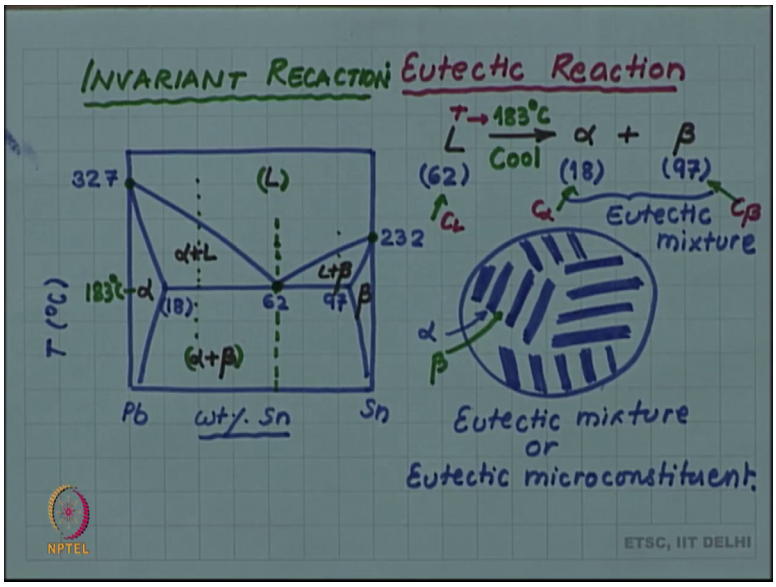
Introduction to Materials Science and Engineering
Prof. Rajesh Prasad
Department of Applied Mechanics
Indian Institute of Technology, Delhi

Lecture – 74
Eutectic Reaction

Let us discuss Eutectic Reaction. This is an important reaction associated with the eutectic phase diagram, which we are discussing.

(Refer Slide Time: 00:17)



Recall that we discuss as an example of eutectic phase diagram, a lead tin phase diagram, which is shown here so, you have a liquid phase, you have 2 solid phases 2 different solid phases alpha and beta. And then by 1 to 1 rule, you have these regions alpha plus liquid liquid plus beta and alpha plus beta. We also talked about that this 62 weight percent alloy, is a very special alloy is a very special alloy because; it melts at a lowest melting point. So, that is why it is called a eutectic alloy an easy melting alloy. Now, this alloy although all other alloys will melt over a range of range of temperatures, this particular alloy melts at a unique temperature, just like pure elements. So, the pure lead melts at 327, pure tin melts at 232 and a lead with 62 weight percent tin alloys, will also melt at a fixed temperature and that temperature is 183 degrees Celsius which we call the eutectic temperature.

If we now cool this alloy, so from liquid then it will remain liquid, liquid will thermally contract viscosity will increase and all that, but at 183 degree Celsius below 183 degree Celsius you see that it is alpha plus beta. And above 183 degrees Celsius it is liquid. So, the solidification happens at 1 fixed temperature of 183 degree Celsius just like for a pure element. So, on solidification we can write it like a reaction that on solidification liquid is undergoing a transformation into alpha plus beta. .

This liquid is of composition 62 weight percent 10. So, I write the composition 62 units are weight percent 10 alpha which will form by decomposition of this liquid is given by this end composition 18; 18 weight percent 10 in alpha and 97 weight percent 10 in beta. So, beta is more or less pure 10 with 3 percent lead alpha is pure lead, but with the significant fraction 18 percent of tin in it.

And this reaction is happening at 180 degree Celsius. So, I write this over arrow and, the direction of the arrow is cooling the reaction will happen, if you cool the liquid. So, this is just like normal solidification, where a liquid on cooling through the its melting point solidifies, only difference is that normal liquid like a lead liquid or tin liquid will solidify into a single solid phase, eutectic liquid solidifies into 2 mixture 2 different solid phases.

So, such a transformation is called a eutectic reaction, this has been given a name eutectic reaction. If you think in terms of microstructure you just try to draw the microstructure. So, suppose this was all liquid and you hit at 183 degree Celsius temperature, then the solid phase will start forming and this solid phase will be a mixture of alpha and beta. Let me draw alpha by the as these blue plates and many eutectic and in case of lead tin also, the mixture of the 2 phases come as [noises] alternate plates of alpha and beta. So, in this case I am representing these plates as alpha and in between what I have not colored as beta.

So, you are forming a eutectic mixture this is called a eutectic, the product of a eutectic reaction is called a eutectic mixture and, just like you had different orientation of crystal in an isomorphous system, here also in different region the alpha and beta plates will nucleate, but they will not have the same orientation. So, in some other region of the alloy again alpha and beta plates are there, but they are in a different orientation, yet another region you have yet another orientation.

So, this is a schematic I have drawn, you can see a real lead tin microstructure maybe on the web and you will find that or in a text book, you will find a real microstructure will not exactly look like this because, this is a cartoon drawing, but essential feature is that micro structure of eutectic will have alternately alpha and beta phase because, that is the product of liquid transforming through this eutectic reaction.

So, this is this feature this micro structural feature is called the eutectic micro constituent, or eutectic mixture eutectic mixture, micro constituent this eutectic reaction, I will end with mentioning 1 point that. This eutectic reaction is an example of an invariant reaction, invariant reaction what it means that the eutectic reaction happens at fixed composition of the phases.

So, liquid in this case liquid is of 62 weight percent alpha is 18 weight percent and beta is 97 weight percent and it happens at a fixed temperature. So, neither the temperature nor the composition of the liquid phase the alpha phase, or the beta phase is a variable when this reaction happens. So, since all these the 3 compositions and the temperature is fixed during the inter invariant reaction, during the eutectic reaction we call such reaction, an invariant reaction and eutectic reaction is one example of such reaction, we will have opportunity to look at some other invariant, several other invariant reactions during this course.