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

Lecture – 126
Annealing of cold-worked metals

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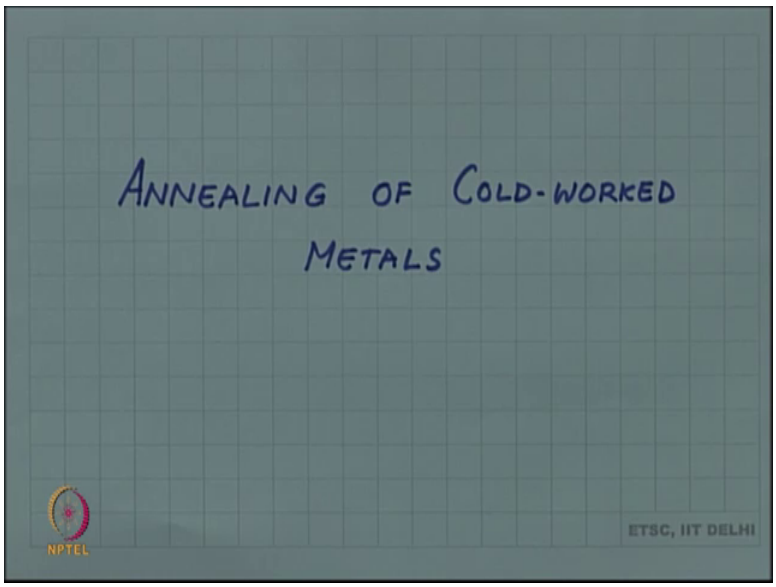

Let us discuss annealing of cold work metals.

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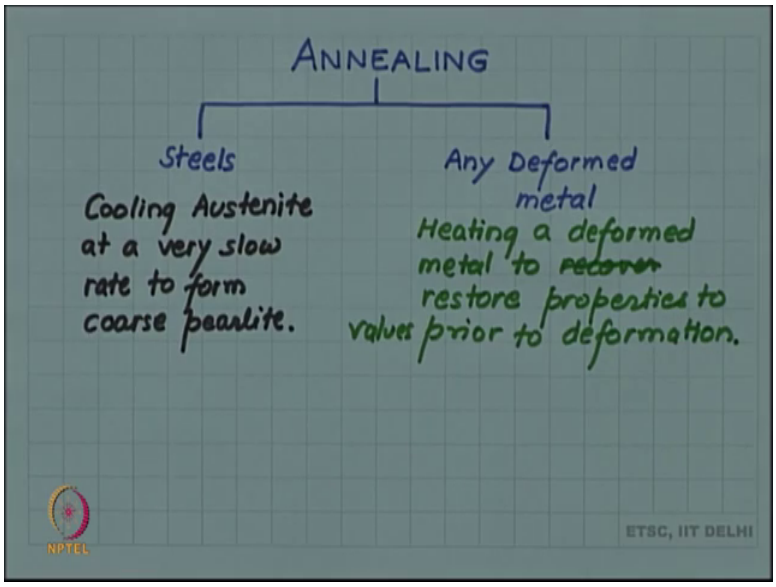

This is a slightly different sense; we have already met annealing in case of a steels. There, we saw that annealing meant in that case annealing meant cooling austenite cooling austenite at a very slow rate to form coarse pearlite; that is what we meant when we talked about annealing in case of a steels.

But there is another sense in which annealing is used in materials engineering and that that is called and that is also called annealing and that is applicable to deformed metals. So, in this case, it involves heating, heating a deformed metal to restore properties prior to deformation restore properties to values prior to deformation. So, you understood distinguish between two different kinds of annealing or two different uses of the word annealing, in case of a steels, it is cooling of austenite; in case of deformed metal, it can be any metal which is being deformed and is being heated to restore some of its properties.

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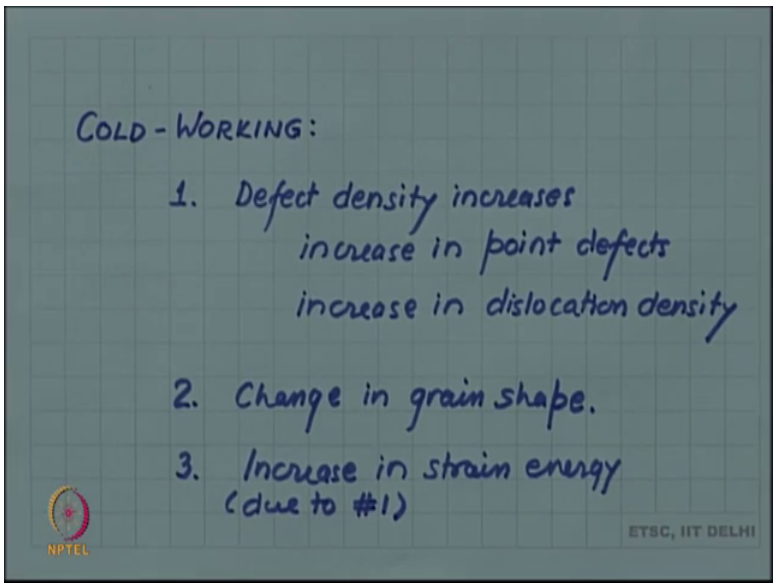

Let us see; what is involved in this kind of annealing. So, in cold working, various kinds of defects increases; so, the defect density increases. So, there is increase in point defects and there is also increase in dislocation density there is no increase in the grain boundary area, but grain shape changes. So, there is change in grains shape because both dislocations and point defects are associated with in strains, there is also increase in the strain energy of the system energy due to point number one that is increase in point defects and increase in dislocation density.

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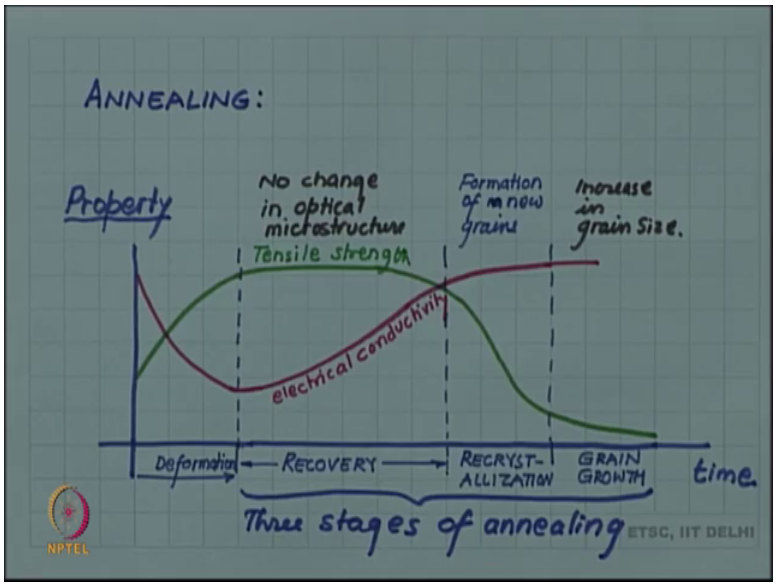

Now, let us see, how some of the properties changes. So, on y axis, I am drawing property and on x axis, let us say, it is time and the green in the green curve, let us say is tensile strength whereas, the red curve represents electrical conductivity.

So, you can see that there are three there are four phases; three to four phases, actually, four phases; the first phase here; let me mark it as deformation. So, we were deforming the material and you can see the deformation due to cold working and strain hardening which you have studied the strength of the material goes up the green curve, where as electrical conductivity comes down because electrical conductivity the dislocation density dislocation and point defect density also scatter electrons. So, they increase the electrical resistivity of the material or decrease the electrical conductivity.

Then after this deformation, we put it in a furnace at a high enough temperature and the annealing begins the first stage of annealing is what is called recovery. So, what is found in recovery that the mechanical property the tensile strength does not change much where as the electrical conductivity changes rapidly and restores more or less to its original value before prior to deformation. So, electrical conductivity will show its signal during recovery whereas, the tensile strength does not show much change also there is not much change in the microstructure.

No, you can write it; no change in optical microstructure after recovery, there is a second stage of annealing which is called recrystallization during recrystallization you can see

electrical conductivity. Now, only gradually increases, but there is a sharp decrease in the tensile strength to its value equal to or less than the prior to those the value at prior to deformation and in the final stage, we have what is called grain growth where there is significant increase in grain size.

So, in this stage, there was a formation of new grains that is why it is called Recrystallization and then in during the grain growth, you have increase in grain size. So, we will look at. So, this entire process, this recovery recrystallization and grain growth are three stages of annealing and we will look at them one by one.