MEC-E1070 - Selection of Engineering Materials, Lecture, 4.9.2023-13.10.2023

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Grade	**3** out of 3 (**92**%)

Question 1

Flag question Mark 1 out of 1 Partially correct

When a low-carbon steel is austenitized and then slowly cooled to room temperature, the following phases are present:

Select one or more:

- a. carbon
- b. cementite
- c. pearlite ✔
- d. ferrite ✔
- e. austenite

Your answer is partially correct.

You have correctly selected 2.
The correct answers are: ferrite, cementite, pearlite

Question 2

Flag question Mark 1 out of 1 Complete

What is the difference between TTT and CCT diagrams?

TTT (Time-Temperature-Transformation) and CCT (Continuous Cooling Transformation) diagrams are used to illustrate the behavior of material transformation during cooling from a high temperature, typically from austenite above the low critical temperature line.

While TTT and CCT have both y-axis as Temperature (Linear) and x-axis as Time (Logarithmic), they differ in these aspects:

1. Transformation Interpretation:
TTT diagrams represent phase transformations that occur at constant temperatures (isothermal transformations). In other words, TTT diagram is only valid when the steel is cooled very rapidly to a certain temperature, then it is kept at constant temperature. Each phase combination where the horizontal line crosses is where the material turns into when it is heated at the correct amount of time from the x-axis. The phases where rapid cooling lines go through are not counted.

CCT diagrams depict phase transformations that happen during continuous cooling rate (for example: cooling from 700 to 400C from 10 seconds to 100 seconds) instead of rapid cooling and kept at constant temperature like TTT. Each phase combination where the vertical line with a certain slope crosses is where the material turns into when it is heated at the correct amount of time from the x-axis. The steeper the slope, the more rapid the cooling in CCT such as quenching in water.

2. Practical Relevance:

TTT diagrams are suited for theoretical knowledge of phase transformations where materials can be held isothermally.
CCT diagrams are more representative of real-world manufacturing processes where materials are continuously cooled.

This is because continuous cooling rate is much more easier to conduct than rapid cooling and kept at constant temperature

Comment:

Question 3

Flag question Mark 1 out of 1 Complete

What type of aluminum alloys are used in high-strength aircraft structures, and how are these alloys heat-treated?

Owing to its impressive strength-to-weight ratio and other superior characteristics, aluminum has emerged as the favored metal for the aerospace industry. The multiple advantages of aluminum include [1]:

1. Exceptional malleability, facilitating the creation of intricate aerospace parts.
2. Robustness even in conditions of intense stress, as well as extreme pressures and temperatures.
3. Economic viability relative to other metals, attributed to its lightweight property.
4. Higher electrical conductivity

Out of the many series, the 2xxx and 7xxx aluminum alloys are common in high-strength aircraft structures. Particularly, the aluminum alloy 2024 is used extensively for aerospace and aircraft components [1]. It possesses high tensile strength, is treatable, and stress resistant for various applications such as aircraft wings. On the other hand, the aluminum alloy 7075 is used to strengthen aluminum aircraft structures, which has the best machinability and results in a neat finish [2].

How aluminum 2024 is heat treated: 2024 undergoes age-hardening by annealing at 398°-426°C for at least 2 hours, followed by slow cooling in the furnace. The T4 condition is attained by a 494°C heating and cold water quenching. Aging then occurs at room temperature. [3]

How aluminum 7075 is heat treated: 7075 is processed in T6 treatment. The first process is heat treatment in 480ºC for 2 hours, followed by rapid quenching. After this process, the aluminum alloy has process in ageing step 121°C for 24 hours. [4]

[1] https://www.howardprecision.com/what-is-aerospace-aluminum-aluminum-alloys-used-in-the-aerospace-industry/#:~:text=Alloy%202024%20–%202024%20Aluminum%20alloy,%2C%20aircraft%20wings%2C%20and%20repairs.

[2] https://www.experimentalaircraft.info/articles/aircraft-aluminum.php

[3] https://www.speedymetals.com/information/Material53.html#:~:text=2024%20is%20an%20age-hardening,10%20hours%20and%20air%20cooling.

[4] https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjs9rDluqKBAxUFJRAIHbyxDJ8QFnoECA0QAw&url=https%3A%2F%2Fpubs.aip.org%2Faip%2Facp%2Farticle-pdf%2Fdoi%2F10.1063%2F1.5024116%2F14153519%2F030057_1_online.pdf&usg=AOvVaw1LngTzMeuMr_7R5GT2d1OO&opi=89978449

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