metals 27 03 forth cut

can draw essentially, more or less, the same plane. What you see in there, in the figure in there, is the example in the case where we are essentially at compositions which are of the eutectoid. So in many cases, my alloy is not exactly at the eutectoid composition.

It can be a little bit to the left or to the right from the base diagram. In this case, we call them hypo- or hyper-eutectoid alloys. And what happens is that typically, if you have a hypo-eutectoid alloy, you have nucleated already some ferrite at the grain boundaries.

So you have already some ferrite at the grain boundary. And later on, when you reach, essentially, you nucleate the ferrite at the grain boundary, typically here in this region. And then when you reach the eutectoid horizontal line, the eutectoid temperature, you start forming the pearlitic microstructure in the way that you see here.

So you have already some ferrite at the grain boundary. On top of it, you nucleate cementite. And then you have the growth of the colony, like we have seen, essentially, earlier.

So the mechanism that we have. If it is a hyper-eutectoid alloy, it's just the other way around. So you have already some cementite in the microstructure at the grain boundary.

And the colony will start, essentially, forming in a similar way. We're just nucleating some ferrite on top of the cementite. Diffusion, as always, can be somehow enhanced.

So diffusion mostly happens in the matrix. But if there are some other defects that can somehow act as, essentially, a preferential path for diffusion, they can also play a role. So other defects in this location, in this case, more other interfaces, can act as a faster, essentially, path for carbon diffusion and somehow speed up the overall process, the growth process.

The transformation can be described in terms of using, as we know now, the TTT curves. The TTT curve, in this case, is the picture that you see here, where, essentially, you have the typical two curves for the beginning and the end of the transformation. So here is austenite.

It's above this temperature, which is the A1 temperature, the eutectoid temperature. Nothing happens. These TTT curves refer to the exact eutectoid composition.

And, essentially, if you are, essentially, at any of these temperatures, you wait for long enough, you will start, after a certain time, to form the ferrite. And when you cross, again, the second line here, you end the transformation, and you have, essentially, the overall liquid in the matrix structure. The maximum rate for ferrite is happening.

For the eutectoid transformation in iron carbon in the bionic system, it happens at 550 degrees. Notice that we have some other lines in the lower part of this curve, which refer to bainite. This is another microstructure, essentially, that we can have if we go, essentially, to lower temperatures.

If we manage somehow to go to lower temperatures, without starting the formation of ferrite, we have the formation of this other microstructure that is called, essentially, bainite, and that we will discuss, essentially, better in the next slide. If we cool down even faster, you notice that here there is an horizontal line, which is with the label, essentially, MS. This is the martensitic start temperature at which you start forming another phase, which is a metastable phase, which is called martensite. So, basically, here, from this TTT curve, for the eutectoid composition in iron carbon, you see that you can have, actually, different final microstructures depending on how fast you cool your system and for how long you keep it at a certain temperature.

If you keep your system at a higher temperature, here, below the A1 temperature, somewhere in this region here, you will get pearlite. If you lower the temperature of your system in this region, above the MS temperature, you will get bainite. If you cool your system very fast and you go below the MS temperature, there, at the horizontal line, you will get, essentially, martensite.

For the martensitic transformation, we will have, essentially, a later lecture in which we will discuss all the details about this transformation, but everything is somehow summarized in this TTT diagram here. This is for a eutectoid composition, binary iron carbon. If you change the composition, of course, things will change and also the TTT diagram will change.

You see how they actually change, essentially. You can understand how they change referring to this diagram here. This is essentially the phase diagram of iron carbon.

These are the usual lines. This is the eutectoid point, the horizontal eutectic line. These are the liquidus lines.

So, not liquidus, sorry, because here we have gamma. Essentially, this is the gamma field. Here we have gamma plus alpha and here we have gamma plus semitide.

Typically, we don't have this extrapolated line, but I'm telling you, essentially, what they mean, essentially, now. These are, essentially, extrapolations of these two lines, down in time. Which is the meaning of this extrapolation line, extrapolated line? Take a specific composition, the one that you see in this vertical line here.

So, in this vertical line, if the composition of your system is this one, when we go from gamma, when we go down from gamma, essentially, below this line, we can form alpha from gamma. So, thermodynamically, essentially, here it is favorable to obtain alpha from the gamma mechanism. If we go even below this other temperature, which is a temperature which, for this composition, we cross this extrapolated line, below this line, we can not only form alpha, but also semitide.

Because, essentially, you see, below this line here is where you expect to form semitide from gamma. So, below, essentially, this extrapolated line, even for this composition, I'm expecting, essentially, down here, that both the formation of semitide and alpha are thermodynamically favorable. And this is essentially where you can form, if you somehow manage to pull the system down to this temperature, without forming alpha in here, if you get here, essentially, without anything happening here, you can get perlite without any pro-eutectoid perlite, even for this composition, which is off-eutectic.

And this is essentially what you can see in this TTT diagram, which is corresponding to this plot in this grid. So, if you somehow, your phase transformation happens in here, you will get first alpha, gamma plus alpha, and only later on, perlite. However, if you manage to get quickly enough down to this temperature, you might form, essentially, directly perlite.

I think I've gone a little bit over time. So, we'll continue next time, essentially, with the binitic transformation and the other transformations. Any questions?