Introduction to Materials Science and Engineering
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Lecture – 108
Shape change

In the last video we saw that crystal structure does not change during plastic deformation. This was what was derived by actual experimentation using x-ray diffraction but then, the question arises that how does external shape change without any change in external crystal structure?

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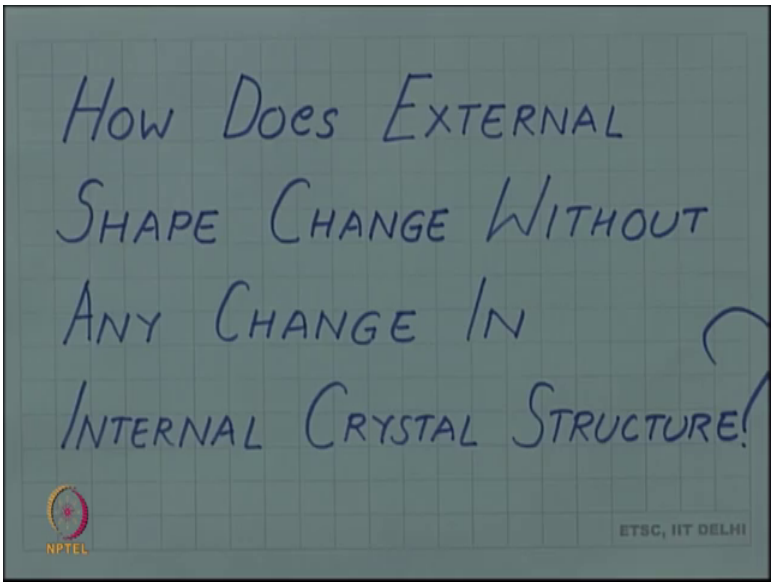

So, this is the question which is a sort of varying question or sort of count because intuition tells us that if any external shape is changing there should be some corresponding internal changes, but that internal change is not the change in the crystal structure. So, without change of crystal structure how does this external shape changed? So, when the crystal structure did not change.

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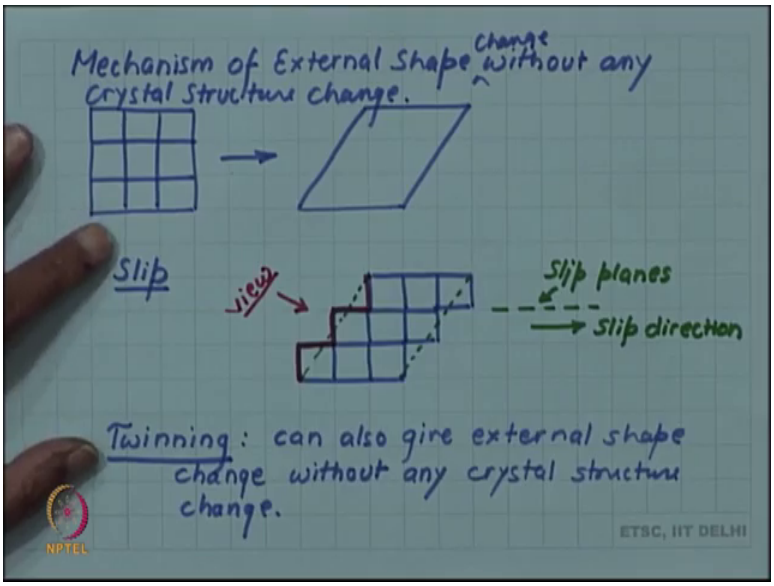

So, people thought about it and various models were proposed one particularly successful model is the model of slip. And in the slip model the deformation happens because the unit cells stone deform, but unit cells slide over one another to give us a macroscopic shape change. So, for example, this shape change this macroscopic shape change can be achieved by this kind of sliding.

So, we will say that crystal is slipping on the slip planes and in this slip direction. So, a slip on these horizontal planes in this direction will give me external shape which will macroscopically appear like this deformed sample. So, slip was one particular model to explain why deformation external deformation can take place without any internal unit cell change or the crystal structure change.

In fact, there is yet another model we will not discuss that, but we have discussed that in the structure is the twinning. The twinning can also give external shape change without any crystal structure change. So, slip and twinning are 2 particular deformation mechanism and both can give external shape change without any crystal structure change. So, mechanism we can call this mechanism of external shape change external shape change without any crystal structure change.

Of course, the motivation for such thinking motivation for this explanation came from the fact that x-ray diffraction had already shown that there is no crystal structure change,

but then there were other experiments which were indicating to this kind of mechanism, and that was the micro structural study of deformed metal.

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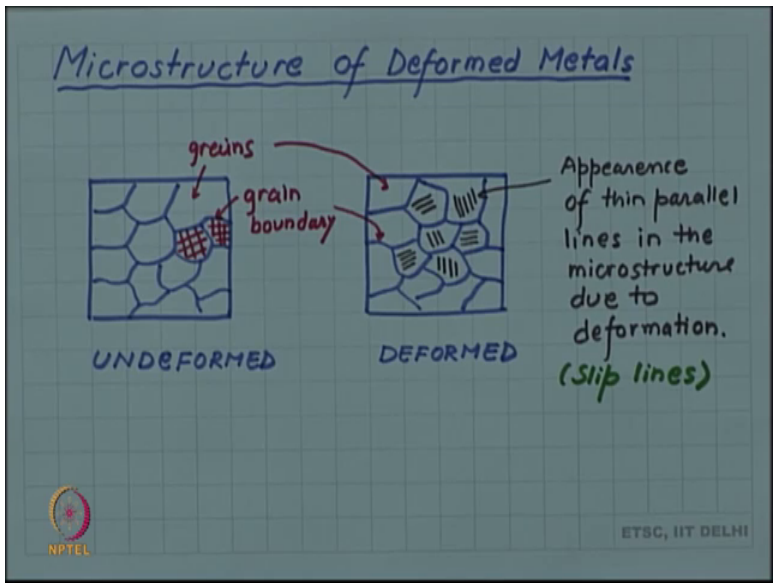

When you study the microstructure of undeformed and deformed metal, you see grains and grain boundaries as so these are these are grains these are grain boundary. Recall that grain boundaries a boundary between 2 different orientations of the same crystal we have discussed that.

So, grains and grain boundaries are seen in undeformed metal, but when this metal is slightly deformed and viewed again I say slightly because, the sample has already been prepared from micro structural observation, and you have to do the micro structural observation after deformation also. So, if you deform it too much then, the sample will not be you will not be able to observe the microstructure in the deformed sample. So, you have to only deform it slightly, and in that slightly deformed material what people saw that grains and grain boundaries were still present.

So, here also here also you had grains and here also you had grain boundaries; however, a new feature which was not there in undeformed material also appeared, that is some thin parallel lines differently oriented in different grains started appearing in these grains. These thin parallel lines appearance of parallel lines in the microstructure due to deformation. So, when this slip explanation was proposed, you can see that if you see the

sample if you see the sample on this surface. So, that is if this is your viewing surface view it from this side then you will see these steps as lines on the surface.

So, these 2 things were connected and one could then relate this appearance of thin parallel lines. This was itself this was an independent study from the x-ray diffraction, and people were worried about this that how these lines are appearing? What is the origin of these lines? But then, when this crystal structure change or rather no change in crystal structure was established by in x-ray diffraction and a slip model was proposed.

One could connect that because of slip these lines are appearing these are nothing but slip steps which are seen on the surface on the observation surface. So, that is why these lines were named the slip lines. So, the x-ray diffraction observation and the micro structural observation both then indicated this slip model of deformation which will lead to change in shape of the material, change in the shape of the crystal without change in the internal crystal structure.