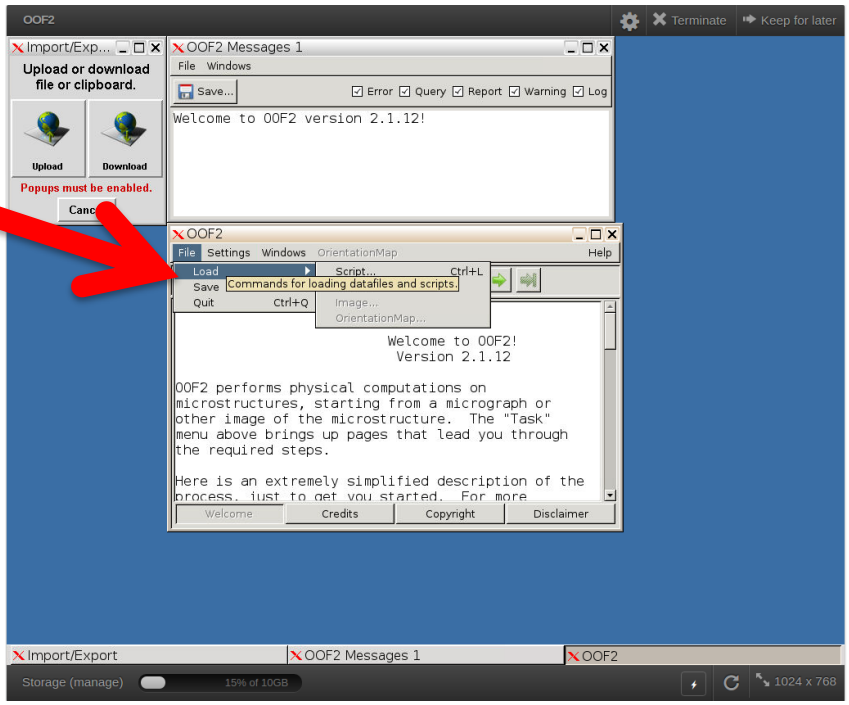
Upload the image file (crack.png) and the script file (crack_script.py) for your assigned crack. Both files are located on the desktop in a folder titled “Fracture Simulation”





Make sure to upload both files!

In the OOF2 titled window go to File > Load > Script and load in the crack_script.py file



Wait. It will take about 2-5 minutes to run the initial script, depending on which system you’re working on

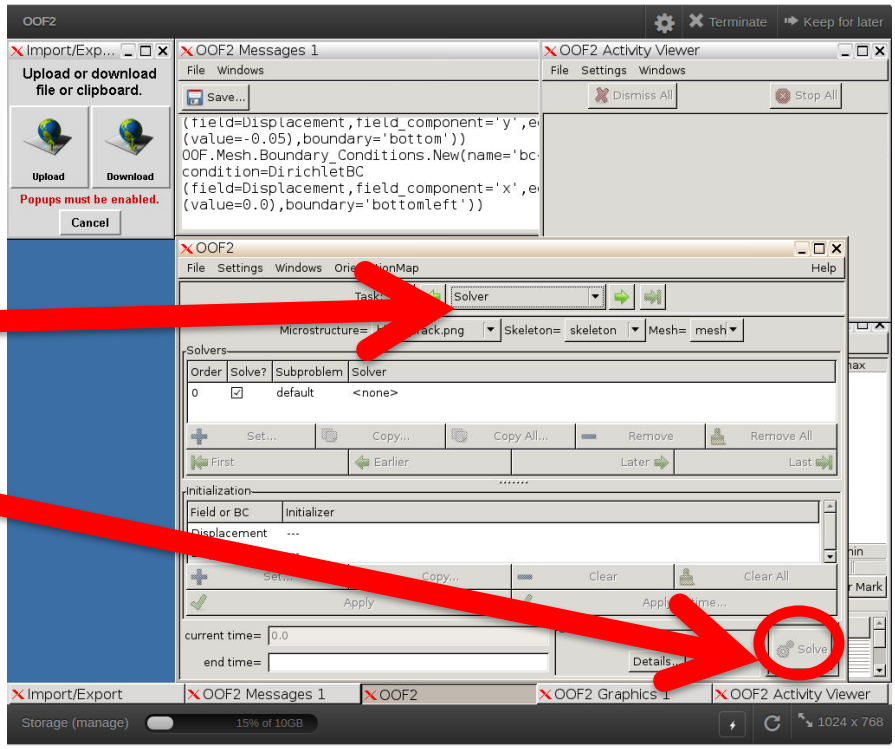
Fracture Behavior with Cheese

Run Simulation:

After the setup finishes…

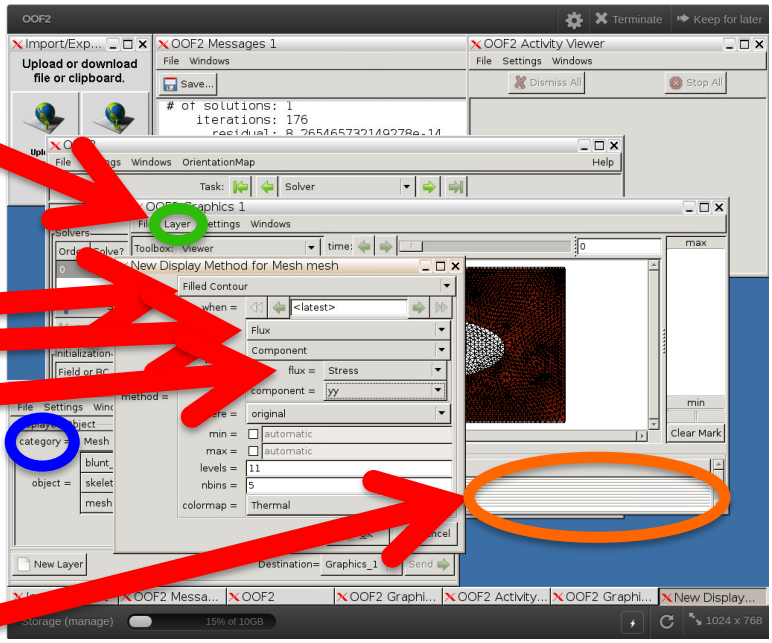
Using the dropdown menu in the OOF2 window, go to “Solver”

Click “Solve” and wait for a minute or so



Visualize Data:

- In the OOF2 Graphics 1 Window, click Layer > New
- In the window that pops up, select category = Mesh
- Click “new” in the “Display Methods” section
- Now set the top drop-down menu to “Filled Contour” and the second to “Flux”
- Set flux = “Stress” and component = “yy”
- Now hit OK
- Wait until the main window updates and then click back in
- To see the color map of stress better, scroll through this panel at the bottom
- Uncheck anything other than the mesh labeled “FilledContourDisplay” until you have an image you can see easily



Fracture Behavior with Cheese

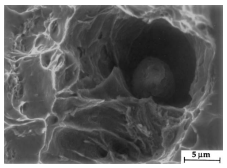
Discussion Points:

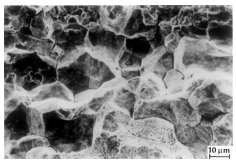
What you are looking at is a scaled color map of the stress intensities at various locations around an initial fracture shape (or no shape, if you are simulating without an initial crack)

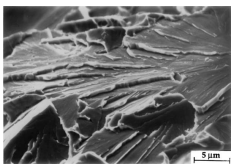
1. Using this picture, predict how you think a soft cheese like mozzarella would fracture compared to a harder cheese like parmesan for different types of crack geometries?

2. What kind of fracture behavior do you think you have modeled?

Circle One: **Ductile** **Intergranular** **Cleavage**







Please explain your choice:

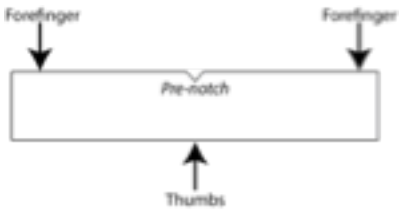
3. Compare your simulation results to the results of the other groups. From the simulations, how does initial geometry play a role in crack propagation?

Fracture Behavior with Cheese

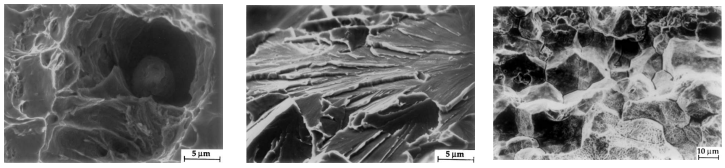
You Will Be Able To:

Predict and explain how different types of cheese will fail under three-point bend tests

Three-point Bend Test



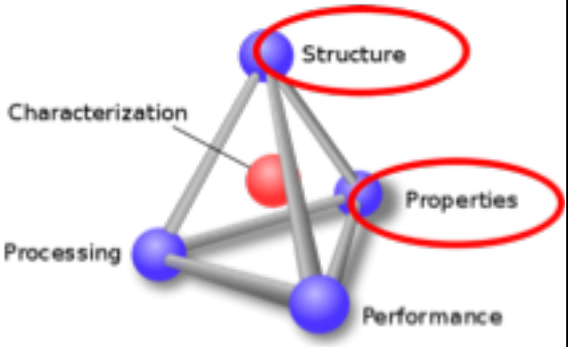
Fracture Surfaces



Pre-lab Questions:

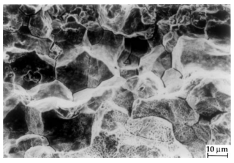
The lecture before this lab should have explained the basics of fracture and the types of fracture mechanisms.

1) The cheese fracture activity fits into the structure and properties categories of the tetrahedron. Please explain why cheese fracture fits in these categories.

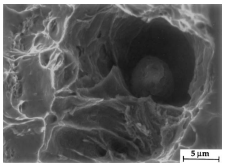


2) Match the type of fracture to its fracture surface

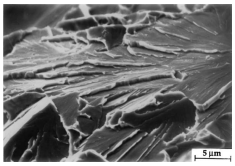
Cleavage



Intergranular



Ductile Fracture



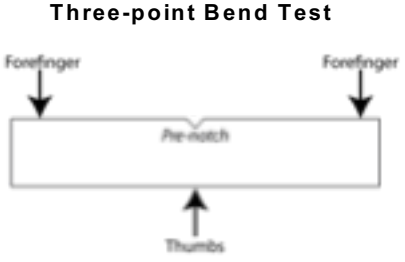
Fracture Behavior with Cheese

Describe Your Cheese:

Describe the properties of your cheese (hard, squishy, crumbly, etc). Sketch each of your samples below then predict how it will fracture—include this prediction in your sketches. **Raise your hand to discuss with a TA if you are unsure.**

Three-point Bend Test Results:

Conduct a three point-bend test and write your results in the table below. Use the pictures in the pre-lab questions to identify the fracture surface.



Sample	Crack nucleation	Crack propagation (Straight or zig-zag?)	Fracture surface (Ductile Fracture, Cleavage or Intergranular?)
Sharp notch #1			
Sharp notch $2			
Blunt notch #1			
Blunt notch $2			
No notch			

Discussion Points:

1) How do your experimental results compare to your simulations from OOF2?
2) Did all of your samples fail the same way? Can you rationalize why or why not?