Introduction to Materials Science and Engineering
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Lecture – 50
Burgers circuit

We will discuss burgers circuit.

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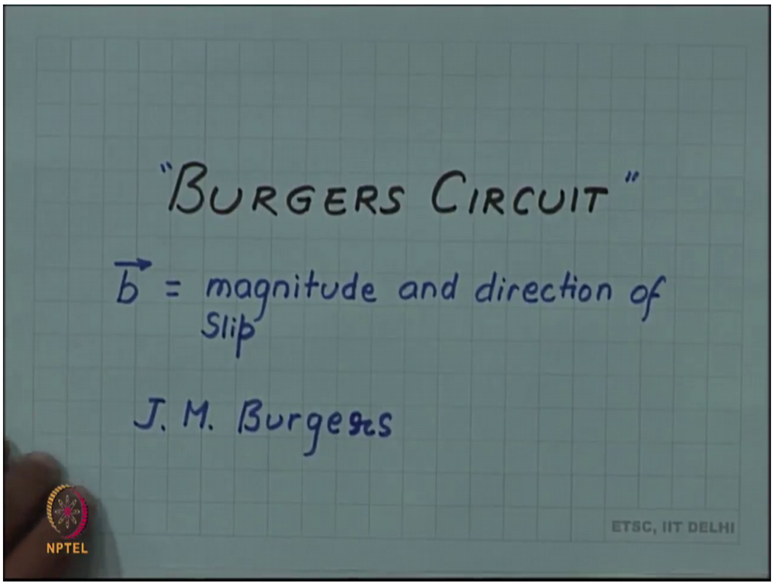

We have already discussed burgers vector and the burgers vector we define currently as magnitude and direction, a vector representing magnitude and direction of the slip. We have defined dislocation as the boundary between slip and no slip region on a slip plane and the slip is characterized by this burgers vector giving it is magnitude and direction, but there is another way of looking at burgers a vector independent of the slip and that was originally given by Burgers, a person who is quite famous in fluid mechanics he has contributed and he has lab named after him in his country Netherlands, but he also contributed 1 paper in this dislocation and that is on burgers circuit.

So, let us look at burgers circuit, what is meant by burgers circuit?

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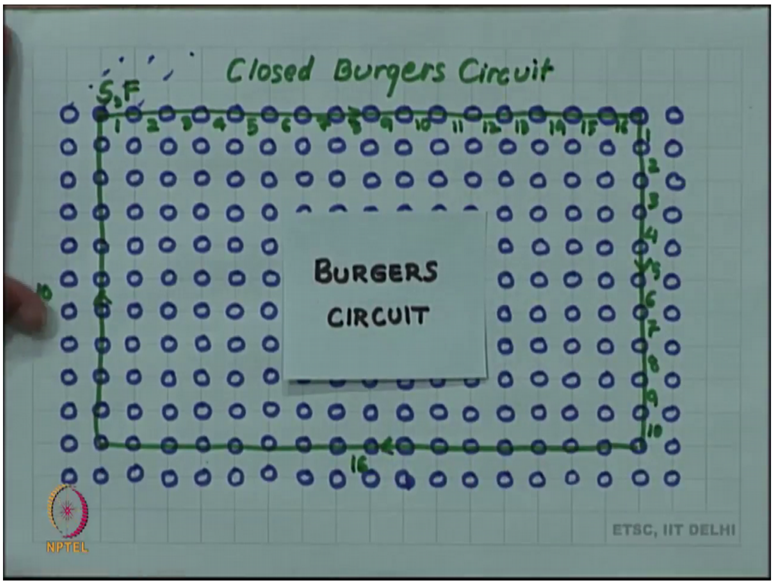

So, imagine we are looking at the front face of a simple cubic crystal with atoms arranged in this square grid. Of course, you will have a 3 dimensional crystals, so atoms will be into the crystal also, but I have not drawn. So, we are seen the front face and let us on this front face draw a circuit, let us draw a circuit; let us try to draw a closed circuit, any closed circuit will do. So, for sake of simplicity I am keeping it rectangular circuit let me keep track of the direction.

So, I am going clockwise and let me say this was the start and this was also the finished point of my burgers circuit and let me count the steps. So, I have steps 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. So, I have gone 16 steps to the right and then how many steps down? So, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, so 16 steps to the right, 10 steps down then I have again taken 16 steps to the left and 10 steps up.

So, this is a complete rectangle and in a nice crystal like this, I have a closed burgers circuit. Now, I do this exercise again rather boringly I try this again on this crystal.

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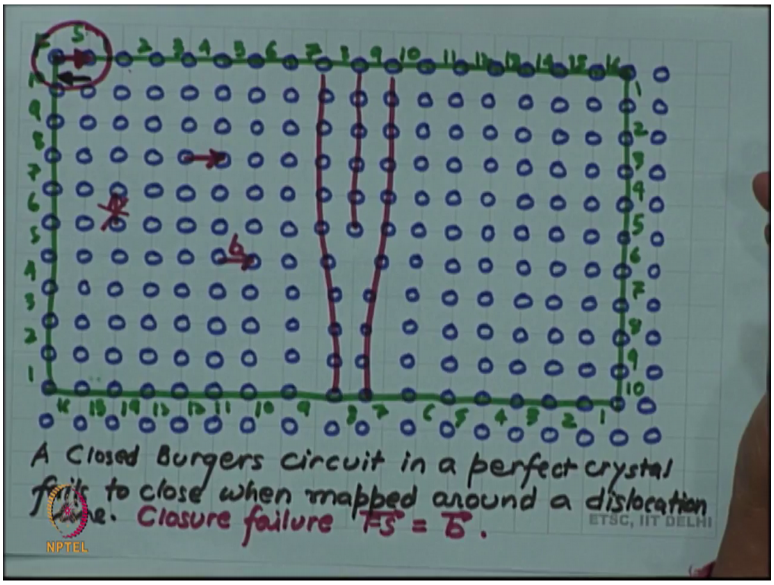

So, I again have a start point, had gone 16 to the right. So, I take 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. So, I go up to the 16, let me be sure 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 and 16; 16 is steps to the right and remember we had gone 10 steps down. So, I come down 2, 3, 4, 5, 6, 7, 8, 9, 10 I reach here, then I again go 16 steps to the left 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 and 10 is steps up, I have not completed the circuit, am I doing something wrong 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; 1, 2, 3, 4, 5, 6, 7, 8, 9, 10. So, 16 by 10 rectangle in this crystal also, but it is not completing, it is not closing.

So, there is a closure failure, what is the reason for this closure failure? So, the reason for the closure failure is hidden behind this sticker. So, let me remove this sticker and what you find is that this crystal is having an extra half plane that was the reason for the closure failure, this is an extra half plane. So, the number of planes above was more than the number of planes below, so this is the property of a burgers circuit. A burgers circuit in the original picture nothing was hidden behind this, thing they were planes were continuous.

So, I had a perfect crystal and I had a closed burgers circuit on the perfect crystal, but if such a circuit is mapped. So, a closed circuit; a closed burgers circuit in a perfect crystal fails to close when mapped around a dislocation line. So, this is what you are seeing and that closure failure, let me draw this closure failure as a vector. So, if I go from finish to start I go to this vector, which is exactly 1 inter planar spacing and remember in the slip picture also with this edge dislocation we had introduced a burgers vector which was 1 inter planar spacing.

So, the closure failure is nothing but the same burgers vector which I had gone; which I had obtained by the slip approach. So, the closure failure is equal to the burgers vector. So, a close burgers circuit a perfect crystal fails to close when mapped around a dislocation line and the closure failure in this case finish to start is the burgers vector. One thing to keep in mind about the burgers vector is that the magnitude of the burgers vector and the line along which it will appear is fixed.

So, for example, in this picture the burgers vector will always be along horizontal line, I will never get a burgers vector which is this for this dislocation line, burgers vector will always be horizontal and it is magnitude will also be always this 1 inter plenary spacing for this dislocation line. However, the sense can reverse; suppose I had taken my circuit not clockwise, but anti clockwise. If I had started and gone all the way round in a different direction instead of clockwise, anti clockwise, then I would have got a burgers vector which would have been pointing in the opposite sense.

So, the burgers vector depends upon the way I define my circuit, whether I am taking my clockwise circuit or taking anti clockwise circuit or even taking this clockwise circuit, I could have defined there was no region to define the burgers vector as finished to start, I could have defined the burgers vector as start to finish. In fact, some books will define that way, so start to finish.

So, that also is a proper burgers vector and this is we call in the slip approach also the magnitude and direction of the slip is not uniquely defined. Whenever, there is a slip there is a relative slip. So, an upper part of the crystal is slipping with respect to the lower part across a slip plane. So, if we look at the motion of the upper part that will be in 1 direction, if we look at the motion of the lower part that will be in the opposite direction.

So, burgers vector has a fixed magnitude and direction, but the sense can be either 1 way or other way, this ambiguity is always there and to avoid this ambiguity in any 1 given discussion, on in 1 literature, one defines what is called the burgers vector convention.

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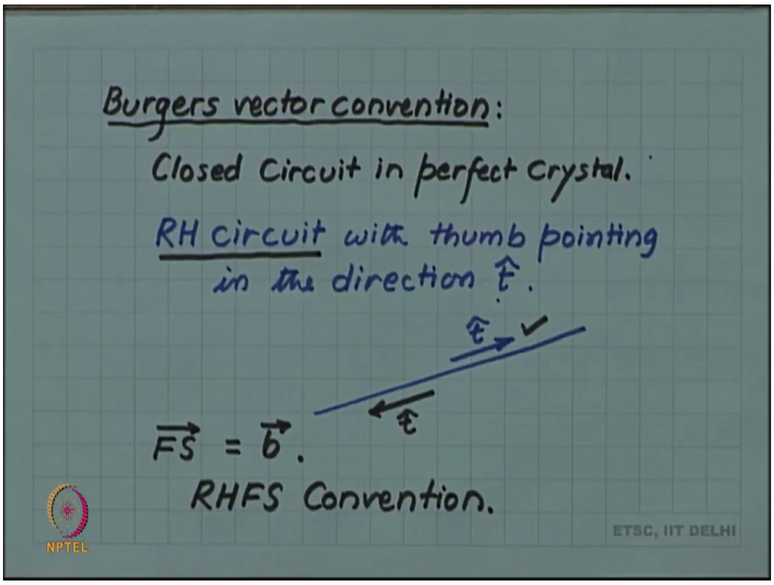

In our course, we will take a burgers vector convention. That our closed circuit is in the perfect crystal and we will take the circuit clockwise, right hand circuit with thumb pointing in the direction of t, the tangent vector. See, the tangent vector also has an ambiguity, if I have a dislocation line I said a unit vector parallel to the dislocation line is the tangent vector, but then tangent vector can be selected this or somebody could have selected the tangent vector like this.

So, the tangent vector also has an ambiguity. So, first you have to select a tangent vector and once you have selected a tangent vector with respect to that tangent vector your circuit can be either right handed or left handed; in this convention, in our convention we are taking a right handed circuit. So, if you curl your fingers again of your right hand, such that the thumb points in the direction of t, then the fingers will be circling in the direction in which you should take the circuit.

So, right handed circuit with thumb pointing in the direction of t and then the closure failure finish to start will be the burgers vector. This is sometimes shortened into name RHFS convention. So, we will be following this convention in all future discussion, but when you are looking up other textbooks or other literature you should make sure, what is the convention of the burgers vector they are using.