Introduction to Materials Science and Engineering
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Lecture – 56
Dislocation cannot end abruptly in a crystal: Dislocation nodes

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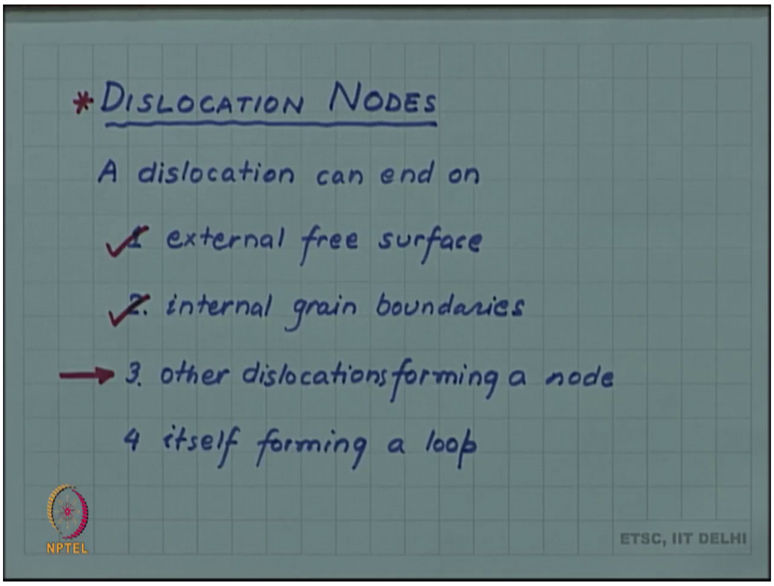

We have seen that a dislocation cannot end abruptly inside a crystals, but it can do one of these things. It can end on external free surface, we have looked at that and it can end on an internal grain boundaries, this was also we have looked at. In this video we will look at this option which is a dislocation line can end on other dislocations and form a node. This dislocation node is the topic of discussion now.

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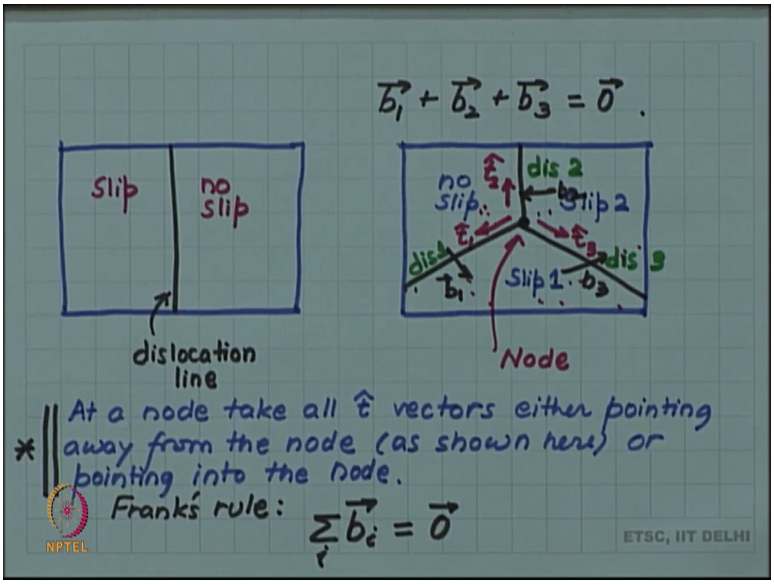

I have been drawing for you many times slip plane and dividing the slip plane into 2 regions slip and not slip by a line which becomes our dislocation line. One side of the line is slip and the other side is not slipped. I call it slip and no slip regions.

Now, it is not necessary that only one dislocation runs throughout the crystal on a given slip plane. If I have a slip plane and then I divide it if I divide the plane into more than one regions let me say instead of 2 now I have divided into 3 regions. I have drawn 3 lines each of these lines can be a dislocation line meeting at a common point and that common point will now be called a node.

This is a node this is let us call this dislocation one a dislocation 2 and this is dislocation 3. 3 dislocations are meeting at that node. This dislocation line which is a start dislocation one is starting on a free surface, but is not ending on a free surface it is not ending on a grain boundary also, but it is ending on other dislocations. This possibility is also there and, in that case, we get such point junction point which are called node.

We can call one of these regions let us say as a no slip region. Let me call this as a no slip region. Which means if I cross this location line one I will come to a slip region. This will be slip one.

But now when I cross dislocation line 3 again there should be a slip if this this region was also slip one then there will be no differential slip between these 2 regions and this boundary or this dislocation line this location line 3 will disappear. There has to be some extra slip some differential slip as I cross this line. This region will be having a different slip and let me call that a slip 2.

And corresponding to the slips all these lines will have burgess vector as you know and the burgess vector according to our convention also depends on the line vector. The convention for the node is to take all the line vectors going either out of the node or coming into the node.

Let me take all the line vectors the t1 t2 sorry t3 and t2 coming out of the out of the node I could have taken all of them inside the node also. In the node the convention is let us write down at a node take all t vectors the tangent vector or the line vector t vectors either pointing away from the node as shown here or pointing into the node and based on these t vectors you determine their burgess vector.

Each of them will then have some burgers vector associated with the dislocation line. Let me call this burgess vector b one this burgess vector b 3 and this burgess vector b 2. All the dislocation line will have the corresponding burgess vectors and the interesting thing is that and that is called franks rule to the sum of burgess vectors at the node has to be 0 if you follow this convention then sum of all burgess vectors at the node will be 0.

This is easy to intuitively see although we are not giving the exact proof, but you can intuitively see suppose we start from the no slip region then as I cross this dislocation line one then I undergo a slip one and the slip is by amount given by the burgess vector b1. This region is slipped by a vector b one with respect to the no slip region as I cross this dislocation line 3 now I get a further slip of burgess vector b3. Now, the total slip of the region 2 with respect to the starting region which was no slip region is b1 plus b3 sorry b3 b1 plus b3.

Now, when I cross from this region to the no slip region I again undergo another slip which is now equal to the amount b2. When I come back to original no slip region I have undergone a slip b1 plus slip b3 plus slip b2, but since I am back to the original the sum of all these 3. Total to no slip because finally, I am in a no slip region. The sum of b1 plus b2 plus b3 in this case should be 0.

In this case b 1 plus b 2 plus b 3 should be 0. This is an important rule to keep in mind, but the validity of the rule will depend on this convention. If you take your t vectors arbitrarily then; obviously, this will not be satisfied it is important to keep in mind that at the node either you have to take all the t vectors going out or all the t vectors coming into the node then you will have this frank rule.

The sum of the burgess vector at the node will be 0 I have shown you here a planar network, but the network in real crystals can be 3 dimensional also. The third dislocation line need not be lying in the same plane of the paper, but may be moving out of the plane of the paper in that case also this rule will be true.