Introduction to Materials Science and Engineering

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Lecture - 67
Phases and components

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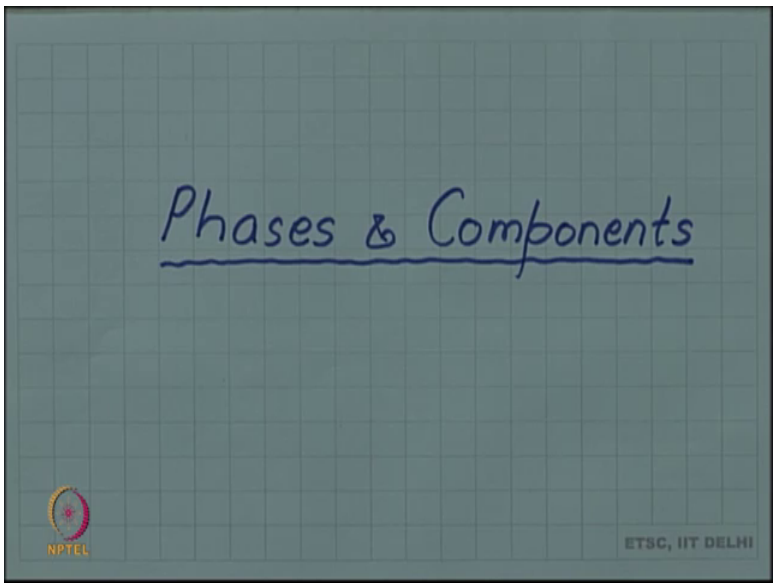

So, we have started discussion on phase diagram, but we have not yet defined phases and components properly. So, let us make an attempt to define these terms which are useful in discussion of phase diagram.

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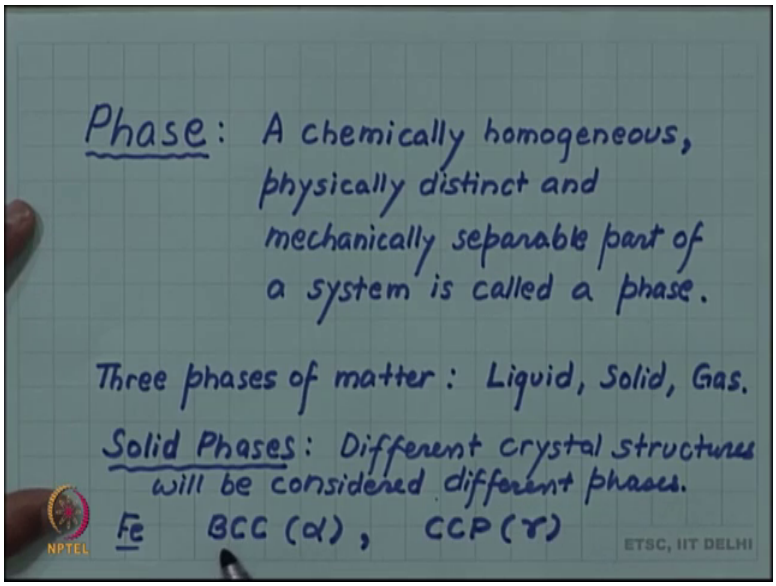

First let us define phase what is a phase? So, a phase is a it is difficult to define anyway.

But we are making an attempt, at chemically homogeneous, physically distinct and mechanically separable this is a traditional definition which is given, mechanically separable part of a system is called phase, so this sort of working definition, which we will be using for phase. So, you have already seen or we know that there are three phases of matter three phases.

So, they can occur in our phase diagram; liquid, solid and gas but from phase diagram perspective solid is not just one phase, they can be more than one solid. So, we will have solid phases and what we will mean by solid phase is that different crystal structures will actually be different solid phases.

We will be considered different phases now already mentioned in the last video that the solid phases in phase diagrams are traditionally shown by Greek letters. So, an example I would like to give here what I mean by different crystal structure considered as a different sort solid phases a good example is that of iron.

So, iron at room temperature is body centered cubic and that is considered to be the alpha phase of iron. But at high temperature it will be cubic close packed and this is considered to be the gamma phase of iron. We will spend quite some time later on the phases in iron

and in iron carbon system, which constitutes steel which is an important engineering alloy.

But for the moment just to emphasize what we mean by this phrase the different crystal structure will be considered different phases. So, both BCC iron and CCP iron both of them are 100 percent pure iron. So, in terms of chemical composition they are not different, in terms of solidness or solidity also they are not different they are both solids both crystalline solid, but the crystal structure is different. So, they will be considered different phases from the point of view of phase diagram.

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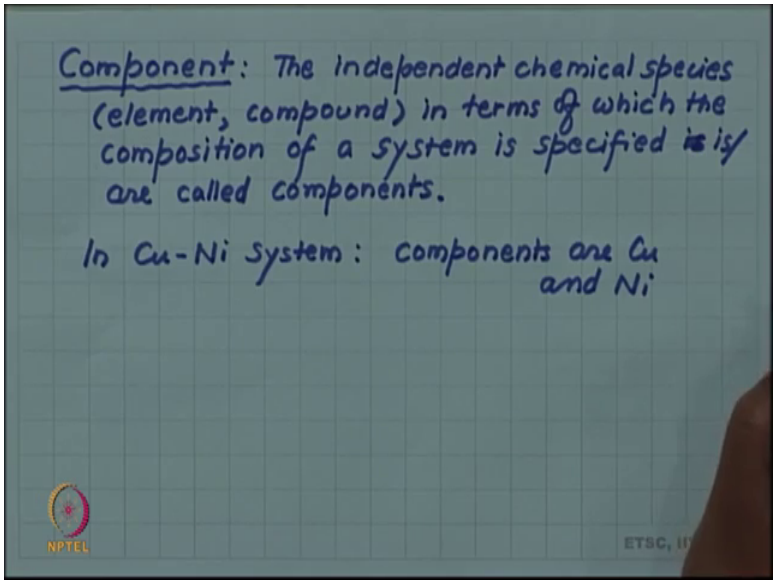

Another important terminology in the phase diagram is the component. So, let us define component. So, we will define component as the independent. Independent chemical species and the chemical species can be either a pure element or sometimes it can be compound the independent chemical species element or compound in terms of which the composition of a system of a system is a specified or is or are depending on whether it is a single component called components.

So, for example, in copper nickel system, the composition will require to give the proportion of copper and nickel. So, in the copper nickel system the example which we considered copper nickel system, the components are copper and 0 nickel. So, the diagram which we had was a two component diagram.

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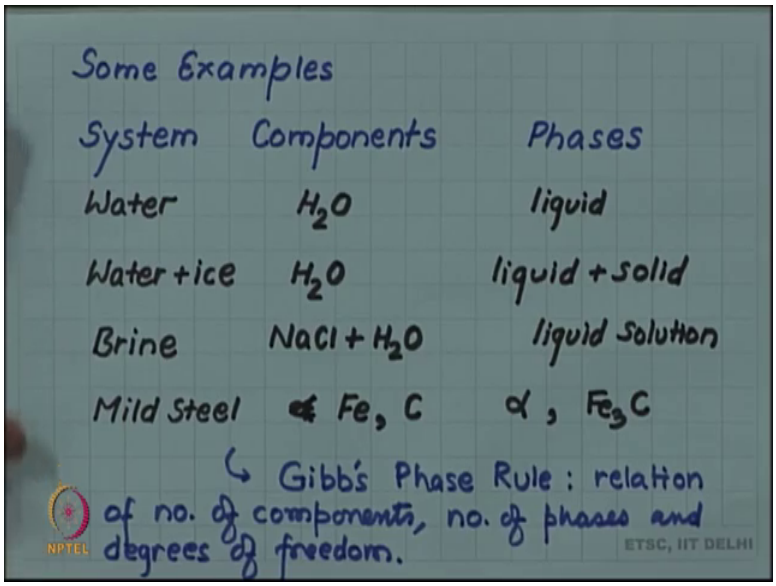

Let us look at some more examples, we have already described components let us look at some more examples. So, let us consider water. Now water of course, you know is compound of hydrogen and oxygen. But hydrogen and oxygen appear always as one combination and that is two hydrogen atoms, two one oxygen atom.

So, this composition is fixed you cannot vary that. So, in water you cannot vary the ratio of hydrogen and oxygen. So, you will consider it as only one single component. So, the component itself is a compound or the molecule compound H 2 O. So, this becomes the component and phase is just one phase which is water, so the liquid phase. So, you liquid as you are free. So, it is an example of a single component single phase system.

But suppose you have ice floating in water, you have a water ice combination then both water and ice are still composed of H 2 O. So, still you have single component, but now you have two phases liquid plus solid. So, this is an example of a single component, but two phase system. Let us consider brine which you know is solution of sodium chloride in water.

But you can change the ratio of sodium chloride to water. So, the composition can be varied with respect to sodium chloride and water. So, that is why you have two component but you cannot vary the ratio of sodium to chlorine or hydrogen to oxygen. So, it is not a four component system it is a two component system in which you can

vary sodium chloride to water. So, it is a two component system, but the whole thing is one single solution.

So, you have a single liquid phase, which is a liquid solution. Let us take an engineering example mild steel in the mild steel the components are iron and carbon. So, there are two components because you can vary the percentage of carbon in the alloy. So, iron and carbon are the two components, but phases you will find that in mild steel at room temperature, you have two phases one is the alpha phase and another is a compound Fe 3 C. So, it is a two component two phase system.

So, you can see that the components and phases can vary of course; there are constraints on this variation, which gives us rule which is called the Gibbs phase rule, which we will have opportunity to discuss later. Relation of number of components number of phases and something called degrees of freedom we will talk about that later, this we will discuss later I am just mentioning it here.

So, you can have single components single phase system single component two phase system, two component one phase system and two component two phase system.

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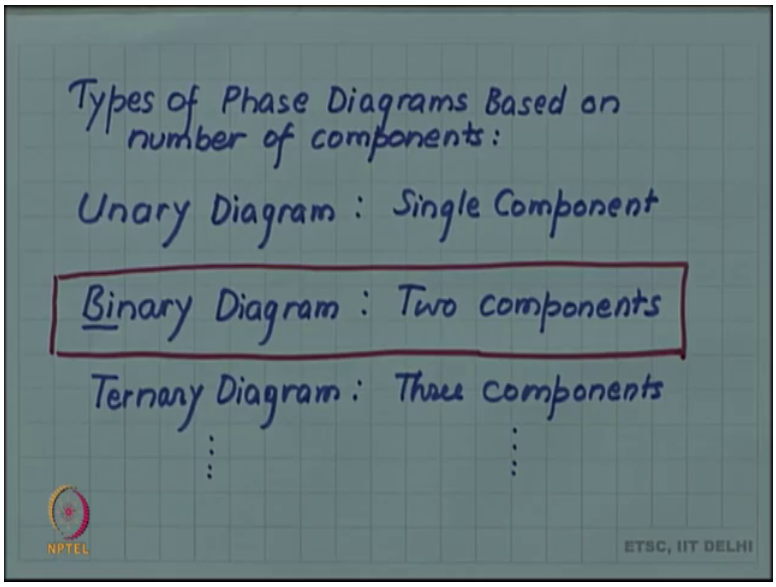

So, different kinds of phase diagrams are possible and there is a nomenclature based on the number of components the phase diagram. If you have a single component phase

diagram for example, one can talk of phase diagram of water we are not going to pay much attention.

So, then you call such diagram as a unary diagram. So, unary diagram single component suppose you are talking about phase diagram of water only when it is ice water or vapour as a function of temperature and pressure. So, you will have a unary diagram the example of copper, nickel, which I gave you was an example of a binary diagram or a binary phase diagram binary as you know means two. So, it is a two component.

Two components are involved then we call it a binary diagram. In a ternary diagram three components will be involved and of course, you can have higher order phase diagrams quaternary involving four components and so on. But in this course we will mainly focus on this binary two component diagram.

So, our main attention will be focused on two component binary phase diagrams. So, with this we end this video.