Lab #6

Impact Testing of Metals

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Objective

In the Impact testing of metals lab, 4340 steel and 7075 Aluminum is tested for the impact energy under different temperature conditions in order to determine the properties of the metal's temperature at ductile to brittle transition temperature.

Equipment/materials

- Intron Impact testing machine
- 2 Steel Specimen (4340 Steel)
- 2 Aluminum Specimen (7075 Aluminum)
- Liquid nitrogen
- Impulse data acquisition software

Procedure

1. To start off, carefully place one of each metal specimen into the liquid nitrogen with a pair of alignment tongs.
2. Calibrate the velocity of the hammer by unlocking the weights and setting up the data collecting software. Pick up one of the specimens and place it into the impact testing machine.
3. Unlock the hammer and start the first trial. Make sure the notch is facing away from the striker.
4. Repeat the impact test for the other 3 specimens, recording the velocities at the times.

Results

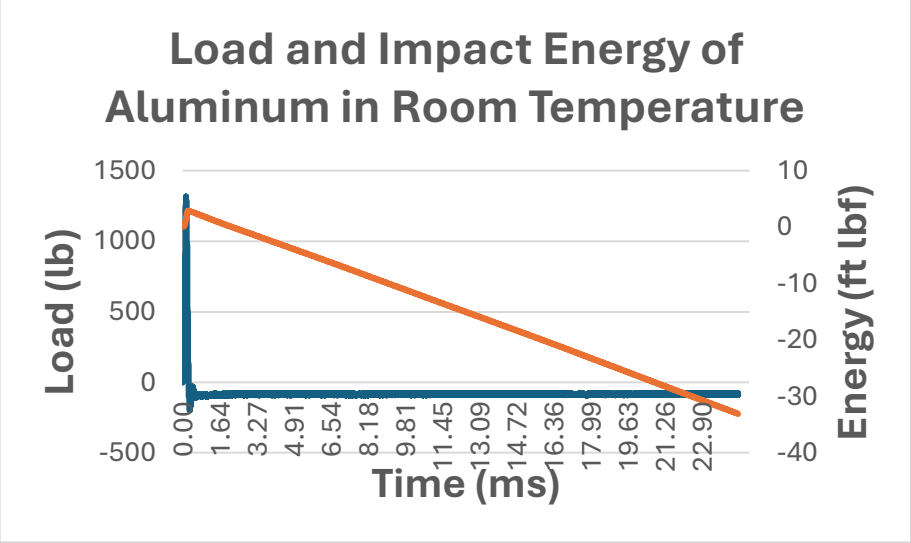

Figure 1: impact Energy and loads over time in the Aluminum specimen in room temperature

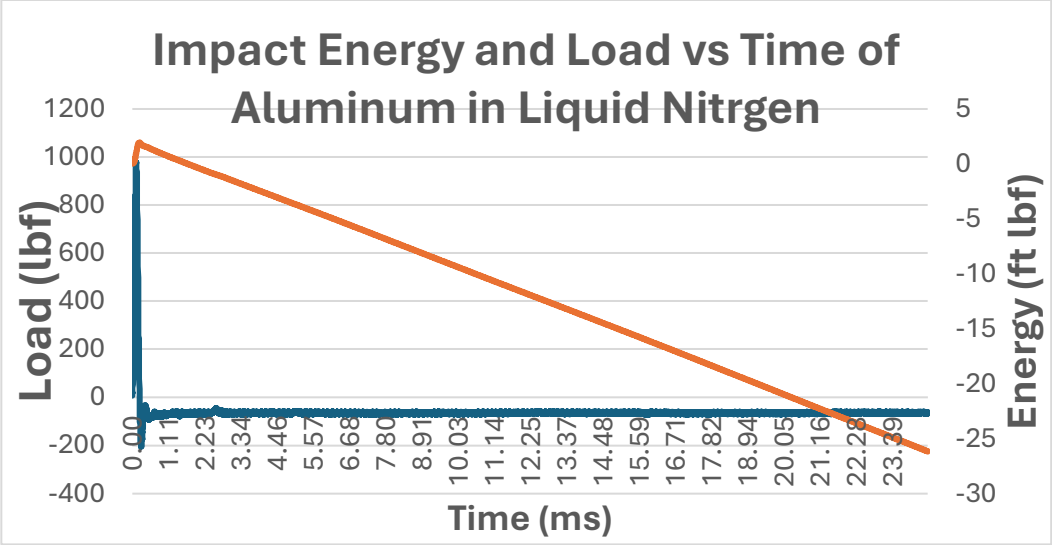

Figure 2: impact Energy and loads over time in the Aluminum specimen in liquid nitrogen

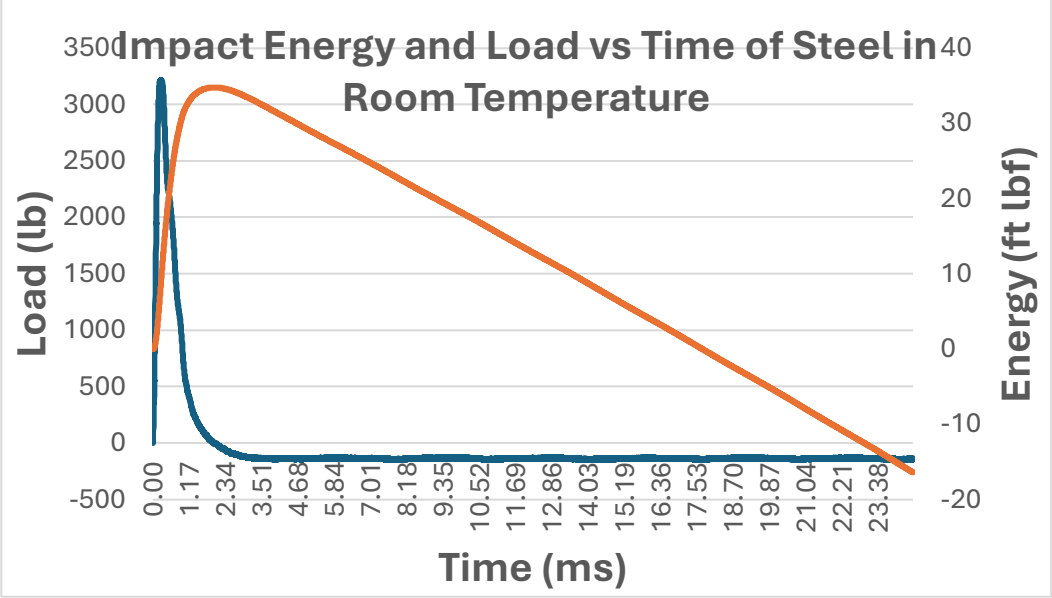

Figure 3: impact Energy and loads over time in the steel specimen in room temperature

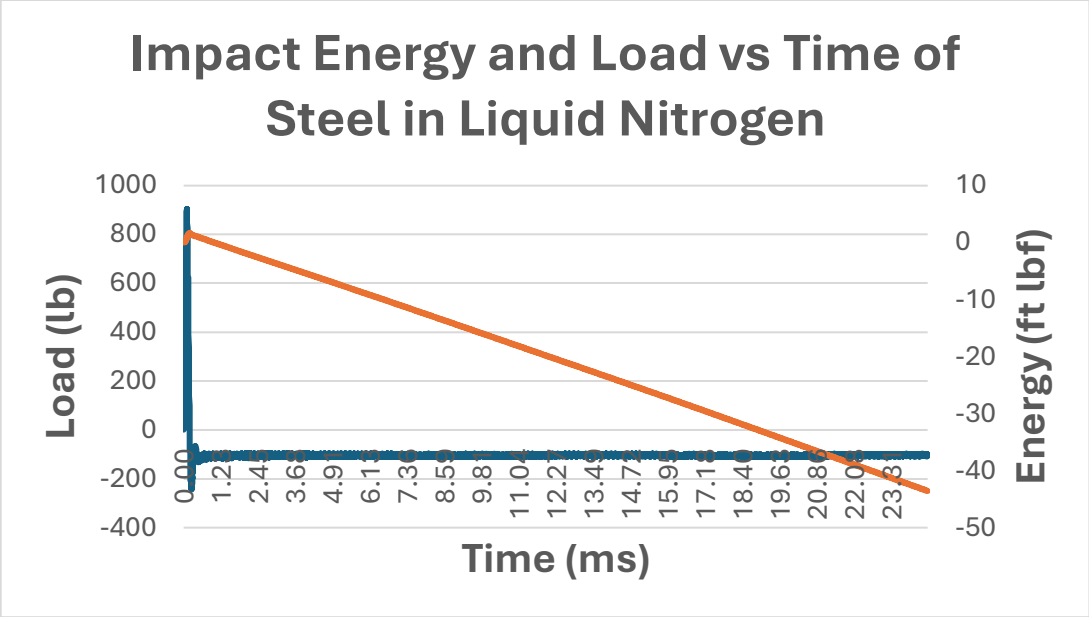

Figure 4: impact Energy and loads over time in the steel specimen in liquid nitrogen

Discussions of Results

It can be observed that the steel, under room temperature has high impact toughness and can absorb a large amount of energy during impacts. Aluminum is seen to be less tough under room temperature conditions. Once the specimens were placed in liquid nitrogen, primarily steel is seen to have a change in the mechanical properties. Steel is seen to become much more brittle and has a lower impact hardness in comparison to aluminum, where it retained most of its toughness. This is due to the ductile to brittle transition that happens for certain materials that can change properties as temperature changes, many of which belong to the BCC crystal structure. For Aluminum, a much more ductile material, they often do not have to be restricted to certain operating temperature as its structure contains more slip systems, allowing for more deformations.

Conclusion

Materials that are generally have less slip systems with a BCC crystal, having high toughness in room temperature may face issues as operating temperature changes due to the ductile to brittle transitions. In such case, temperature is an important factor when working with the material to avoid becoming brittle as it now becomes more unpredictable in failure. Materials which are more ductile are able to have high toughness and may not experience the same ductile to brittle transitions.

Review Questions

1. What is the impact energy?

Impact energy is the energy a material will be able to absorb as a result of an applied loading. Such testing can be done to help determine properties such as toughness and strength.

2. What will affect the impact energy?

Impact energy testing must avoid stress concentration if the goal is to have a more uniform testing, hence the importance of geometry. Other factors include the material's structure which may display more/less ductility. Temperature is in effect for materials that will face the ductile to brittle transitions.

3. How is the impact energy used?

Impact energy is used to determine mechanical properties, usually the toughness of a material. Such testing can help to determine usage of a material to applications where impact is heavy (cars, helmets, building structures.).

4. How do you compare the impact strength of ductile metals (steel and Al) to brittle metals?

Impact strength is much higher for ductile material due to the ability to plastically deform and absorb energy when a force is applied. The deformation the material experiences prior helps to dissipate the energy upon impact.

5. What is the percentage drop in impact strength at the DBTT if there is one?

Impact strength can drop at DBBT based on the material. Such range can be between half to 90%. Such decrease can be due to the inaboli5ty to absorb energy as it becomes more brittle.

6. Is the ductile-to-brittle transition phenomenon observed in all metals? Explain

Not all material experiences the ductile to brittle transition due to the crystalline structure. While certain metals with less slip systems will be susceptible to changes to brittle behavior, more ductile mat3rials will be able to still have dislocations of the atoms in the materials and retaining the large plastic deformations.

References

[1] CCNY ME 46100 Lab Report Preparation, CUNY blackboard website.

[2] CCNY ME 46100 Lab Manuals, CUNY blackboard website.

[3] CCNY ME 46100 Lab Data, CUNY blackboard website.