UCL Mechanical Engineering
MECH0015 TTT & MVC Quiz Questions

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1 Why does the tensile strength of a steel drop with carbon content after the eutectoid composition is reached?

During cooling, we can form three different phases when we vary the carbon content around 0.8%. Let us consider a case when we cool three samples with carbon content 0.4% C, 0.8% C and 1% C from 900 °C to 723 °C.

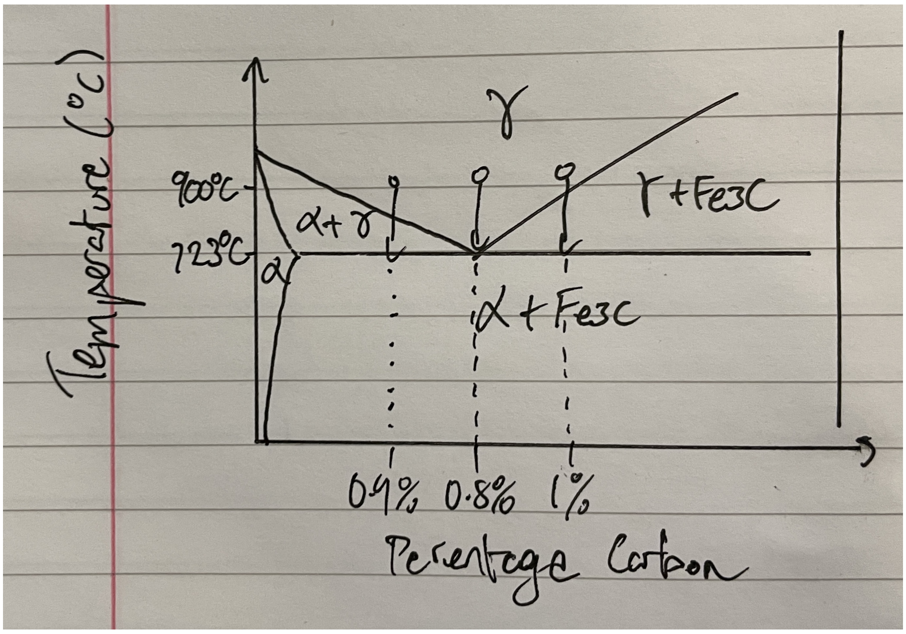

Figure 1: Diagram showing cooling process.

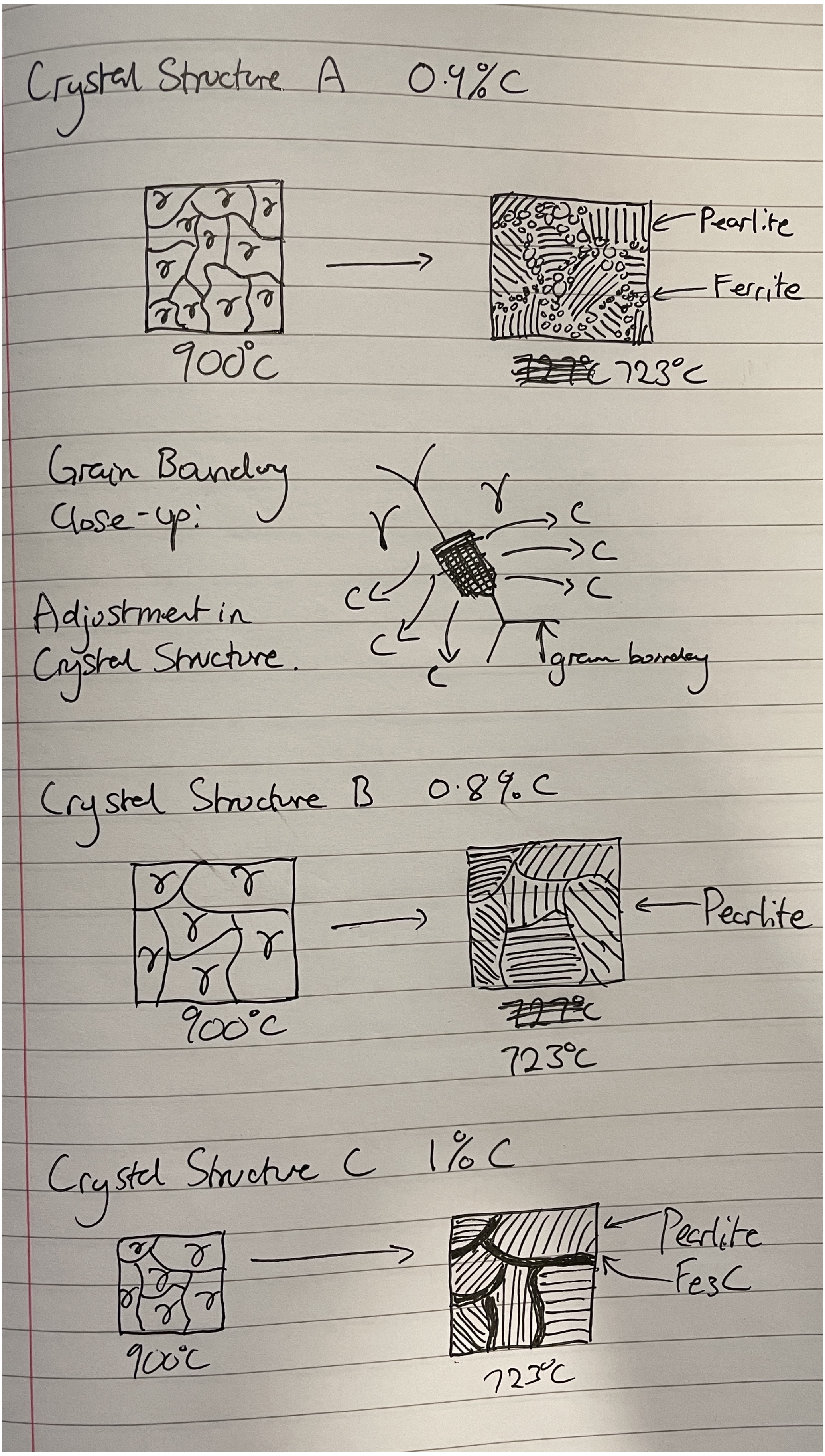

Figure 2: Diagrams showing how crystal structure changes with cooling from 900 °C to 723 °C for 0.4%, 0.8% and 1% carbon content.

For 0.4%, we can see the emergence of α forming at the grain boundary. This adjusts the crystal structure to form BCC areas and carbon must move away, enriching the γ regions. This then converts the remaining γ into pearlite as temperature decreases. With increasing carbon content, tensile strength increases as the pearlite is saturated (until 0.8% carbon content is reached) as dislocations become more difficult in the microstructure.

For 0.8% carbon content, the crystal structure forms a 100% pearlite crystal structure. This structure is tough as the pearlite is saturated with carbon and there is a fine grain boundary with no formation of α or Fe_3C.

For 1% carbon content, we see a conversion of some of the γ into Fe_3C at the grain boundary, leading to embrittlement. We know that γ saturates at 0.8% carbon content, so carbon moves away from γ to form pearlite and Fe_3C at the grain boundaries (which has a higher carbon content), coating the pearlite crystals. This has the consequence that due to the positioning and location of the primary Fe_3C, the whole steel exhibits the toughness of Fe_3C. This toughness is lower than that of 100% pearlite and hence is undesirable for tensile applications and should be avoided.

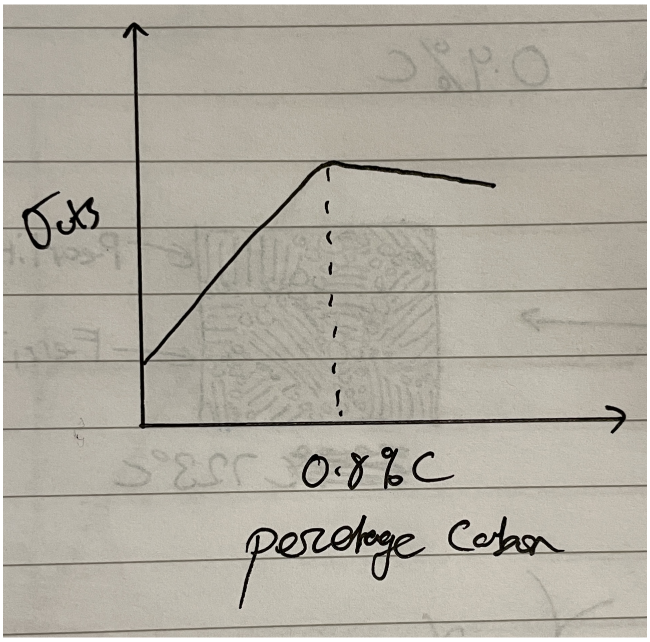

Figure 3: Diagram showing how tensile strength varies with carbon content.

2 **Show that the area under the stress strain curve is equivalent to the elastic stored energy (in a stressed material). What part of the stress strain curve do you need?**

3 **Why is a process anneal (or stress relief anneal) not usually applied to steels above about 0.4% carbon content?**

4 **Which way do we connect up the power supply in an impressed current cathodic protection scheme and why - and why should we still consider painting the buried pipelines as well (in addition to cathodically protecting it)?**