# The Breaking Point: Exploring Ductility and Brittleness

UNIVERSITY OF WASHINGTON ENGINEERING AMBASSADOR PROGRAM


Welcome. We are engineering ambassadors. We want to inspire future generations of engineering students.

# A game called Laser-Eyes

# Agenda

- Failure of Food Experiment
- Ductile vs Brittle Materials Explanation
- Ductile Brittle Transition
- Failure of Food Experiment II
- Titanic
- Applying Engineering to Your Life!

# Failure of Food Experiment

# “fracture”

**when a thing has broken or cracked**

# Supplies

- Cell Phone
- Clip on Microscope
- Swedish Fish
- Skor Bar
- Paper Plate


# Procedure

1. Break your Swedish Fish and Skor Bar in half. Resist the urge to fit them back together! And don’t eat it (swap for a prize at the end).

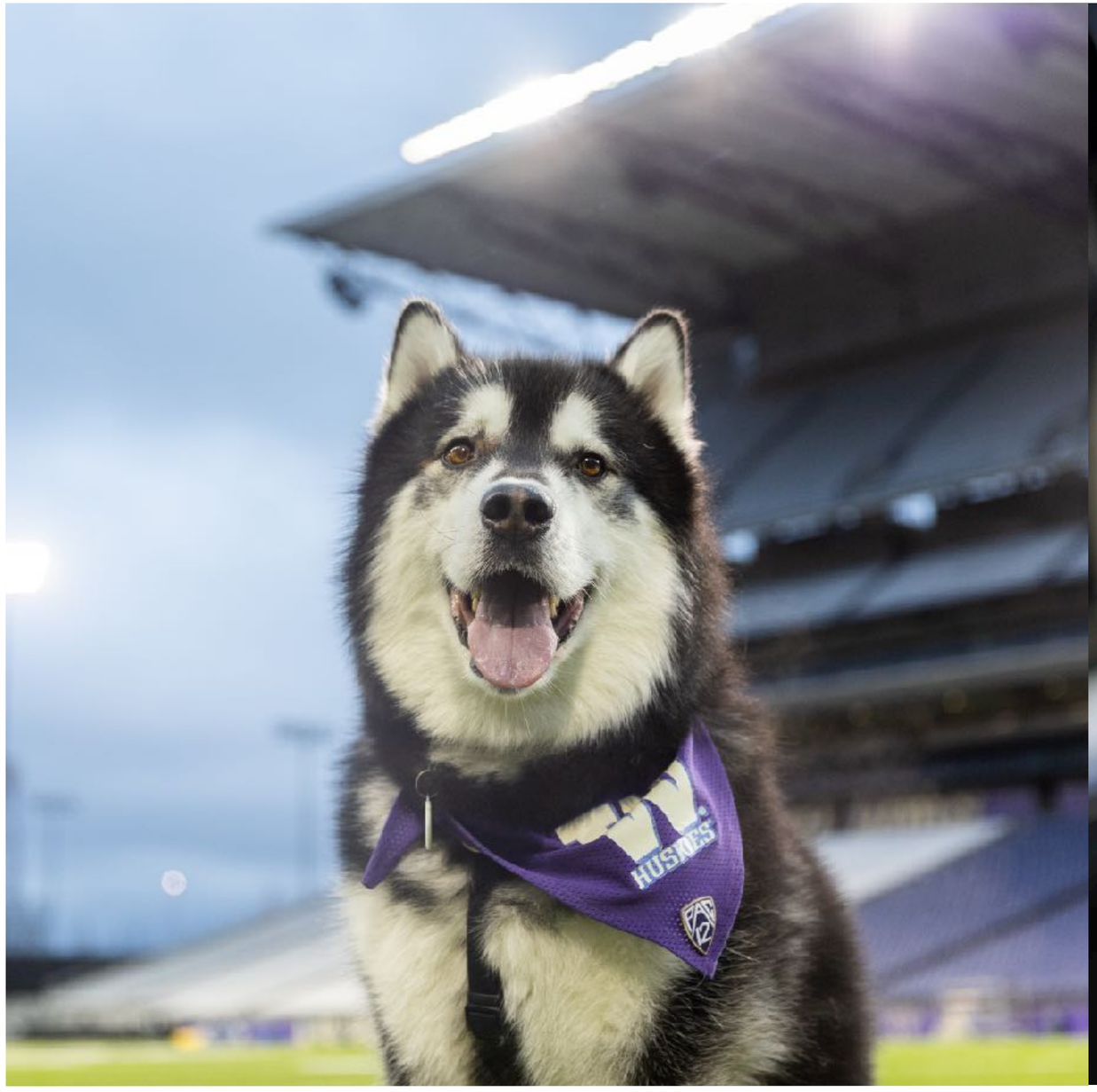
2. Observe your pieces with your eyes. Pay special attention to the overall shape of your pieces, the surfaces where they broke, and what it felt like when they broke.

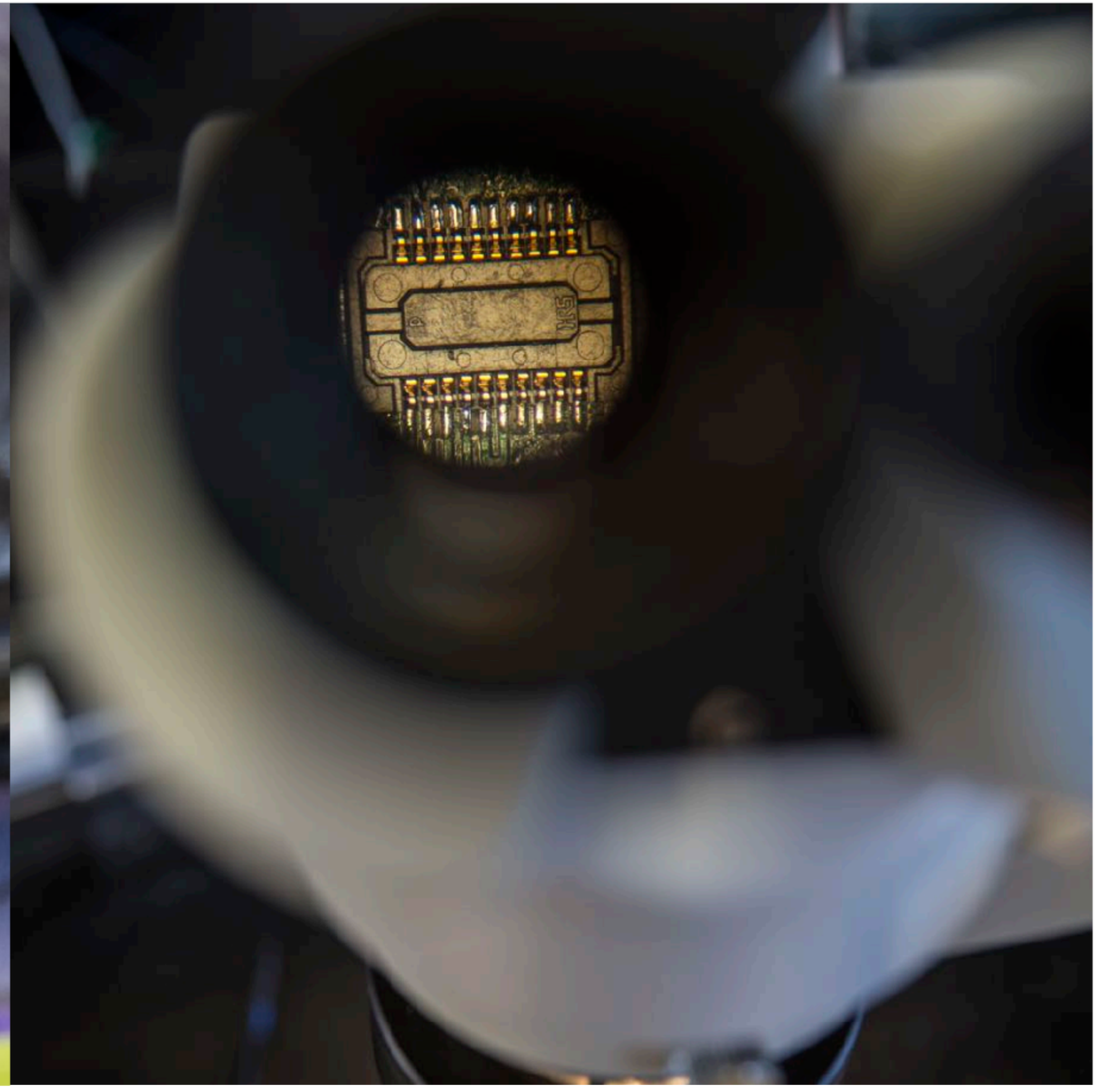
3. Use your clip on microscope to observe the fracture at higher magnification.

# Debrief

# Macro-Scale

# Micro-Scale



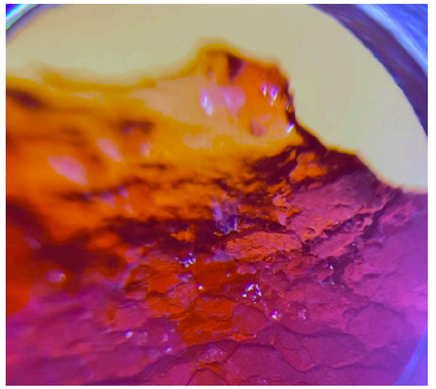
Macro-Scale

Micro-Scale

# Observations - Swedish Fish

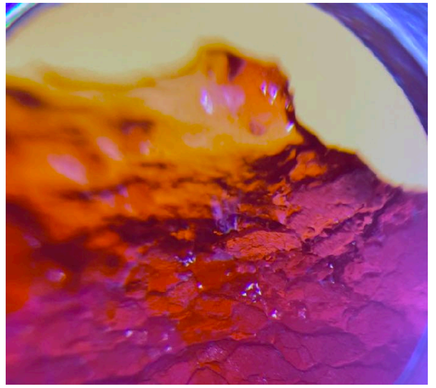
# Observations - Swedish Fish

1. What happened near the fracture?
2. How much energy did it take to break?
3. Were there signs of failure?
4. Did it get longer as it broke?

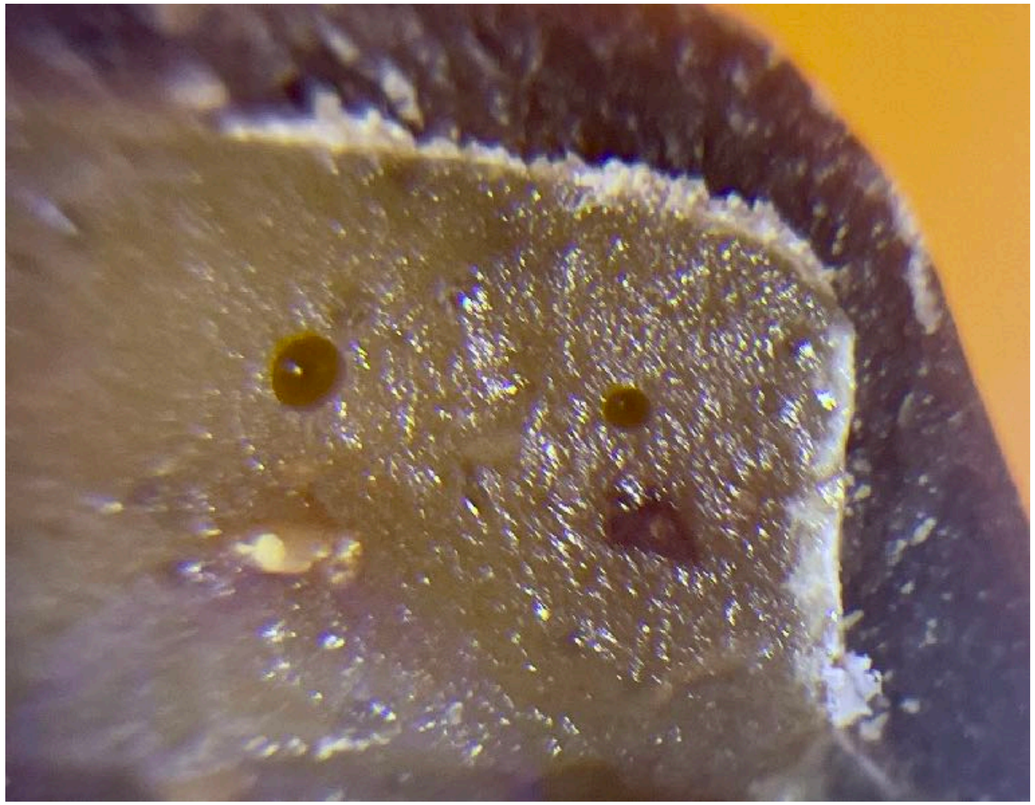


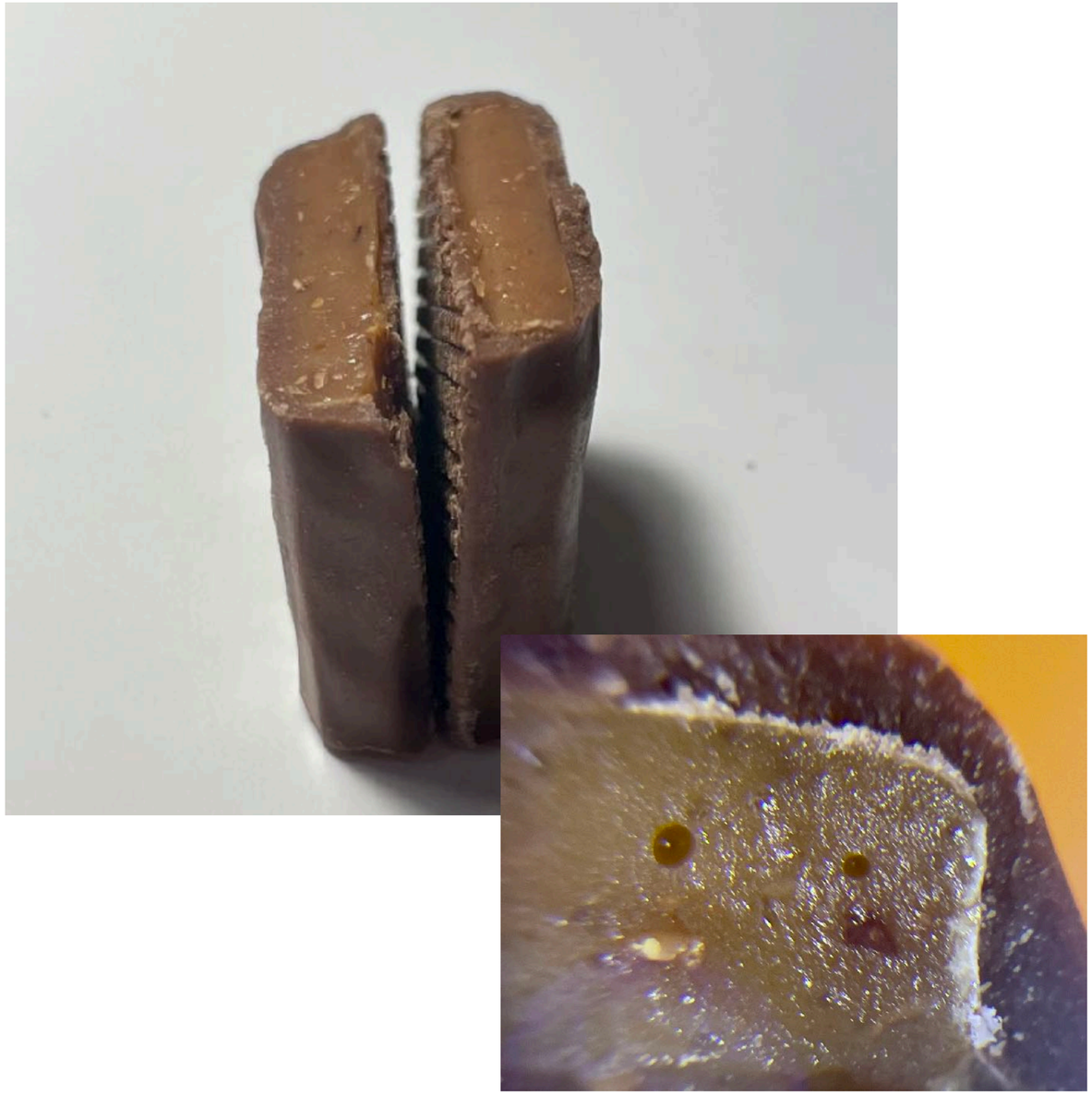
# Observations - Swedish Fish

2. Took a lot of energy (effort) to break
3. Signs of failure before it broke
4. Stretched



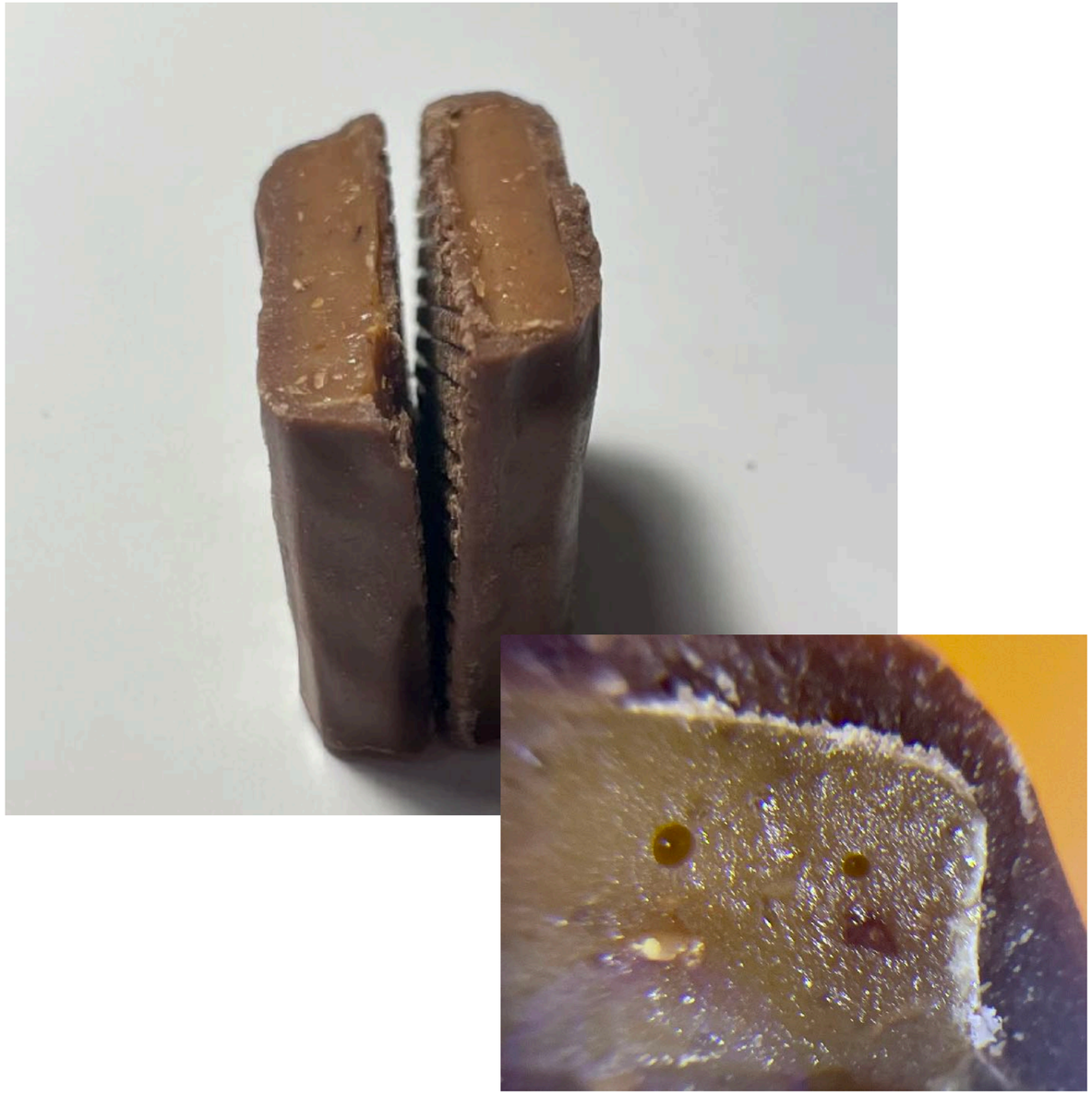
# Observations - Skor  Bar





# Observations - Skor  Bar

1. What does it look like at the fracture?
2. How much energy did it take to break?
3. Were there signs of failure?
4. Did it get longer as it broke?



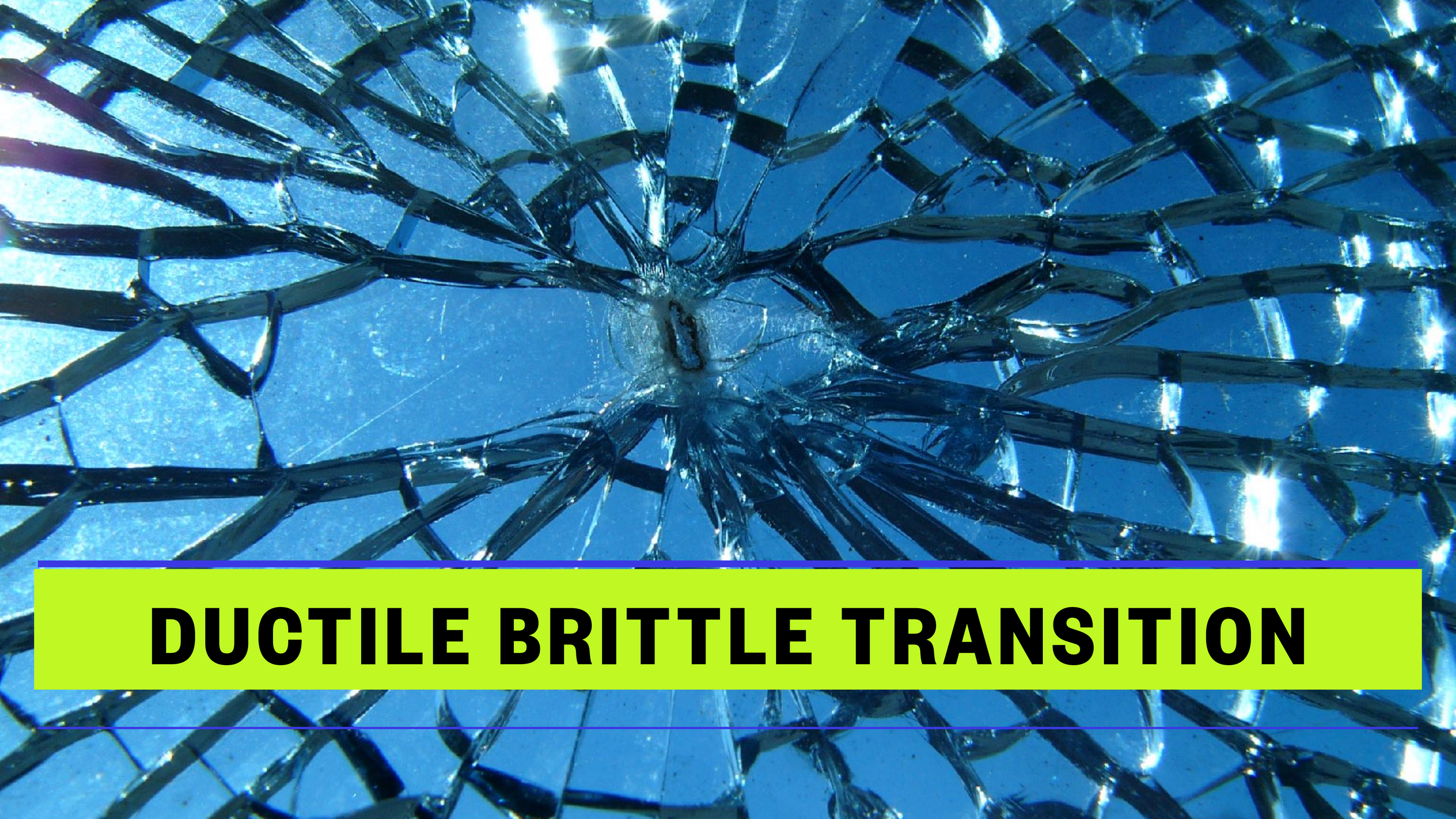
# Observations - Skor  Bar

1. Flat surface
2. Did not take a lot of energy to break
3. “Snapped”
4. Did not stretch (elongate)

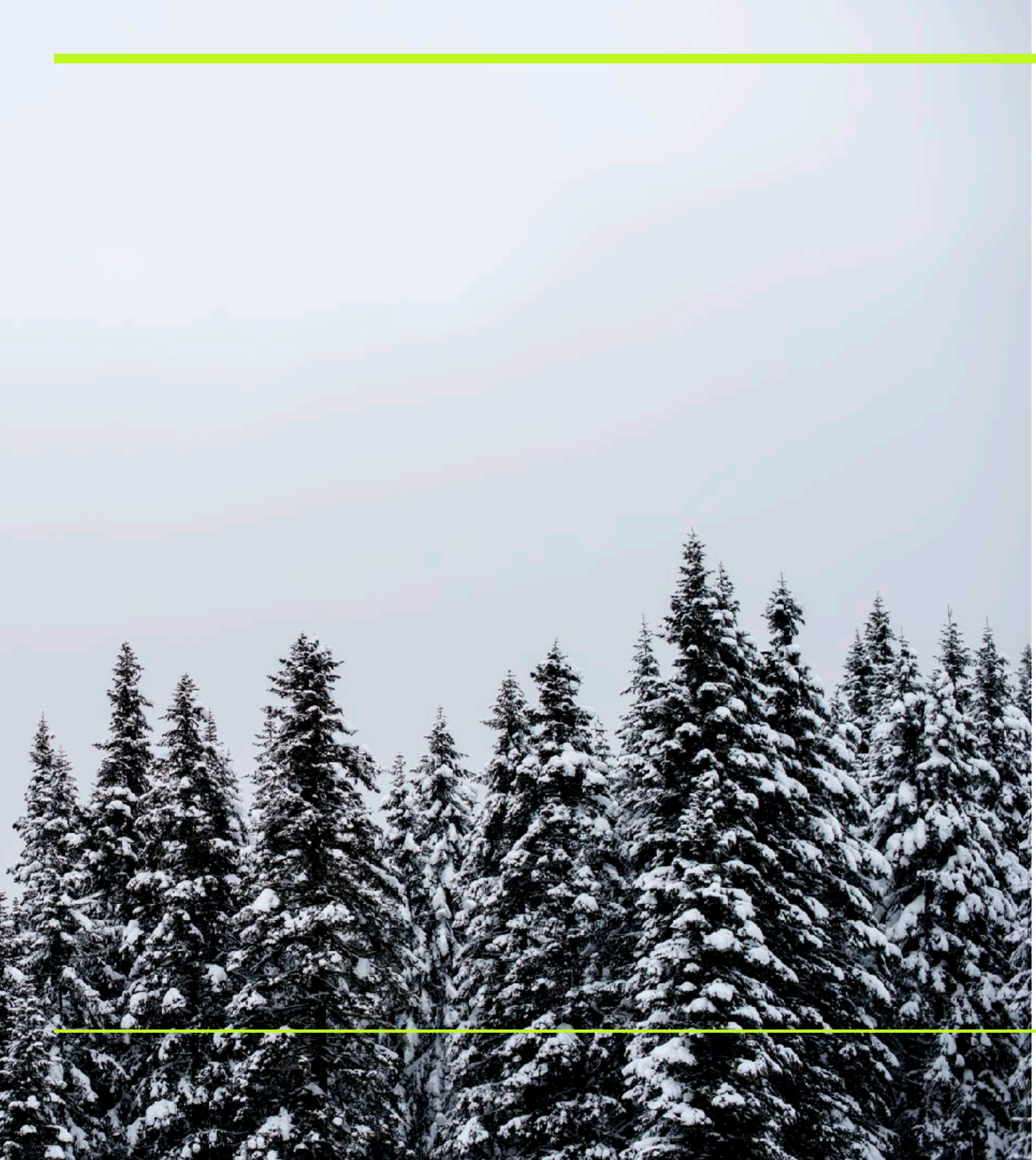
# Ductile and Brittle Materials Information

# Definitions

- **Ductile materials** can change shape without breaking
- **Brittle materials** can’t stretch or change shape without breaking
- Ductile materials can absorb more energy before breaking than brittle materials



# DUCTILE BRITTLE TRANSITION



# Ductile Brittle Transition

- The **ductile-brittle transition** describes how many materials can change between ductile and brittle materials. They become more brittle as they cool down.

# Ductile Brittle Transition

-160ºC -120ºC -80ºC -40ºC 0ºC 40ºC 80ºC 120ºC

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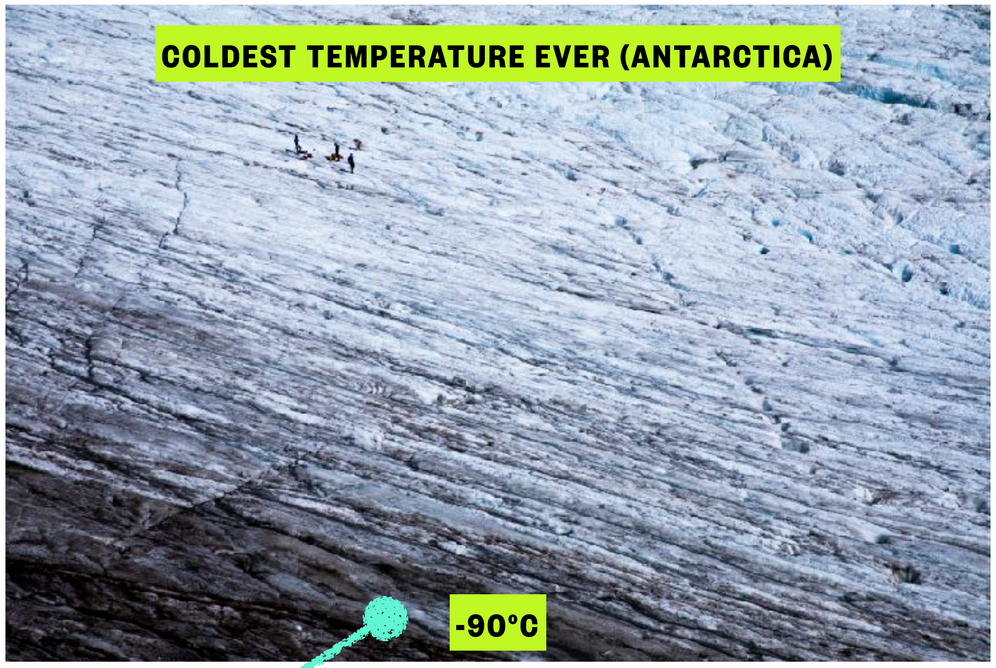
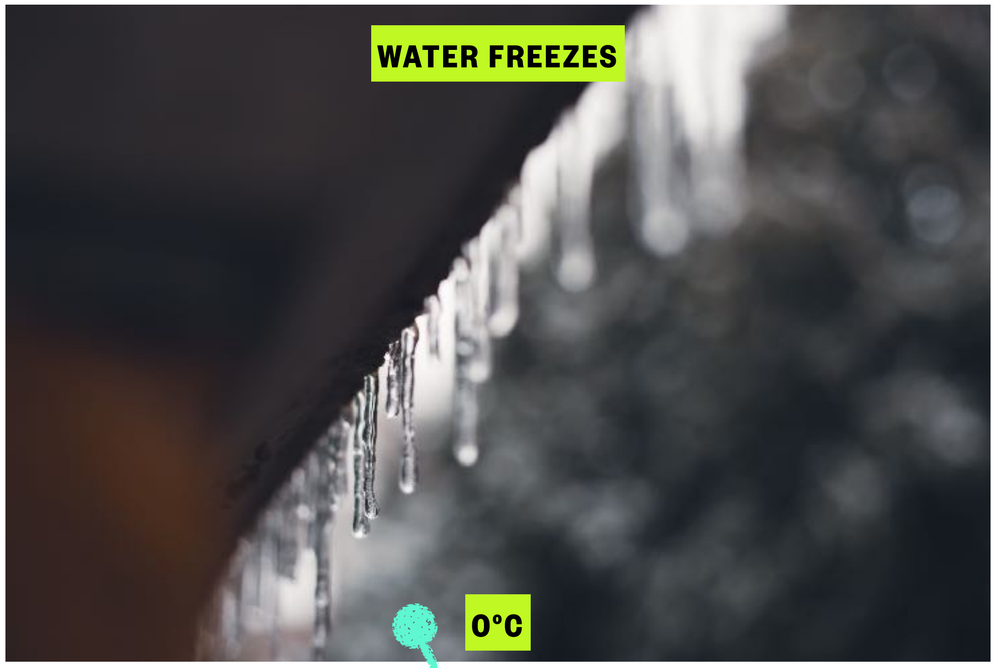



-160°C -120°C -80°C -40°C 0°C 40°C 80°C 120°C

# Ductile Brittle Transition




-160°C -120°C -80°C -40°C 0°C 40°C 80°C 120°C

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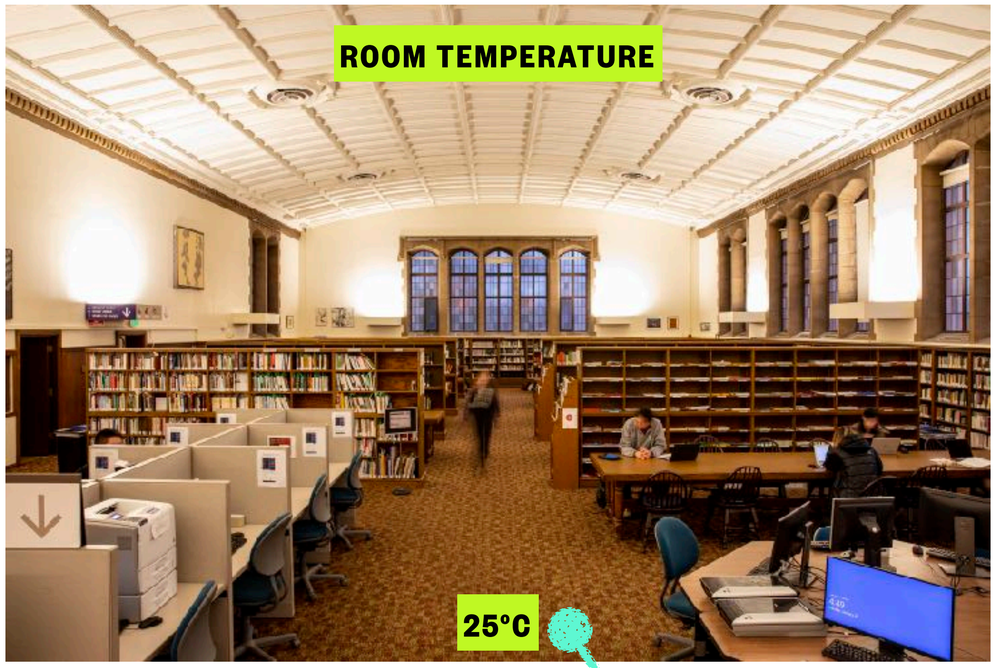


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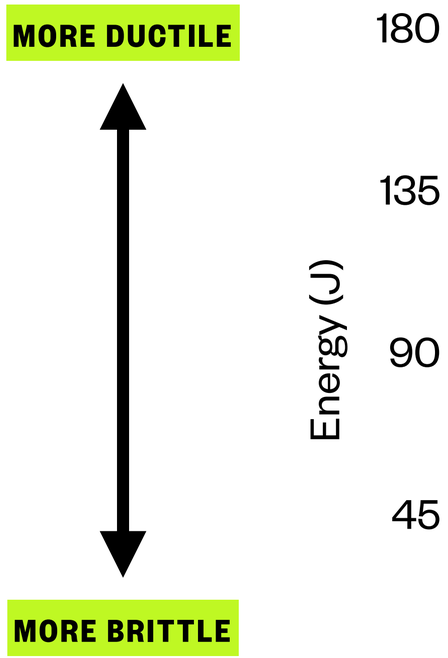
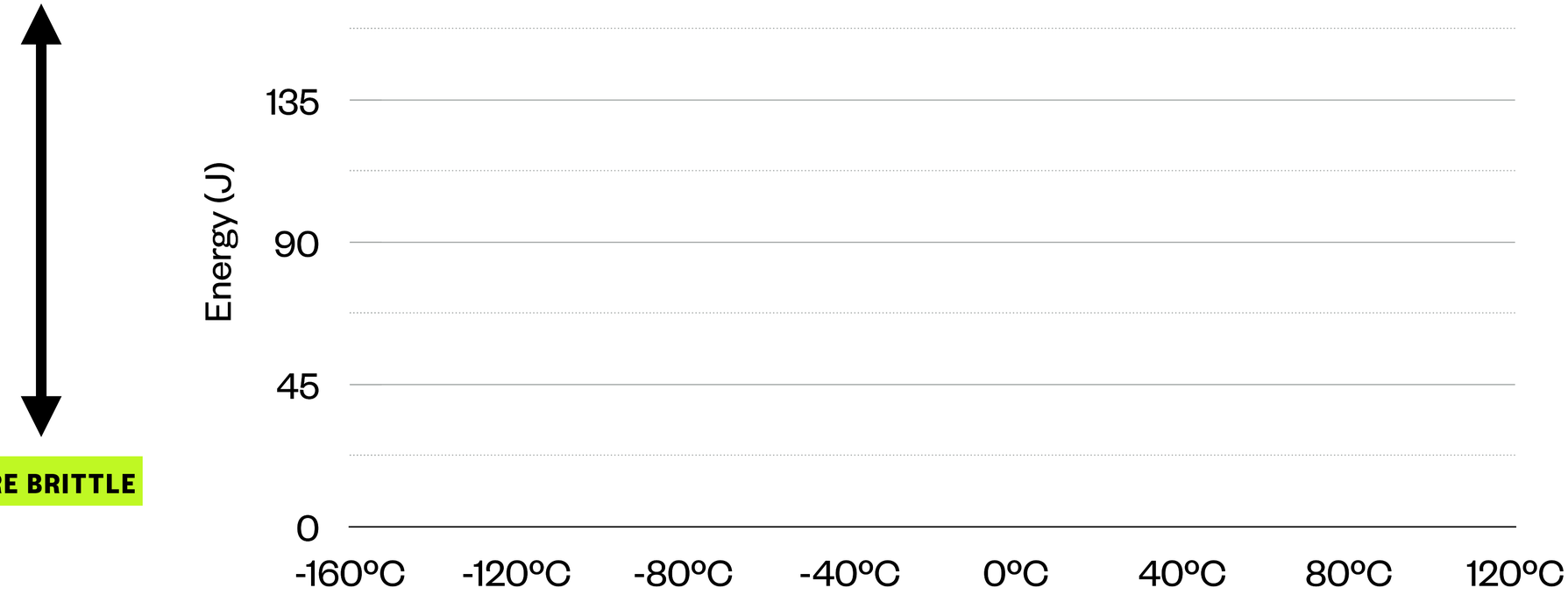


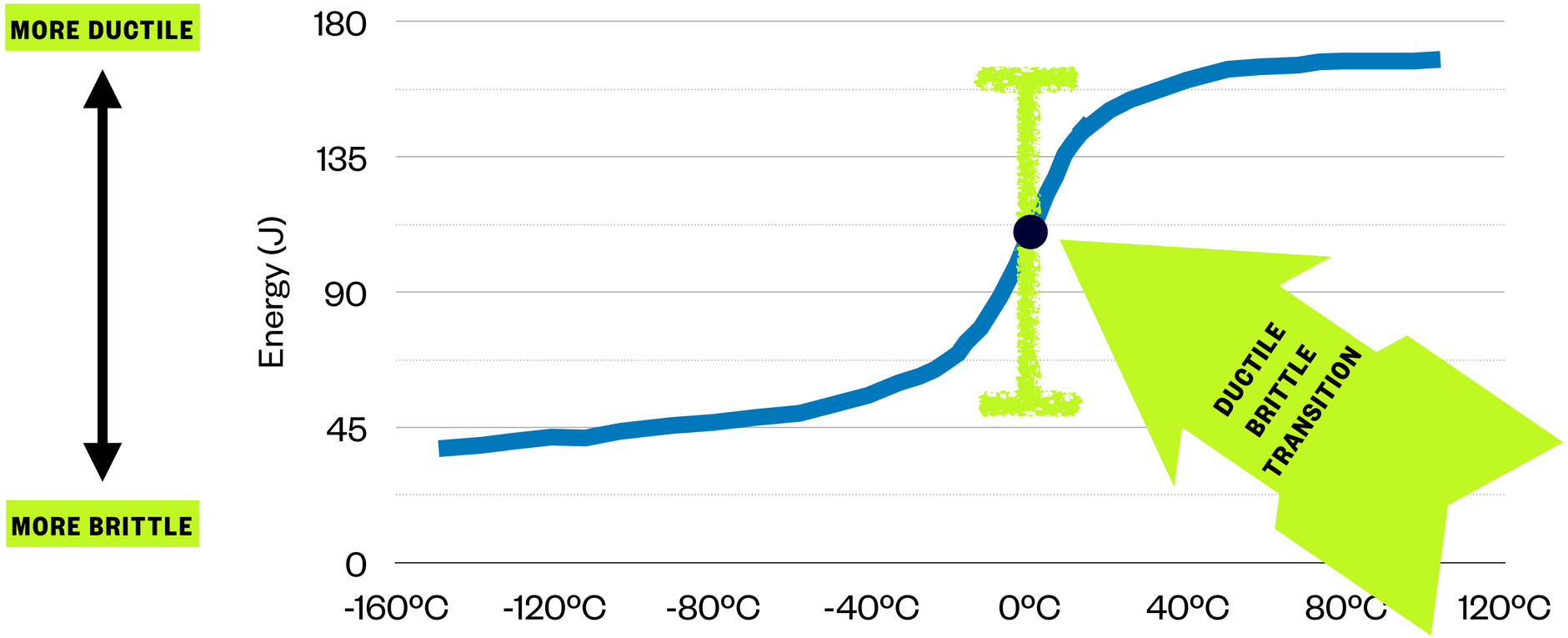
# Ductile Brittle Transition

MORE DUCTILE




MORE BRITTLE

# Ductile Brittle Transition



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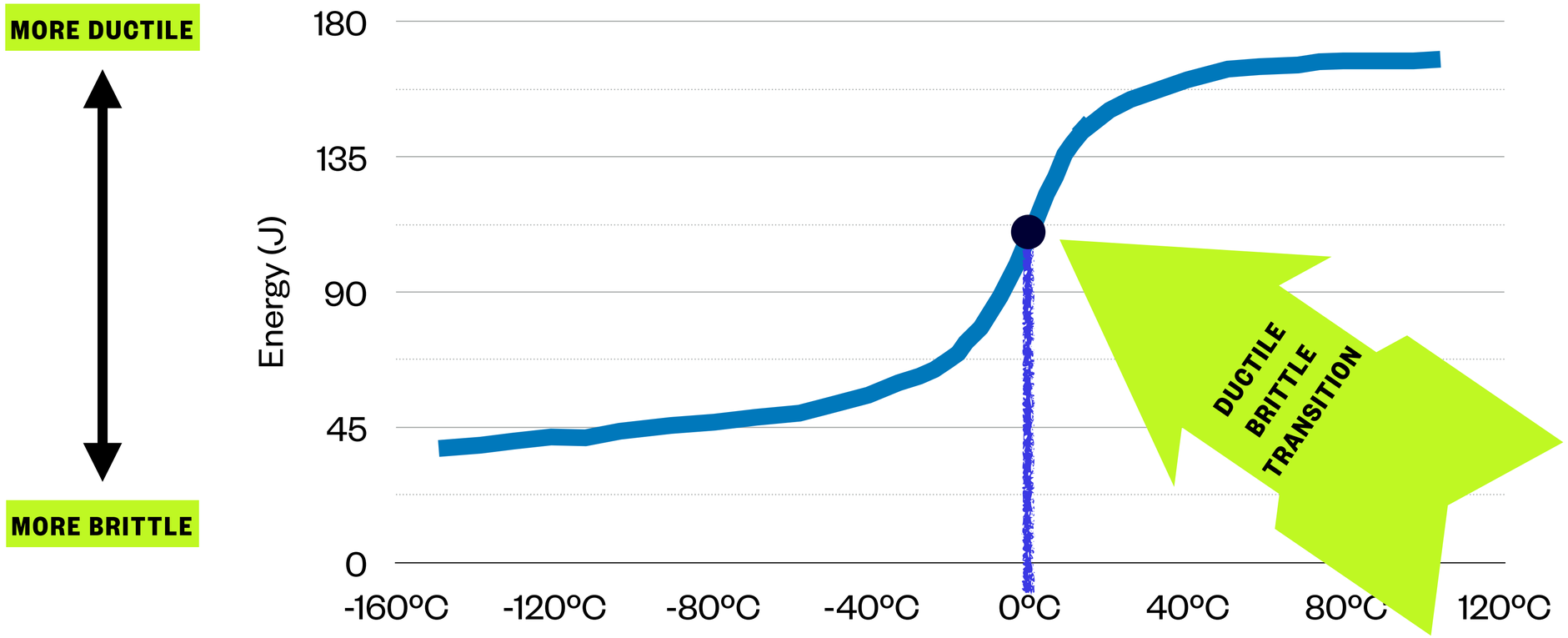

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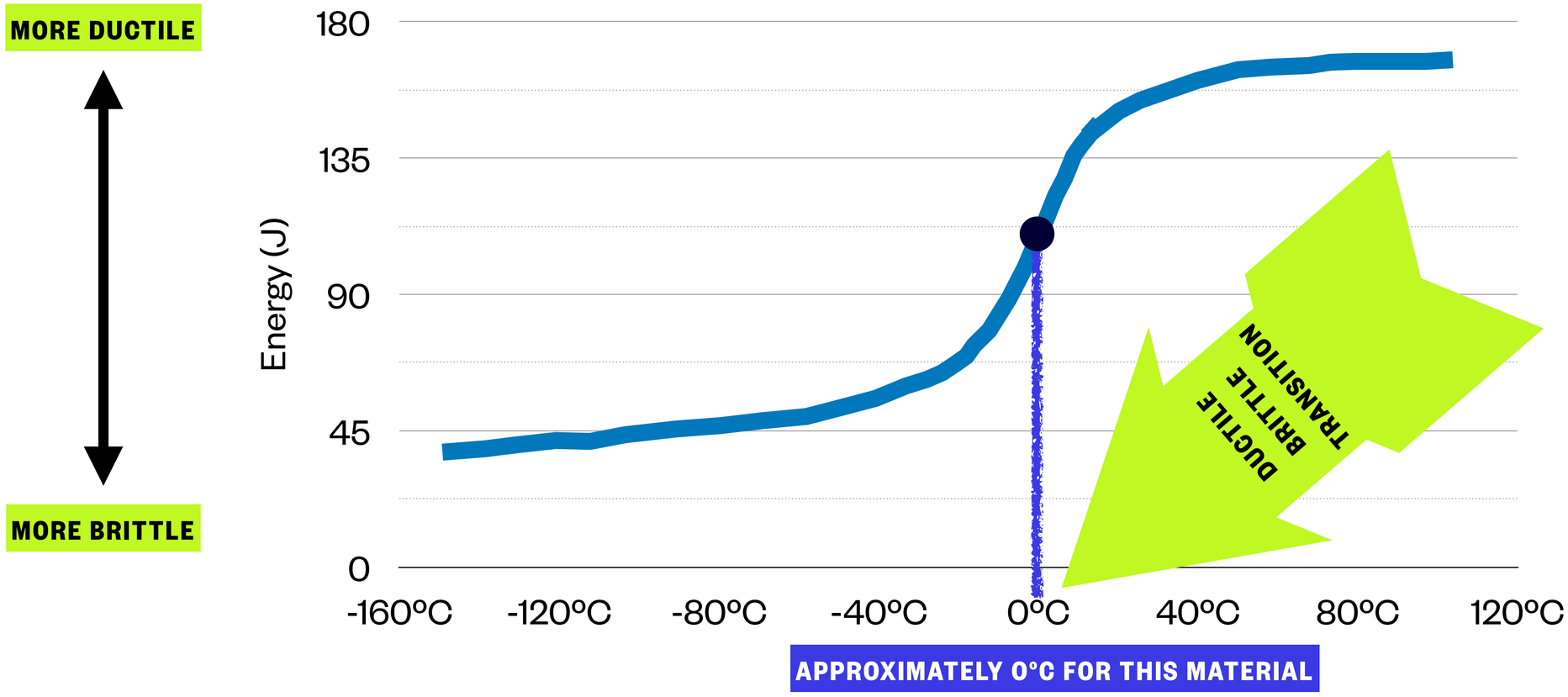
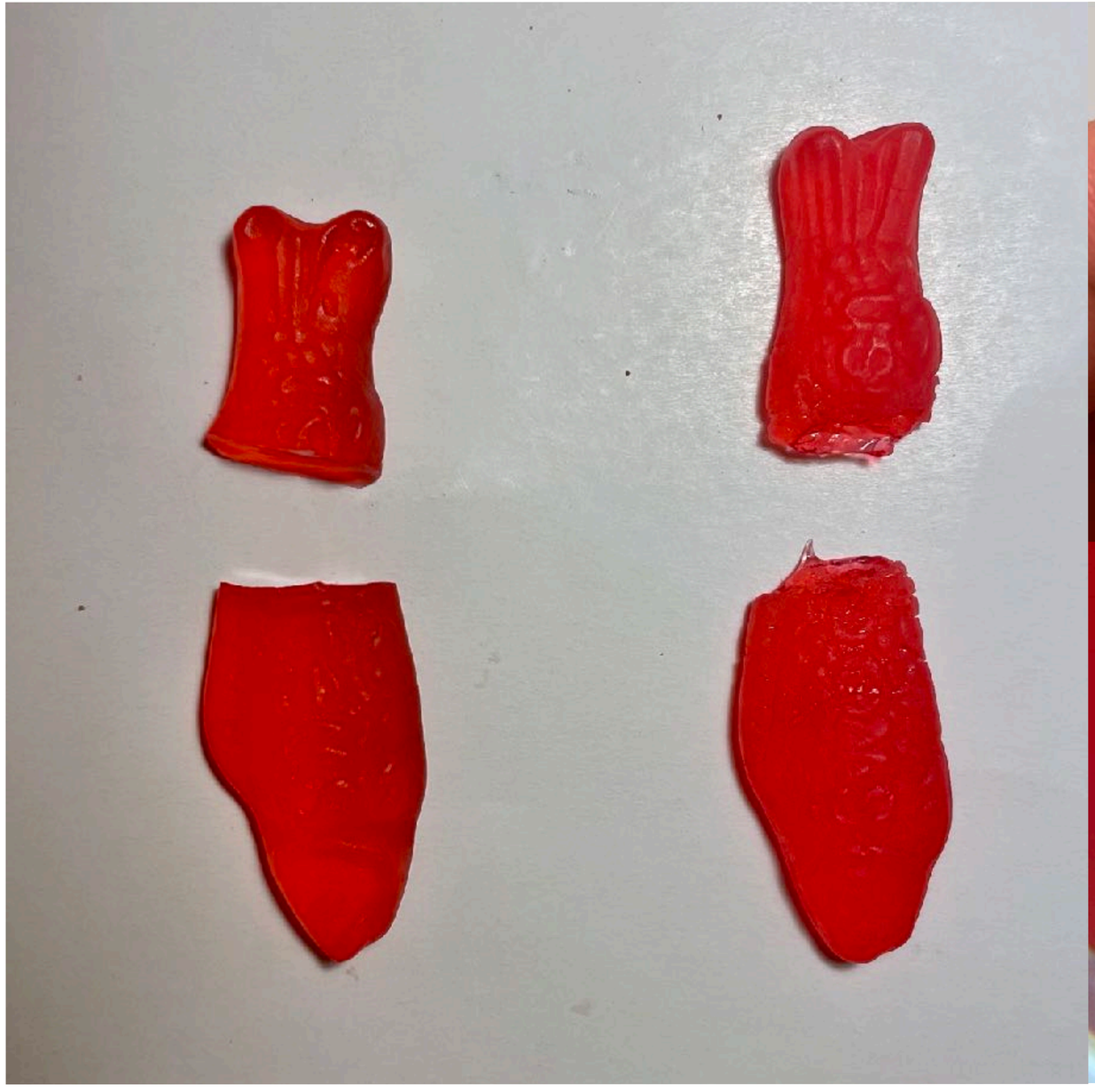
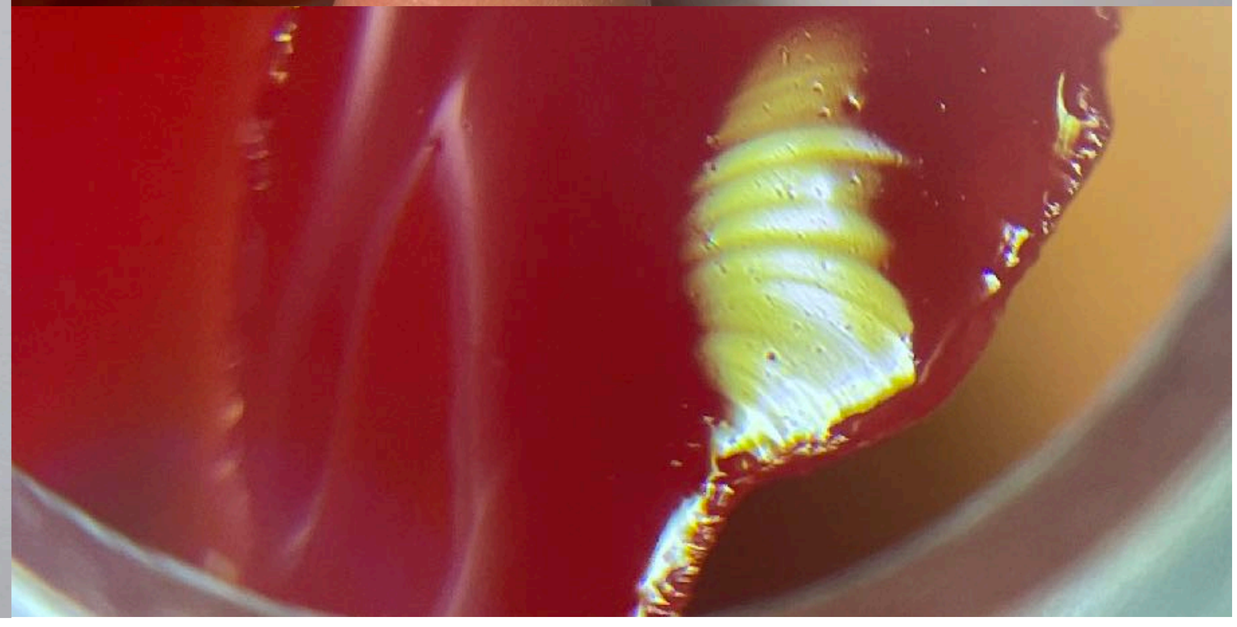


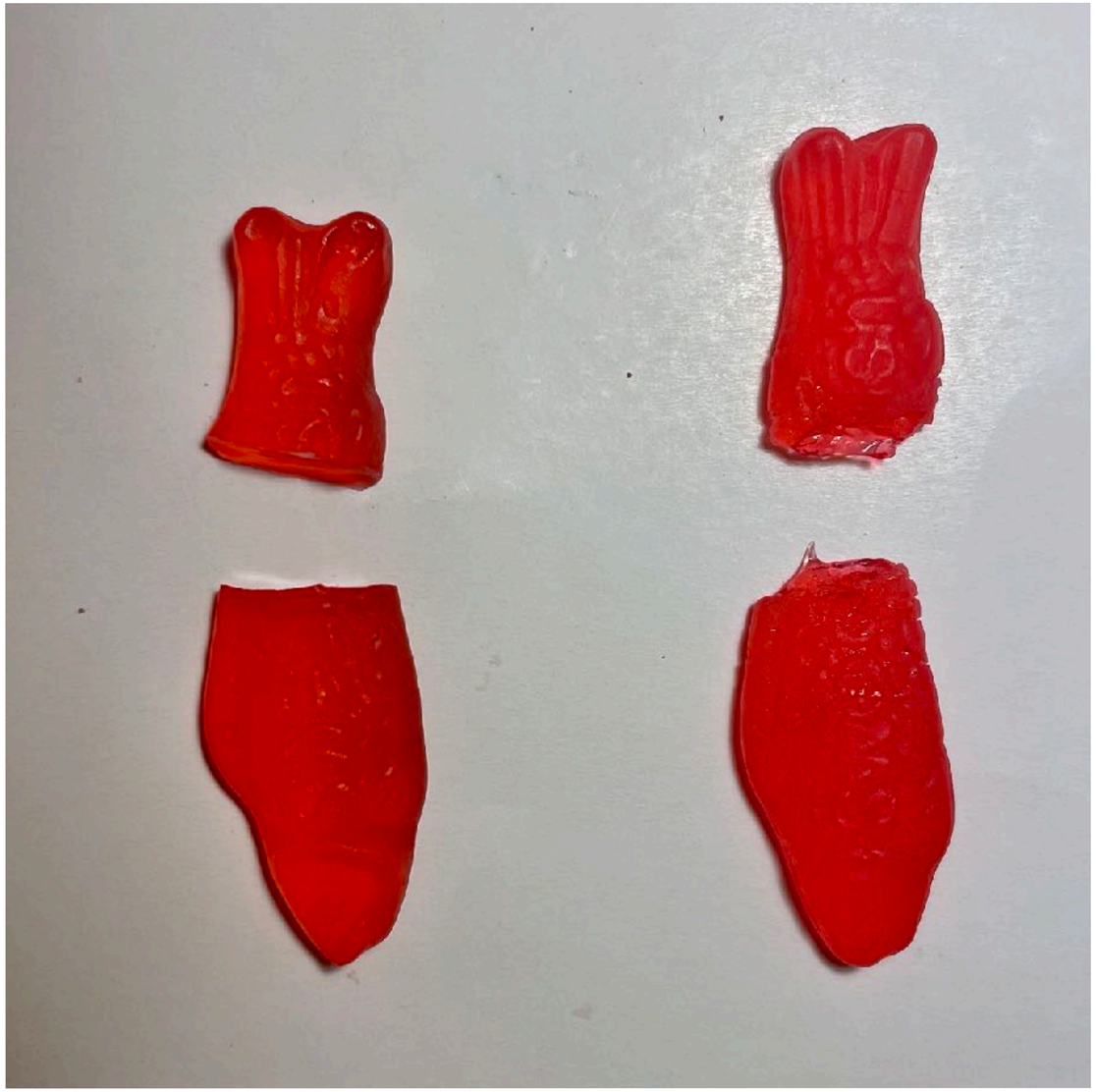
# Failure of Food Experiment Part II


# Procedure

1. Obtain a cold Swedish Fish sample from an EA. Before it gets too warm, break it in half.
2. Again, observe the pieces with your eyes. Pay special attention to the overall shape of your pieces, the surfaces where they broke, and what it felt like when they broke.
3. Use your clip on microscope to observe the fracture at higher magnification.
4. Work quickly!

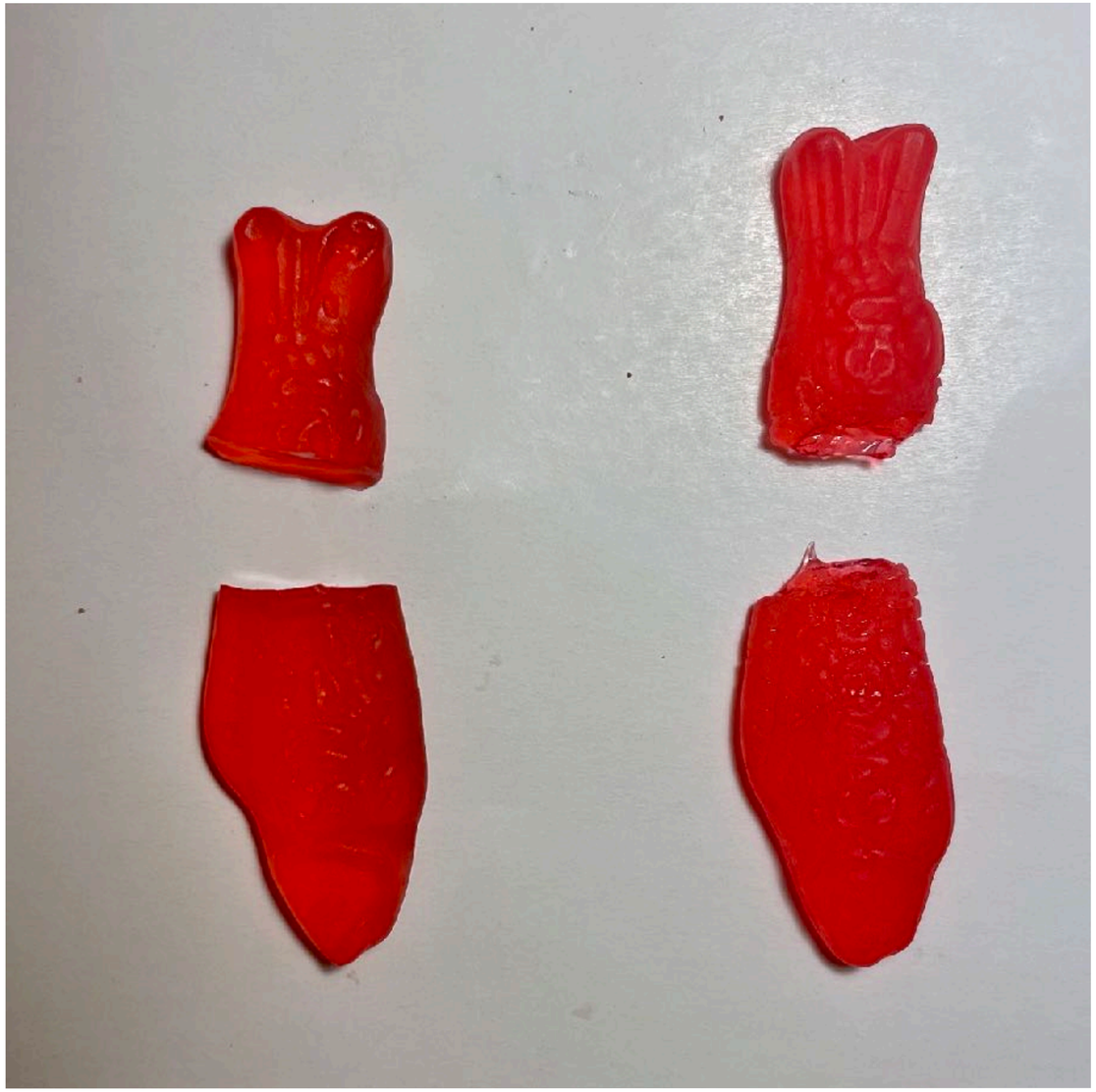






# Observations - Cold Swedish Fish

1. What does it look like at the fracture?
2. How much energy did it take to break?
3. Do we notice any similarities to previous experiments?



# Observations - Cold Swedish Fish

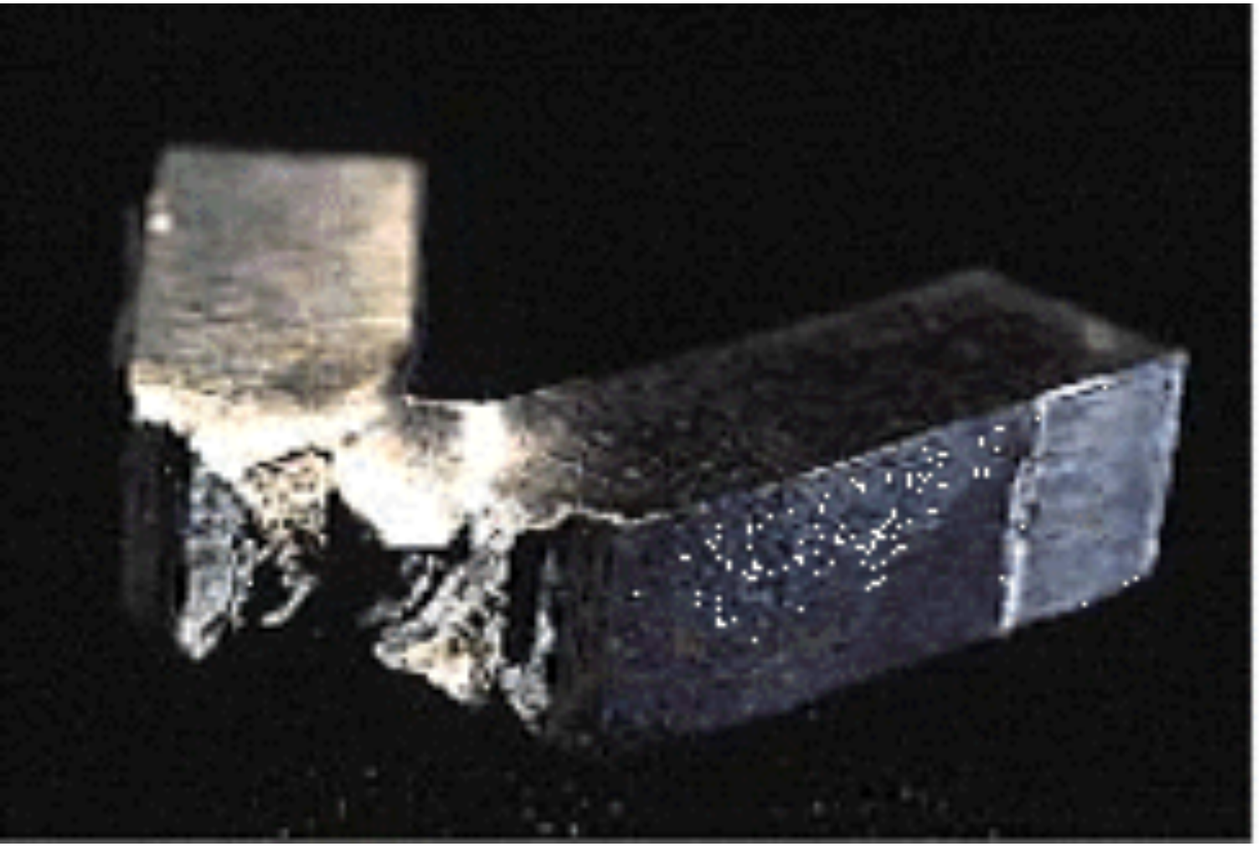
1. The surface is flat
2. It took much less energy to break
3. The Swedish Fish now fails like the Skor bar – it is brittle

# Metal test samples

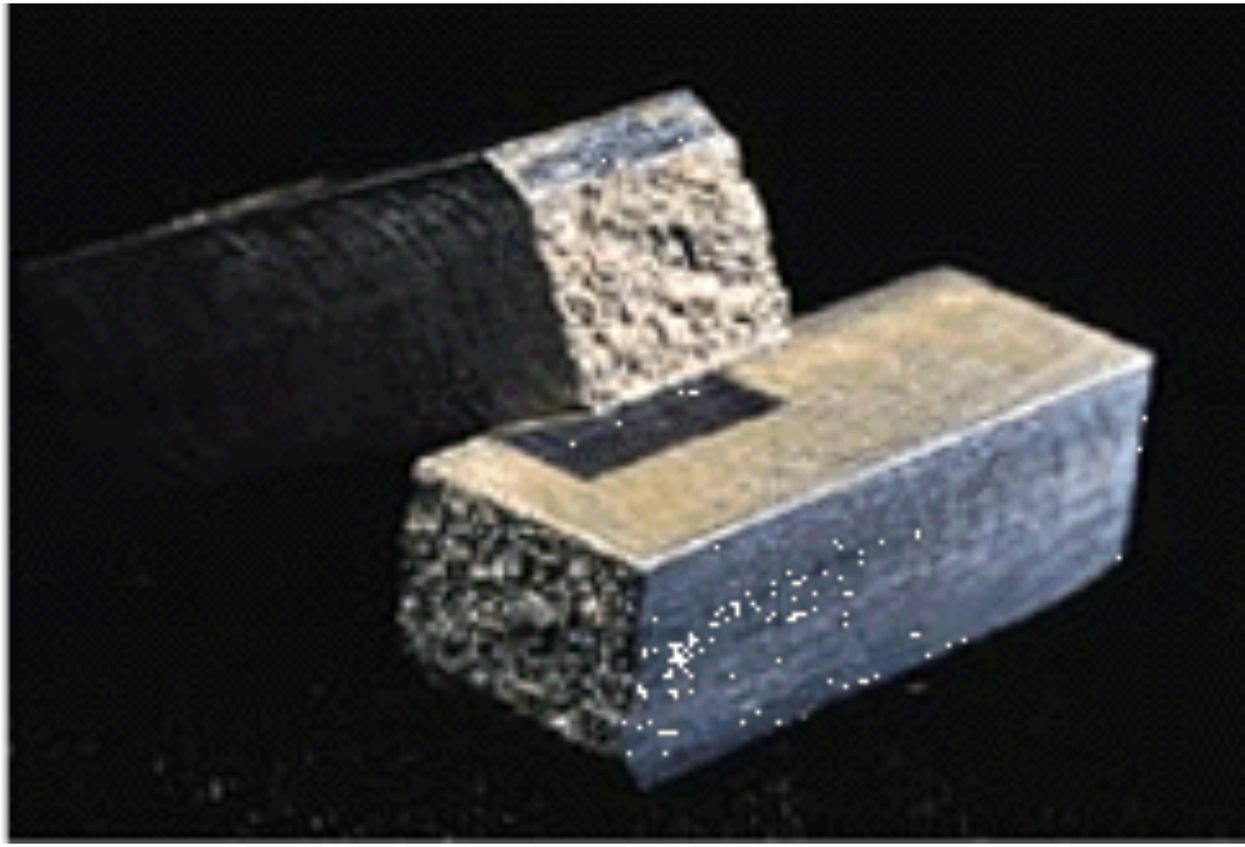
**We’ll pass around metal samples while we present the next section.**

What went wrong?

# Titanic



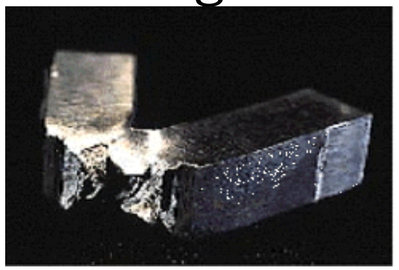
SAMPLE OF MODERN SHIP METAL

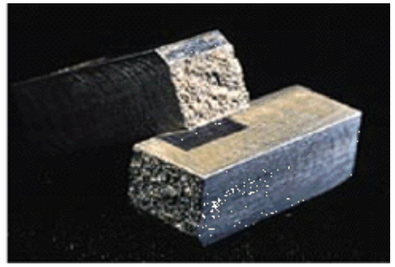


SAMPLE OF TITANIC METAL

# Contributing Factors

- We learned that materials can be ductile or brittle. We also learned that many materials get more brittle when they get cold. Brittle materials take less energy to fracture.
- Samples retrieved from the Titanic show signs of brittle fracture. Designers of the Titanic did not expect the metal to fail brittlely. Scientists at the time had a poorer understanding of metals.
- Modern ships are less susceptible because: They use materials that have lower ductile brittle temperatures, don’t hit ice bergs because of ice patrols, and better designs.

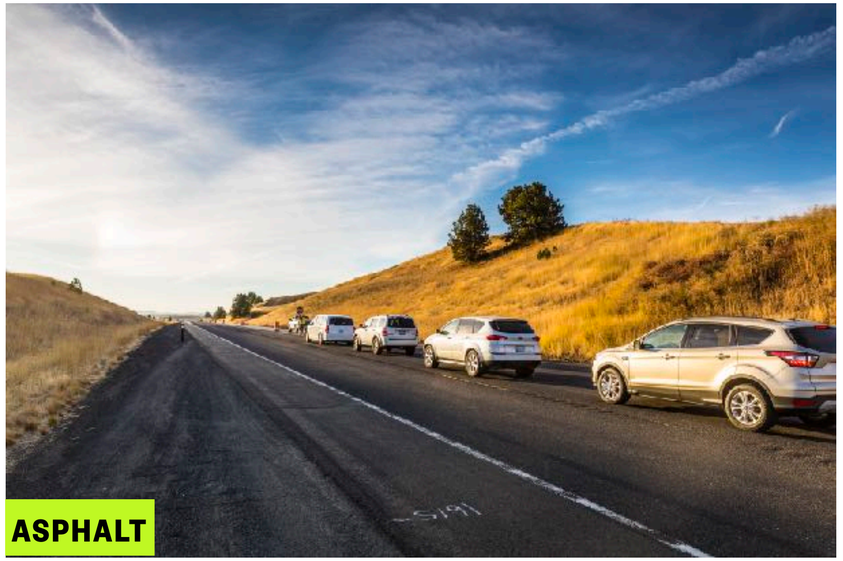




# Using Engineering in Your Life!

# Why Materials Matter

PHONE SCREEN AND PHONE CASE

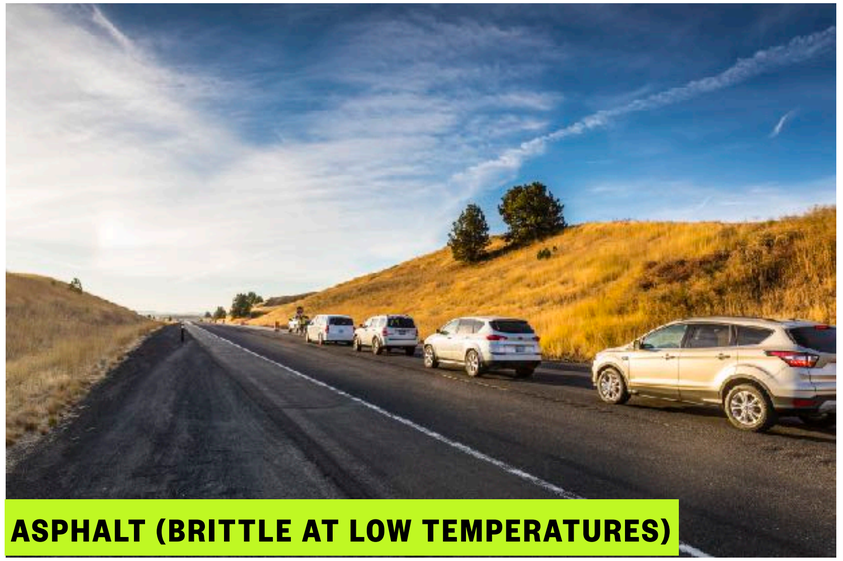


ASPHALT

AIRPLANE LANDING GEAR

# Why Materials Matter

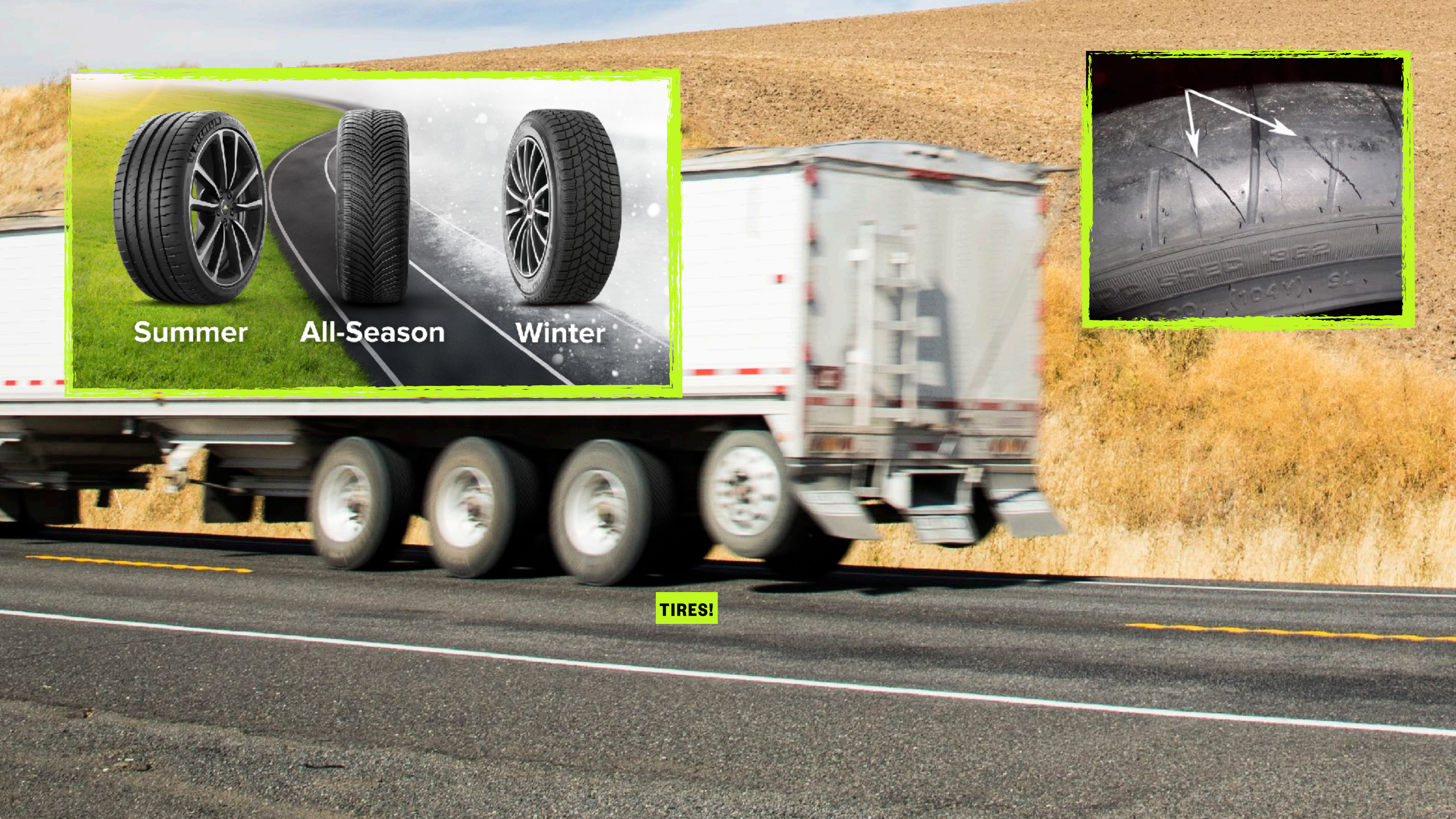
PHONE SCREEN (BRITTLE) AND PHONE CASE (DUCTILE)



ASPHALT (BRITTLE AT LOW TEMPERATURES)

AIRPLANE LANDING GEAR (ALWAYS DUCTILE)


Don't bring memory foam pillows when winter camping 🤦🏻‍♂️😂


Summer
All-Season
Winter
TIRES!


# Thank you!

WE WOULD LOVE TO ANSWER YOUR QUESTIONS NOW.