**Introduction to Materials Science and Engineering**
**Prof. Rajesh Prasad**
**Department of Applied Mechanics**
**Indian Institute of Technology, Delhi**

**Lecture - 70**
**Composition of phases present in the system**

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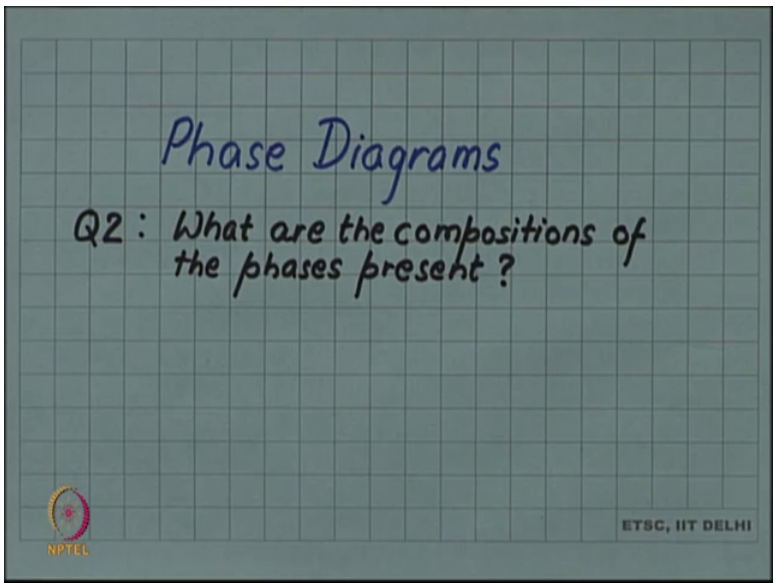


Let us now take up the second change in our list, that what are the compositions the phases present. Recall the first question was; what are the phases present. So, once we have answered that question, we know what phases are in equilibrium at a given composition and at a given temperature in the alloy.

Now, once we know the phases the second question we want to know the answer to is; what are the compositions.

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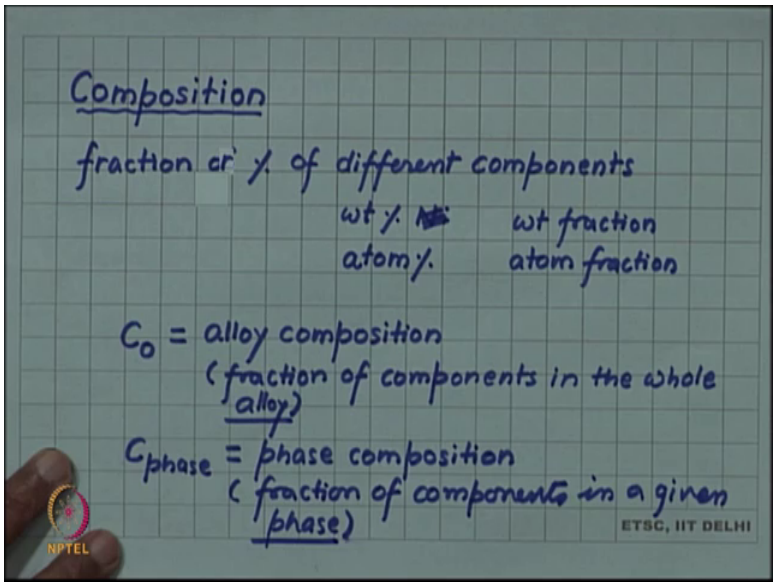


And by composition we mean fraction or percentage of different components is what is called composition. So, we have seen that in our binary alloy or a binary phase diagram, we will have two components. So, the fraction of those two components or the percentage of two components is called the composition.

You have already seen in the examples, we were using the weight percent nickel as our composition axis. But fraction or percentage can be given either in weight percent as we were doing for the copper nickel diagram or it can be given in atom percent also. So, weight percent or atom percent or weight fraction weight fraction an atom fraction.

These two ways of representing composition is there, and also it is important to distinguish may sometimes for beginning a student this creates some confusion, there are two kinds of composition which we are talking about one is usually designated at C naught and this is the alloy composition. So, this is the fraction of two components in the overall alloy, the whole alloy.

Another composition is composition of the phase or the phase composition and we will see that these need not be the same, unless and until the alloys single phase these two will not be the same. So, phase composition is fraction of components in a given phase. So, one is in the alloy and one is in a given a phase this one has to keep in mind.

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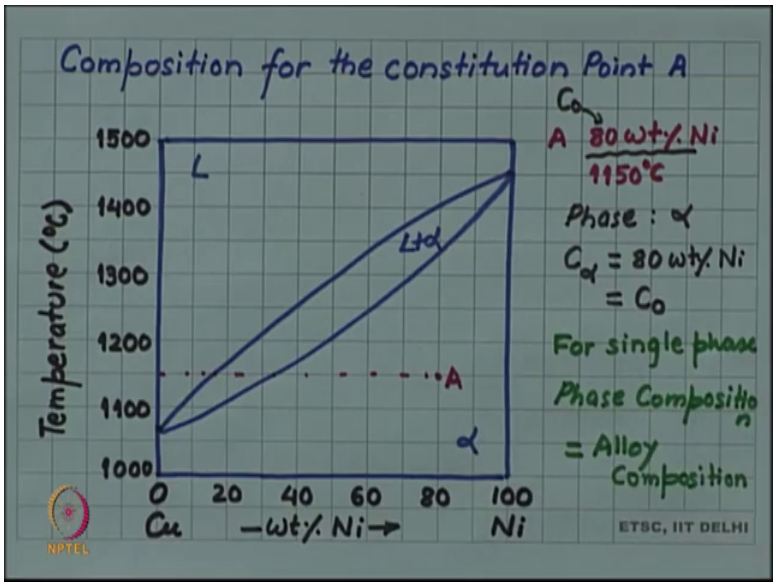


So, let us again begin with as an illustration, begin with our phase diagram which we have already become quite familiar by now and let us consider point in this phase diagram. So, let me take a point here. So, this point represents an 80 percent alloy. Point A 80 weight percent nickel at a temperature of 1150, and we have already seen that what were the phases present in this alloy the phases present was alpha.

So, we can read this from the phase diagram the phase present is alpha. Now the current question is what is the composition of this phase, which means what is the proportion or fraction of copper and nickel in alpha, this I will designate as composition of the alpha phase C alpha and since we are using weight percent nickel as our composition axis, I would like to tell how much weight percent nickel is present in alpha.

But since this is a single phase alloy, entire alloy is consisting of alpha. So, whatever is the composition in the alloy is the composition of the phase. So, C alpha is very easy here is 80 weight percent nickel is same as C naught the alloy composition this was C naught.

So, for single phase this will be a general rule that, for single phase at the phase composition phase composition is equal to alloy composition for the obvious region that the entire alloys of the same phase. So, whatever percent nickel is in the alloy is also there in the given phase alpha.

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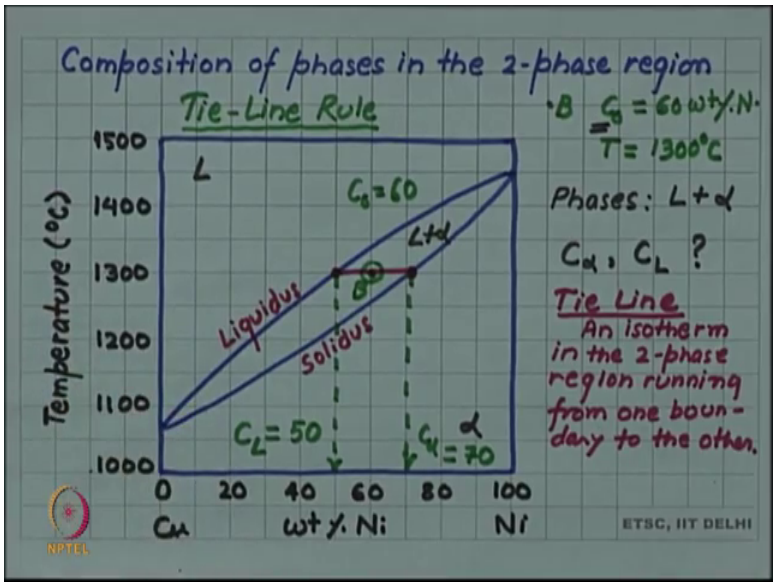


And the situation becomes interesting if you are having the alloy in the two phase region.

So, if you have let us say an alloy point there. So, now, let me call that point B point B. So, the alloy composition is 60 weight percent nickel read on the x axis and the temperature on the y axis 1300 degrees Celsius. So, that is the point of my interest. So, first of all I will of course, like to find out what are the phases and if you recall this was liquid region, this was all for region and this lens is a two phase region liquid plus alpha.

So, the phase is present in liquid and alpha. Now the second question is what are the composition of the phases. I know the composition of the alloy C naught, but what is the composition of C alpha of the alpha phase C alpha and of the liquid phase CL are they also 68 percent nickel?

The answer is no. The proportion of the components the redistribute when you have an alloy of in two phases and this is obtained by what is called a tie line. Let us draw a tie line tie line is nothing, but a horizontal line in your phase diagram in the two phase region an isotherm in the two phase region running from one boundary to the other.

So, this is a tie line very important line in phase diagram for answering this kind of questions. And once that since the tie line runs from one boundary to the other boundary remember at one point it is hitting the liquidus boundary that is boundary on the liquid

side. And at another point it is hitting the solidus boundary that is boundary on the solid side.

Now, the two compositions which I am looking at C alpha and C liquid can be directly read as the x components. So, the composition value of these two endpoints. So, if I come here, I find that I am at fifty weight percent nickel and this is the value of C liquid because see that this point is on the liquid side.

So, the liquid endpoint of the tie line will give me the liquid composition, which is 50 weight percent nickel and similarly the solid end of the tie line will give me the composition of the solid phase in this case the alpha phase. So, C alpha which is 70, 70 weight percent nickel

So, sometimes we can call this we can give a name to this rule as tie line rule. So, although note that although the alloy C naught was 60 weight percent nickel, but then it got decomposed into two phases liquid and the solid, liquid and alpha, but liquid has less nickel in the liquid phase and only 50 weight percent nickel. Of course, since the alloy is having 68 percent nickel the other phase has to have more nickel to get an overall composition of 60.

So, liquid has 50 weight percent nickel less than the alloy of composition, but alpha counterbalance is that by having more nickel 70 weight percent nickel. So, in the two phase region the phase composition is not equal to alloy composition and is given by the tie line rule.