Defects in Materials
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Lecture - 18
Description of dislocation-02

Welcome you all to this course on Defects in Material. In the last class we talked about the basic concept of dislocation. Let us just do a recap of what the essential features of the dislocation which we have talked about it, before we go further. The first thing which we talked about it is what is the need for having there dislocation.

Now extend from the fact that when the people were trying to find out stress which is necessary to deform a material, it was observed that the stress is much lower than what the theoretical fracture strength. Then the other factor is that when people were looking at how at the crystal growth, then it was observed that the growth of the crystals are much faster than what is dictated by the general theory that, they thought that there may be some defect which is responsible for it. Similarly, when x ray diffraction peaks from single crystals ere looked at it the intensity of the peaks were found to be much higher and what is expected if that sample were perfectly flat and did not contain any defects. So these features necessitated for putting forward the concept that the defect is present which is a one dimensional line defect. We looked at it what is the type of this line defect.

There are 2 types of line defects which we can think of, one is called as a screw dislocation and another is called as an edge dislocation. Then we also mentioned that these dislocations have some features how do we characterize these dislocations are what are all those properties which we should look at it all that this is an edge or a screw dislocation. To do that we should know what is the line direction, what is the burgers vector of this dislocation. We looked at it how to define the burgers vector of the dislocation, what is the convention which is being followed. Essentially to find out the burgers vector of the dislocation what we should do it is that.

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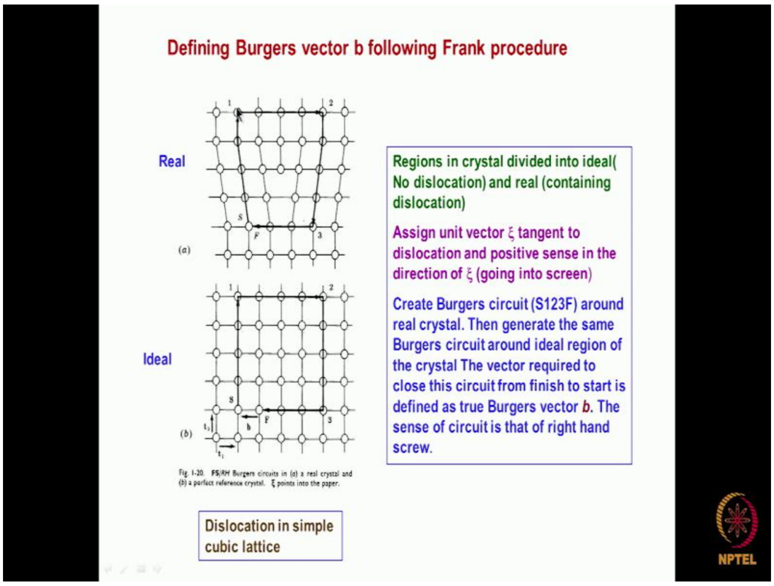

First we do burgers circuit around it that is starting from one point complete a path coming back to the starting point. Keeping the defect within that circuit. And then do the same process around the region which we call it as an ideal crystal which does not contain any defect in it. Then one we find that there is yeah when we reach the end point there is a gap between the starting point, then the end point and that separation between them defense this burgers vector. And in this particular specific case that line direction of the dislocation is taken to be the one which is looking into the screen that is called as the sense of this dislocation this particular diagram which is being given is for a simple cubic lattice. We will talk about the dislocations in other lattices in the later class.

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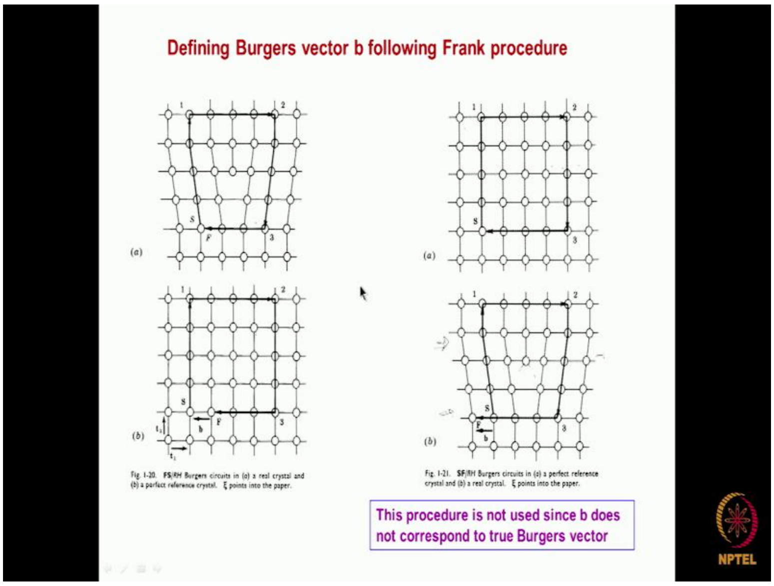

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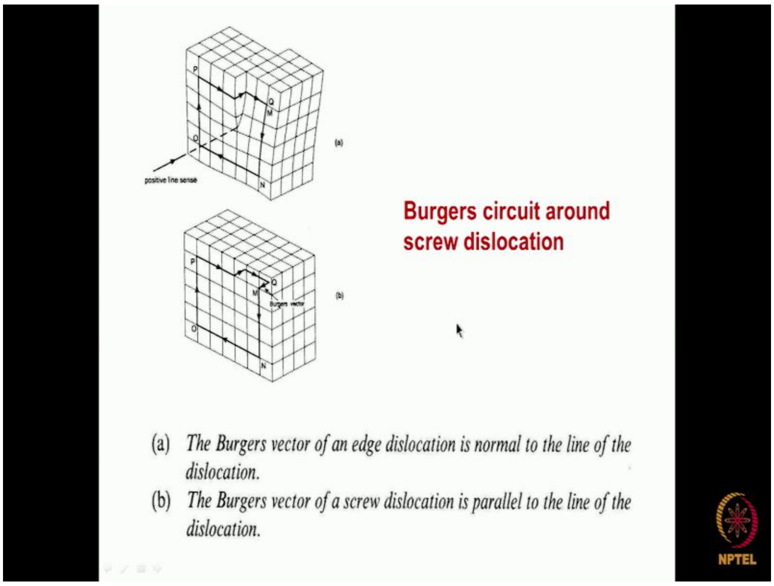

Then I also mentioned that what all the other ways in which the burgers vector could be defined, and why it is important that this is the only method which has to be used then about burgers circuit around there screw dislocation.

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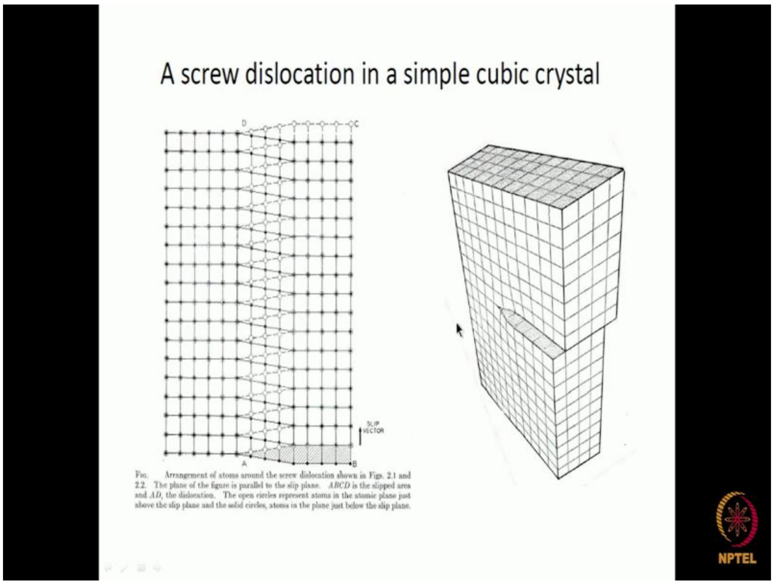

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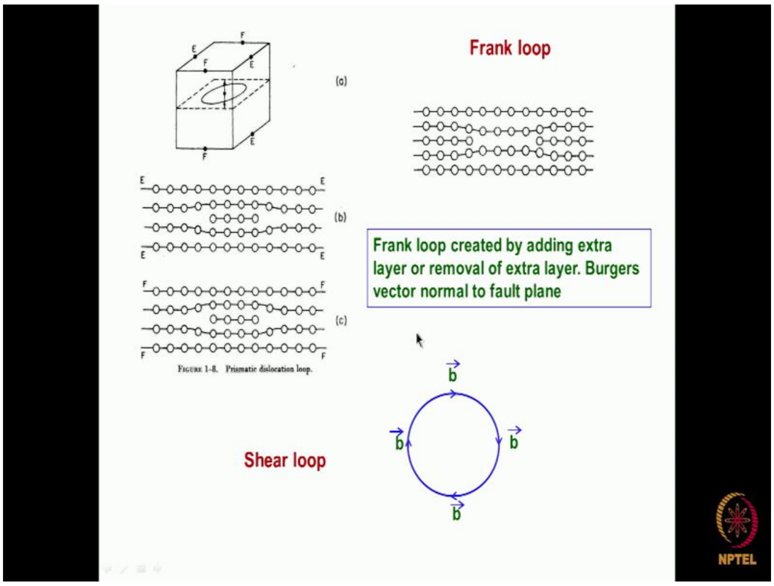

Then another type of a dislocation which we considered are the frank dislocation or the frank loop. This essentially is that if we remove one of the layers partly not completely like.

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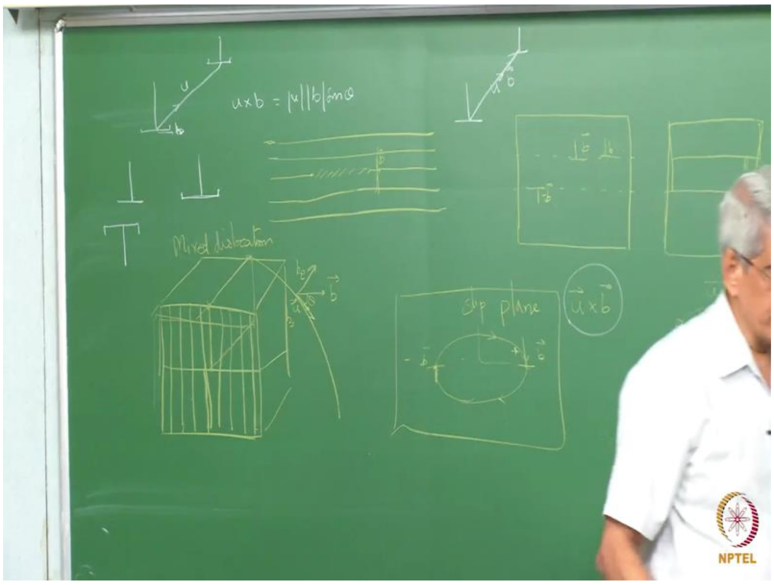

We assume that the part of the layer has been removed sample. So we are only showing a cross section of the sample. Now one can immediately make out that from between this region and this region there is an extra apply which has come and this is exactly similar to an edge dislocation.

Right, but in this case the burgers vector of the dislocation this is the plane of the defect. And this burgers vector is essentially perpendicular to the plane of this effect. Then we talked about the shear loop and most of the time that dislocation need not be a perfect screw or an edge configuration. It can always most of the time it is going to be a mixed type of a dislocation. That is the dislocation can have that is the dislocation on this and that tangent to the dislocation gives the line direction. Suppose I denoted by u and the burgers vector is inclined with respect to the dislocation.

This type of dislocations is called as mix dislocations. Mixed dislocation can be thought of as combination of yes small screw and an edge segment together. That is if I take a component of this, if this is the angle theta between them I can find a component of this dislocation in this direction, which I will denote it as b s, and the component which is perpendicular to this which I will denote it as b e. So b e is nothing, but the edge component of the dislocation and b s is nothing, but the screw component of this dislocation. That way also we can define here mixed dislocation.

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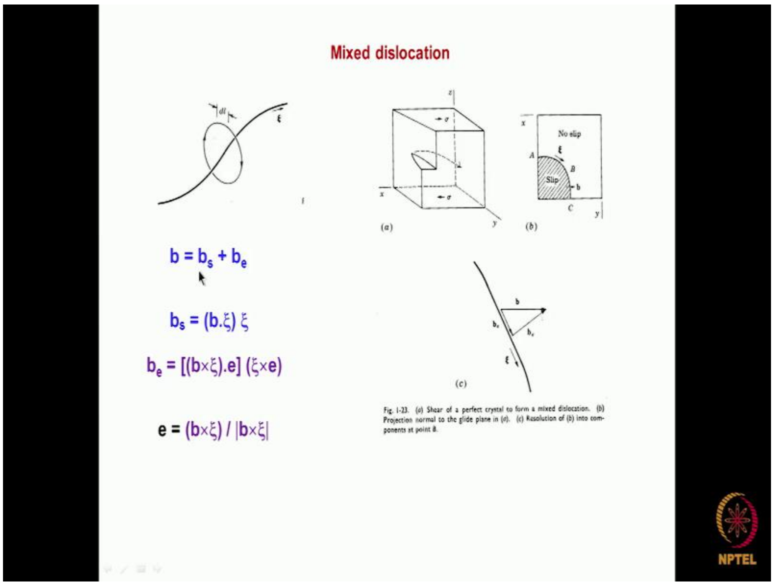

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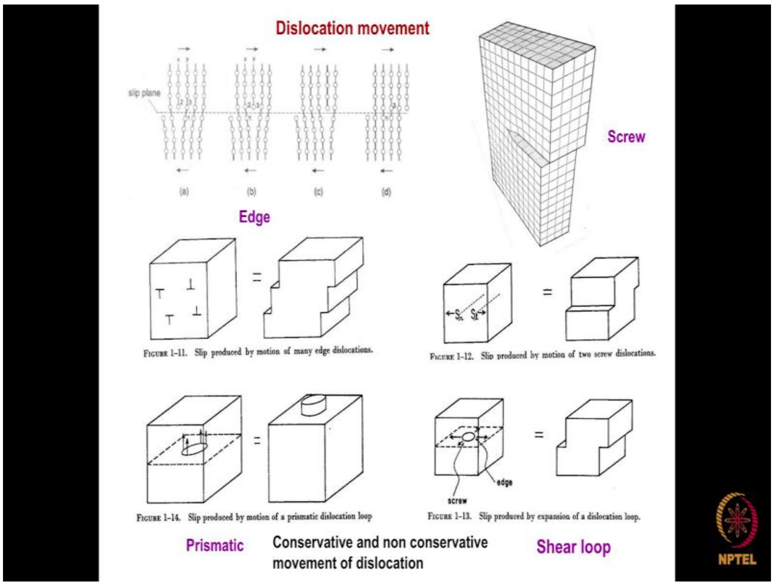

In this equations what has essentially be given is that using vector notation, how to find out the burgers vector of the screw and the edge component. So the type of dislocations which we can think of is either edge or pure screw or a mixed dislocation which is a mixture of both screw and edge component together. Or a frank loop these are all the type of dislocations which we can have as perfect dislocations that is another type of dislocation which is there is called as a partial dislocation, which we will talk about it later much later.

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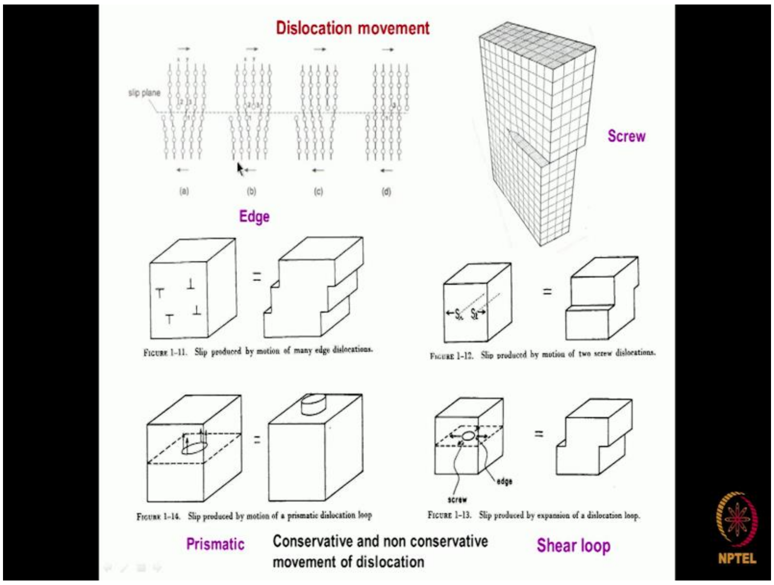

Having talked up, talked about perfect dislocations. Let us look at the movement of dislocations. Just because we know that the dislocations are responsible for bringing about shape deformation to the materials or plastic deformation of the material; that means that plastic deformation is a permanent deformation of the material that measure the material has flowed from one region to another. And this is associated with the movement of dislocations. What all the type of how exactly this a movement of dislocation brings about the shape change let us look at it. Let us takes the example of an edge dislocation. In the case of an edge dislocation here essentially a cross section for a simple cubic lattice is being shown, that is cut section of a cubic lattice is being shown. By applying a shear stress essentially what we and this dash line shows essentially the slip plane, the extra half plane is lying extra plane is lying above this slip plane and the below the slip plane is the normal lattice.

If we look at either of this region, the above the slip plane as well as below the slip plane the lattice seems to be perfect. Only difference is that between these 2 layers one extra half plane has come. This is how we define an edge dislocation. Suppose we applied a shear stress, then what is going to happen if that under the action of this a stress the atom that numbered one, here essentially is that since the stress is being applied in this direction this is moved a little bit and when the 2 is moved a little bit it is becomes closer to one, and it makes a bond with it, and when such a bond is being formed the layer becomes like this. And now this layer 3 has now become the extra plane.

By doing a process like this we can see that essentially at the end of it that dislocation has come out of the sample surface. When the dislocation has just come out of the sample surface it is perfect lattice we see in between, but with extra on either side of it. So this step is essentially being what it gives rise to the shape deformation.

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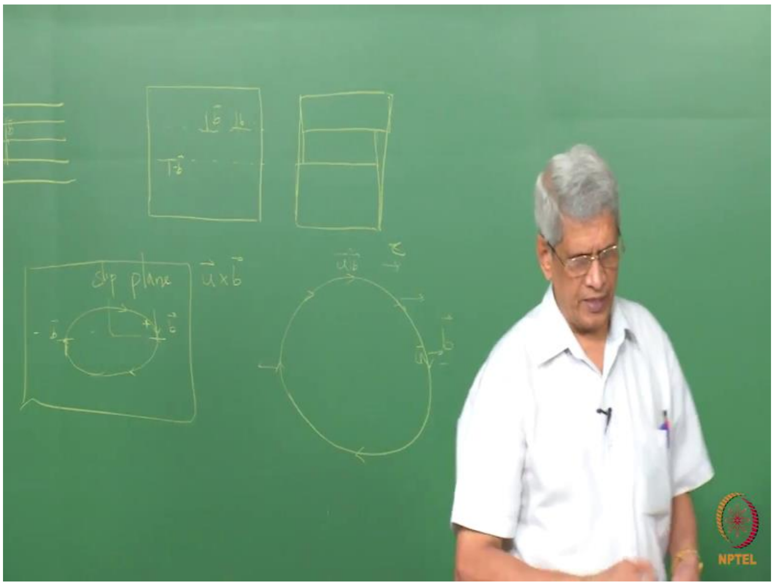

Suppose we assume that we have a solid block in which that is I will just show you a 2 dimensional analog of it. Suppose we have dislocations which are present in this sample like this is one, with an edge dislocation with a burger vector which is positive another with the burgers vector which is negative.

And this is the slip plane, when the dislocations are within the sample, and when they are moved partly suppose we assume that this dislocation. Let us assume that dislocation is lying here. And from here it has moved a distanced reached here. Actually the dislocation has done some work with a shifted some plane, but shape deformation has not taken place. When does the shape deformation takes place when the dislocation completely comes out of the sample surface, like the way we have considered it what will happen is that in this case the dislocation will come out.

And in this specific case that dislocation comes out like this. So now, we have from an original shape which is there the shape as average shape has changed so; that means, that shape change has taken place. So when the dislocation comes out of the sample surface, it generates step and the magnitude of the step which it creates is of the order of is the same as the burgers vector. This is what is being shown for a screw dislocation. What is the direction in which this step has been created? In both the cases it is in the same direction has the burgers vector and in the slip plane. Let us look at what happens in the case of a screw dislocation in the case of a screw dislocation.

As the dislocation moves in this particular direction step is created in this direction. The movement of the dislocation and the step which is being created are perpendicular to each other. So that is what is actually is being shown in this specific case in the case of a cube where here screws dislocation is a moving. As the screw dislocation moves it finally, generates a step which is this is the line direction. And the dislocation moves in this direction as the dislocation moves it creates a step and when it comes out of it you find that on either side a step has been created.

Let us look at the case of a slip which will be produced by motion of approximating dislocation view or the frank loop which we have just mentioned. In the case of a frank loop that as you can see the burgers vector is all going to be in this specific direction. There is it is perpendicular to the plane of the loop. Since burgers vector is perpendicular to the plane of the loop, as we know in the last class we the defined that is defined by u cross b where u is a line direction and b is the burgers vector of the dislocation.

So the plane which contains are the slip plane which contains which is perpendicular to the line direction, as well as the burgers vector is essentially there this particular plane and which is perpendicular to that had a plane in which the loop is laying. So the loop has to move up or down and finally, it will come out of it creating a step. This is what essentially will happen. In the case of motion of a shear loop shear loop is a how can we visualize what is a shear loop. Essentially if we take at dislocation which is in a plane you have the same plane we have a dislocation which has a burgers vector which is in this direction and another where the burgers vector is negative when this is positive. We assumed that this is in a particular plane.

Because one of the property of the dislocation is that the dislocation can never end within a material. First one should understand this concept. How one can understand? This suppose we assume that there is an extra plane which is going to be there, sample I will just, this is the slip plane. This is the extra plane the extra plane is completely they are up to the end. Suppose we take a perfect to swell which has got only this much number of lattice planes which are there and join it to this surface. That is equivalent to making this dislocation line which goes like this.

End that is suppose I put on another slab of it here, which is a perfect crystal that is equivalent to the dislocation line ending at this point, when this happens this is if you look in this particular direction essentially it is equivalent to putting an extra half plane in this direction as well as in this direction and another extra half plane; that means, that this also in this direction also there is an edge dislocation this direction is also an edge dislocation and they are joined together at this point and that dislocation has come out of the sample surface here, and out of the sample surface at the other side; that means, that the dislocation can never end within a material. The dislocation can end either if the grain boundaries are at free surfaces. So if a dislocation cannot end within the material the 2 options which it as, either it can come out of the sample surface or it can form a loop. So that it is a we can say that it does not neither begin nor that we cannot defend where it starts and where it ends because it is come by forming a loop, we can make a dislocation which satisfies the condition that the loop does not neither begin or end within them in the material.

In this specific case, you such a loop is being formed and the when the line direction cements like I can assume that this is the loop which is being formed and one part of it. You assume that this part of it is under behind that screen and this part is above this are in front of this board and we are only shown a cross section. And as you have mentioned always that the as I mentioned earlier that line direction of the dislocation.

Has to be some particular sense has to be chosen and the line direction cannot just like that change it has to follow the same line direction. So if the line direction remains that same if you try to construct a burgers circuit around the dislocation, we will find that the same way we will be defining it, but we find that with respect to a coordinate system which we have chosen this side it has to become a negative value, for the same sense of the because here the sense is going to be the dislocation line coming out of this screen, and here the sense of dislocation is going to be going into the screen.

So when this sort of a dislocation loop forms, if the burgers vector is in a specific direction then, with respect to that line direction u, here the line direction and burgers vectors are perpendicular to each other here the line direction. And the burgers vector are in the same direction and in between regions the burgers vector is inclined with respect to a line direction. So for a shear loop, some region will exhibit pure screw type of dislocation. Some region exhibit is edge pure edge component and in between regions will exhibit both screw and edge components.

In this to this dislocation, if we apply a shear stress and try to deform it. Suppose we are assuming that the stress is supplied in this particular direction. As we know that the edge component will be propagating the positive one in this direction negative one is in this direction. When they propagate like that finally, they will be coming out of the sample surface and creating an edge, but the screw component if we consider it, this is the line direction or this is the line direction and burgers vector is also in this direction. So when these dislocations also move as the dislocation moves in these direction. The step which is going to create it is the same direction is the one which the burgers vector is create as it is being shown here. So finally, what is going to happen is that when a shear loop comes out of a sample surface step is created only in one direction.

This I will give it as an assignment when we try to solve it, you will understand clearly how the shear loop what sort of a steps are created under sample surface when the shear look comes out of the sample surface. Another thing which one should understand is conservative and non-conservative movement of dislocation the cases which, so far we have considered everywhere when the dislocation moves in their slip plane both the screw and the edge dislocation and as it comes out of the sample surface. The volume is being conserved. When the volume is being conserved this sort of movement of dislocation is called as a conservative movement of dislocation if it is like for example, if an edge dislocation.

You consider this specific case dislocation moves perpendicular to the slip plane. If it moves perpendicular to slip plane some row of patterns should be removed from this region, and it should be brought to somewhere on the surface. So when that has been brought on to the surface in that process what we have created is that the dislocation is moved, but if you look at what is the volume which has happened the volume has increased. So anything which involves increase in volume it is called as a non-conservative motion of movement of dislocation. And the best example of non-conservative movement is climbed of dislocation.

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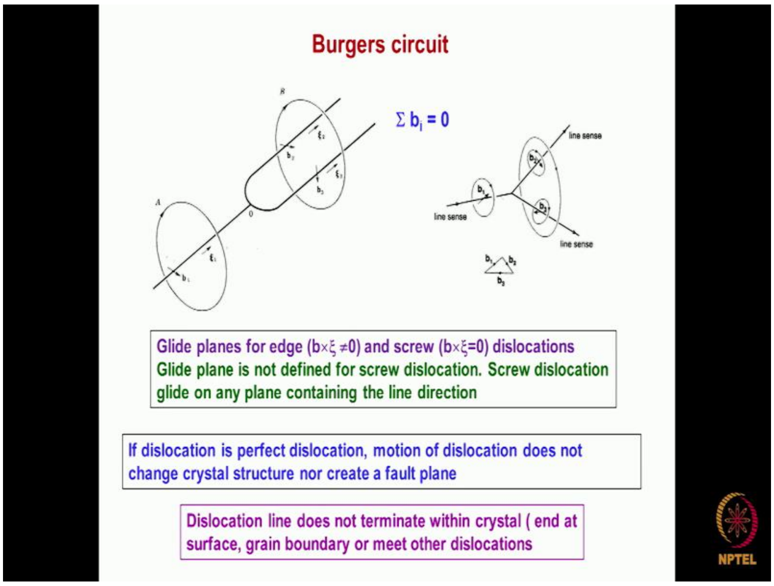

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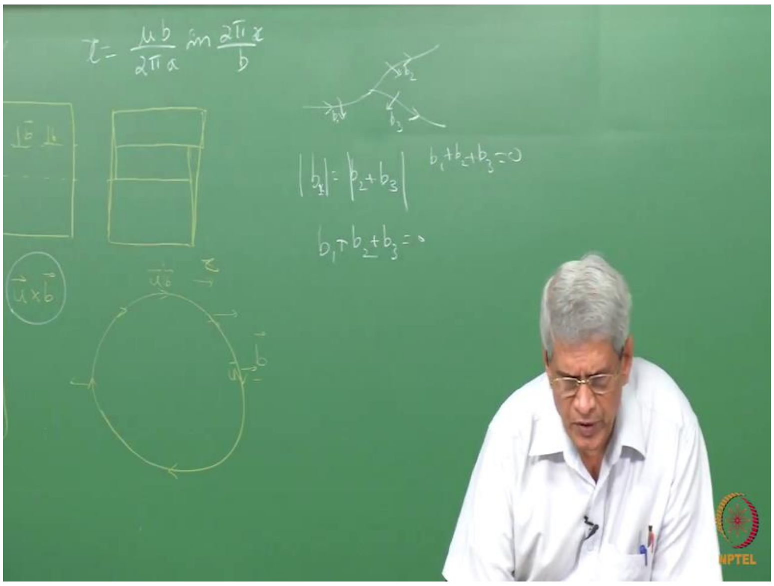

Another important aspect which one has to think about it is that in most of the materials are as I had shown in some of the example earlier in the last class. You might have noticed that many dislocations are at many places they are splitting in to different type of to various components in this particular case. What is the rule which is governing the burgers vector of the different components of this dislocation this is one important aspect one should know? To understand this what we have done it is we have taken at dislocation with a burgers vectors b 1 this has split into 2 dislocations with burgers vectors b 2 and that one another with burgers vector b 3. You should notice carefully that the line direction here in this direction is it the same line direction which it follows with respect to dislocation. So; that means, that if this is the line direction of the dislocation this will have a line direction everywhere the line direction maybe line direction is defined by tangent to a dislocation, but the sense of the direction remains that same at all places.

Suppose we form a burgers circuit around this dislocation that is how we around the line direction, we create a burgers circuit and then a region which is adjacent to it, which does not contain the dislocation we put the burgers circuit and then we can find out what is the burgers vector of the dislocation. That way if we do it we can find out what is going to be the burgers vector and it is given us b 1. In this region which contains the dislocation which are split. You take a burgers circuit the encompassing both the dislocations together. If you do the burgers circuit around these 2 dislocations also, encompassing both of them then the burgers vector which we will be getting it.

Since it is the same, is in the dislocation has just gone through this the burgers vector here, since it is in the region which encompasses both the dislocations. This should have a burgers vector because the material continuity has to be maintained. This b 1 should be equal to whatever the values if that b 2 plus b 3 should also when we do a burgers circuit whatever is the burgers vector which we get it should be equal to magnitude wise, it should be equal to that of b 1. If we take the sum of a all these burgers vectors b 1 plus b 2 plus b 3 should be equal to 0; that means, that if the burgers vector is in this direction b 1 if the burgers vector b 2 is in this direction, for this dislocation the b 3 burgers vector will b in this a such that at this junction if you see that b 1 plus b 2 plus b 3 will be equal to 0.

This is similar to the electric current flow. You see that or which we call it a Kirchhoff’s. If different resistance we connect together the current flows current flows in a particular direction at a specific point, if we try to find out when they are joined together the sum of the current should be equal to 0 at that point. This part of it as I have mentioned earlier the glide plane is defined for a dislocation by taking u cross b. For an edge dislocation the glide plane is specifically defined because,

If this is how we look at a yeah one should also remember about what is the symbol which is being used to represent the dislocation. Generally the symbol which is being used to the represent that dislocation is just this perpendicular line, this represents general dislocation. It does not distinguish between whether it is a screw dislocation or an edge dislocation, but if you looking the book of a hirth and lothe in theory of dislocations, there the edge dislocation is defined by a symbol which is being look like this, an inverter T, that is this direction which points is where the extra plane is there. With the extra plane is a this is the weight will be shown this is for essentially an edge dislocation the symbol which is being used.

Using that symbol if we try to draw, this is the line direction u and the burgers vector is in this direction b. If you take u cross b, which is equal to nothing but mod u modulus of u into modulus of b into c sin theta the angle between them, correct? This is going to define an area and the vector is perpendicular to that represents the plane normal. So this plane is called as the slip plane for the case of an edge dislocation. In the case of a screw dislocation, if you take the cross product this is going to be 0. Because there u as well as that b are going to be in the same direction; that means, that in this specific case the dislocation if we no slip plane is define; that means, that any plane which contains this dislocation line is a potential slip plane. The dislocation can move and any of this plane. Then what dictates on which plane this screw dislocation will move. The answer is it is decided by their plane which has got the least frictional resistance to the movement of the dislocation.

In the case of FCC material one-one plane has got the least resistance frictional resistance to movement of that dislocation. And that specially for FCC material the for a perfect dislocation 2 slip planes intersect each other for the same dislocation. Maybe this is one plane and there is going to be another plane which may be inflamed with respect to it these 2 planes in which the same dislocation can move.

Suppose depending upon that depending upon that direction in which the applied stress has been apply direction in which the external least thrust is applied take the component of that in the slip direction a slip plane. Whichever one has got the higher maximum result shear stress that is the plane in which the dislocation will move. Suppose it meets an obstacle at somewhere when it is being moving in this slip plane then, it has always that option to move in the other slip plane also because the slip plane is never defined. Only condition essentially is that all the plane which contains the line direction of the dislocation is potentially a slip plane for screw dislocation.

But on which plane it will move or which will which plane, will act as the slip plane is decided by the plane which has got the least frictional resistance. This I had already explained to you that the dislocation lines does not that terminate within a crystal.

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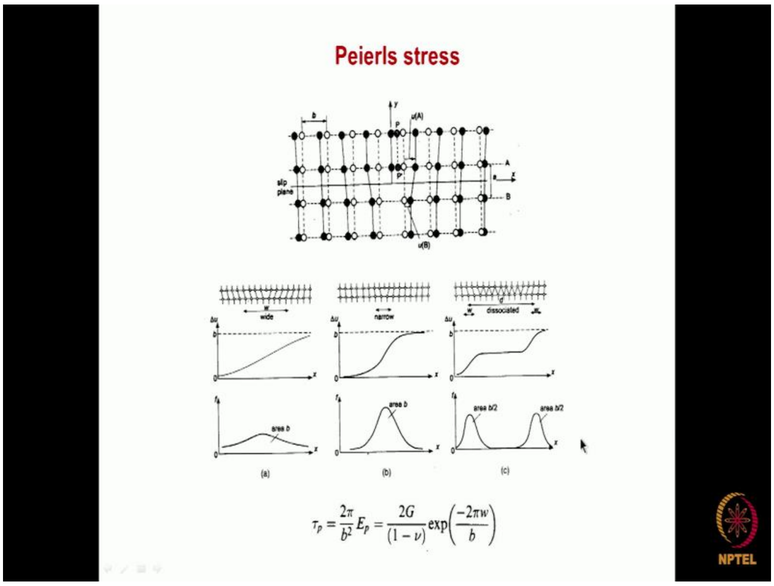

Why it should be? So know one more thing which I will talk about it is I mentioned about the frictional stress.

How do you define a frictional stress? We calculi talked about the theoretical strength which is required in the case of a material, which just does not contain any dislocation in the last class. Now let us look at the case of the same material where it contains an edge dislocation. In this if you look at it this figure the atoms which are represented with open circles that represent a perfect lattice. Into this lattice and this is the slip plane. Across the slip plane now we have added an additional atom at this particular position in between these 2 layers. When one extra layer has been added to add this extra layer the other layers will be pushed on either side. So that is what is being shown is that now this atom is being push from here to here. This atom is being push from here to here. Then this atom is being push from here to here. So, essentially atoms which are originally in this position by adding just an extra layer, the atoms are displaced from their original position to a new position.

As we go further away and away you will find that this displacement gets reduced on either side. This is the same thing can be viewed by 2 different ways. Suppose I take that when I go very further away and choose that as the coordinate axis, then I will notice it that this atom positions will be just identical to each other, that is the original position as well as the atom which is displaced. From starting from that point if we try to measure what is going to be the displacement which is going to take place, we will see that the displacement is increasing like here this atom is a with respect to this. This is the position with respectively, this is the position with respectively, this is the position here to here. So you can see that the b is continuously increasing it.

That is what essentially is being plotted here, how the displacement is changing. And as we go further away the displacement remains the same. This is just the displacement which he have plotted it. For the present you do not bother about this particular figure which we will come to it much later this is regarding a dislocation which as dissociated with the partials. This is a case which corresponds to in the case of a metal and this is one which corresponds to the case of nonmetallic materials like covalent or ionic bond and material. Let us first consider only this case of metallic sample.

In this case, this is what is being plotted is a derivative of this is being plotted. What is the derivative of displacement with respect to a distance? This you know that d x equals nothing, but a strain correct. So from this you can make out that beyond the particular distance, though displacement is going to be there with respect to origin that strain if you try to calculate it, that will turn out to be 0, the maximum strain is going to be there at the center. So that is what essentially it is being shown, but if you see how the displacement is taking place it is a very gradual one. So if you look at the slope of this, then over a large number of planes which are further away from the dislocation line are the core of the dislocation, the displacement is taking place. This is what it happens in the case of a metallic system.

What is the difference between a metallic sample and a ionic or covalent bonded sample? In in the in the case of ionic or covalent bond example the charge neutrality has to be maintained otherwise there is a space charge effect will come. Because of this all the displacements which are being taking place is essentially taking place over a very small region of the sample; that means, that all the change in displacement of the atoms when an extra plane has been added is confined to a very narrow region. So if we try to see, if you try to take derivative of this is the way the sharply that is this is a displacement of the strain will be occurring within this region close to the core of the dislocation. If you try to calculate what will be the stress which will be corresponding to this.

Then one can immediately get an expression of this type; the derivation part of it and just omitting it. Essentially these the stress depends upon the shear modulus poisons ratio in the one minus nu the poisons ratio. And another important factor is coming is that all these regions over which the strain is taking place is confined to very small region. So essentially one more term comes which is essentially called as the exponential of minus 2 pi w by b, where w is defined as the width after dislocation core or the region over which most of this strain is taking place. Because this is a highly strained region, there will be a stress which is corresponding to it if we apply a stress. That stress has to overcome the internal stress to make the dislocation moved. So in this specific case the internal stress which it has to overcome is going to be very high. And in this particular case the internal stress which has to be overcome is going to be very small.

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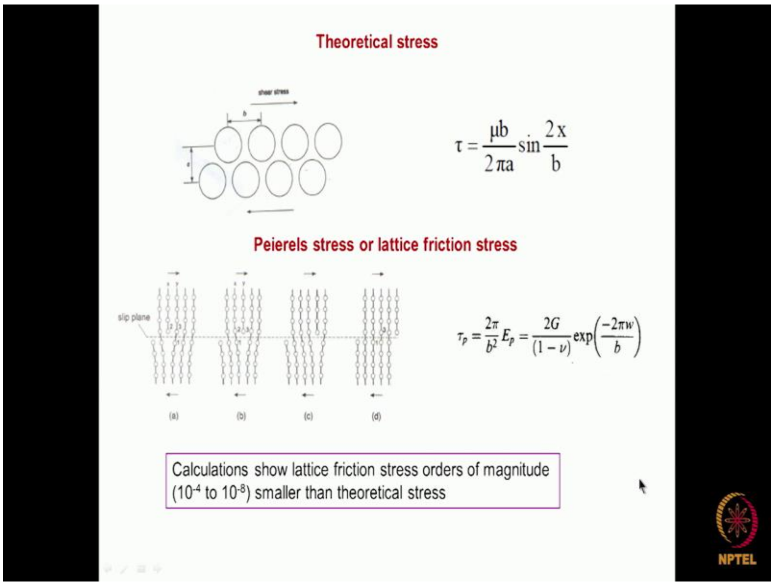

To understand this better, I had given a comparison between the theoretical stress which is required for deforming a material in the absence of a dislocation and one when deforming the same material when dislocations are present. As we have mentioned earlier in the case of a material there no dislocation is present like an example the viscous where only point defects are there no dislocations are there, and one layer of an atom.

The next layer of an atom has to be all the layer has to be completely moved. So what is the area and that gives the total frictional stress these atoms have to move from here to this position. So all the atoms will be shifted correspondingly then it will be moving from here to this position. So this is the maximum theoretical stress which is required and that is given by this formula. The tau is equal to mu b by 2 pi into sin. In fact, this expression should be 2 pi x by b. The pi is missing in this expression.

Let us consider how this expression gets modified in the case of a material which contains a dislocation. If you notice here all atoms have to be displaced to bring about that is every atom has to be displaced by a burgers vectors to bring about the displacement. Let us see what happens in the case of material which contains a dislocation. So we are we will be setting what we have talked about sometime back.

If you look here when we apply a stress shear stress like this in this direction and this is in the negative direction, we are applying it. Essentially under the application of this stress the atoms on the lower half especially this one will be, if it is shifted a little bit. Now it is much closer to the atom which is going to be close to 2. So your bond is being formed and when this bond is being formed like this the bond is being broken here. Now if you see this is what it has happened is that, this has become the extra layer initially the extra layer was here what have we done only the bonds are being broken and joined bonds are being broken and joined. When these sort of a process is occurring it appears as if the extra layer which was here has shifted to this position, it as shifted to this position when finally, this bond is broken and it is joint here. That extra layer has just come out of the sample surface. So what have we done essentially?

We have not moved any of this atom layers by application of this a small displacement which has been created successively to either the top or the both the top and the bottom layers in different directions. Only at regions which is very close to the dislocation core. That is way we are able to make the dislocation move so; that means, that the stress is doing the applied stress is doing work. Only in a very small region of this material and as I have shown in the last let the stress which is required is this is the value of the stress, if we substitute the value because here mu what is being called is nothing, but g it is the same value b is the burgers vector of the dislocation in this case. Here x is essentially going to be the small distance, which is it being displace in this specification, this is going to be w is the width of that dislocation core. If these values are substituted, one will find that the lattice friction stress which is occurring in the material is maybe 10 to power of minus 4 to 10 to power of minus 5 orders smaller than that of the theoretical stress which is necessary for making one layer to move on top of the or theoretical shear strength.

From this it is very clear that, when a dislocation is moving very small stress is necessary to move the material. This one can understand with another example, which is a practical example. For example, if you see in this floor there is a carpet which has been put. Suppose I wanted to move the carpet by a small distance maybe about something like 2 inches. What is the option which I have? Or for example, if I wanted to move this. What I have to do it is I hold that 10 both these sense. Just try to pull it, when I try to pull it, this entire layer has to be shifted by the same amount, the area over which the frictional stress as to be overcome becomes extremely large, correct. What is the other option which we have, which are a smart way in which we can move this carpet, because the carpet is very heavy lifting it, and moving it is going to be difficult? The, another way in which we can do it is, we can introduce a rod into this carpet.

If you introduce your rod beneath it and just roll the rod from one end to the other end, as the rod rolls out and comes out of the sample surface as we find that the carpet has moved by the same distance. So moving of that rod request extremely small force, so this is a very clear indication that all other regions if you try to look at it, it is only it is lifting the carpet a little bit and the rod rolls the carpet is the other region, it is brought back the same position, but a shift has been introduced. This way we will find that at the end of it when the rod comes out of the sample surface, the carpet has been shifted by the distance which we want it to be moved.

These are very this is exactly that same way in which a dislocation also moves within that sample or the dislocation imparts plasticity to the material. So every time I dislocation moves and comes out of the sample surface. It has given a displacement of atoms by the burgers vector and when it comes out of it, your step like as I had mentioned here the (Refer Time: 46:32) of a are of a burgers vector has been created on the sample surface.

So essentially what we have considered so far, is what is the need for a dislocation. How, when edge and the screw dislocation can be defined and how are they defining edge and screw dislocation. Then the burgers vector of the dislocation. Line direction of the dislocation once the line direction and the burgers vector has been defined. How from that we can get information about the slip plane, or a glide plane. There are some subtle differences in some books they make between slip plane and the glide plane. The glide plane is called as the plane in which only a single dislocation when it is moving especially in this specific case itself. If we consider it this plane in which only a single dislocation moves this will be called as a glide plane. And when more dislocations are moving in this plane the terminology which is used this slip plane.

In many other books you will find that the respective whether it is one or this one the same it is being used as a slip plane itself, but one should understand that it is only the number of dislocations which are used to define whether it is a glide plane or the slip plane, but it is the plane in which the dislocation most that is the thing which you should understand.

Then the next question is that how to define the burgers vector? Then we looked at it that if the dislocation many dislocations come and joint together that is we mentioned that the dislocation can either begin nor n with in a material correct. So the consequence of that is that if I dislocation is present in a sample, there is another dislocation which is being present there. The only way in which these dislocations can present their, since they can attend their, they have to join together some point that may me. So there will be many junctions which will be created are yes single dislocation itself can come out only, it is present then it cannot end within the material.

So dislocation line from one end to the other end either it should be from one boundary to the other boundary in a polycrystalline material or if it is a single crystal material from one surface to other surface that dislocation line should go. And many dislocations are there we will find that if the dislocation gets terminated if it has to terminate another dislocation will be originating from this point. So this sort of junctions will be formed. What is the condition for this junctions to deform? That is the burgers vector if we take it that some of the burgers vectors has to be equal to 0 that is a condition which it as to satisfy.

And then we looked at what is the theoretical stress which is a necessary for a material which contains a dislocation, if it has to make the material deform. So far we have cover mentioned about the different type of dislocations. And we have talked just in simple terms movement of dislocations, before we talk about interaction of dislocation. The next thing which we should know we have to understand is about that what all the stress and strain fields around the dislocation. Because in this stock itself you have noticed that around the dislocation there is displacements which are taking place. Whenever there is a displacement which is occurring around the dislocation, it will generate strains and corresponding to that strain using the generalized Hooke's law we can find out what is the stress which it will be generated.

If you take the product of stress and strain, then that will give rise to an energy which is an increase or decrease in energy which is going to take place it in the materials. And all these things we will how to calculate it, we will discuss in the next few classes. We will stop here now.