Introduction to Materials Science and Engineering
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Lecture – 51
Elastic energy of a dislocation line

Let us look at elastic energy of a dislocation line.

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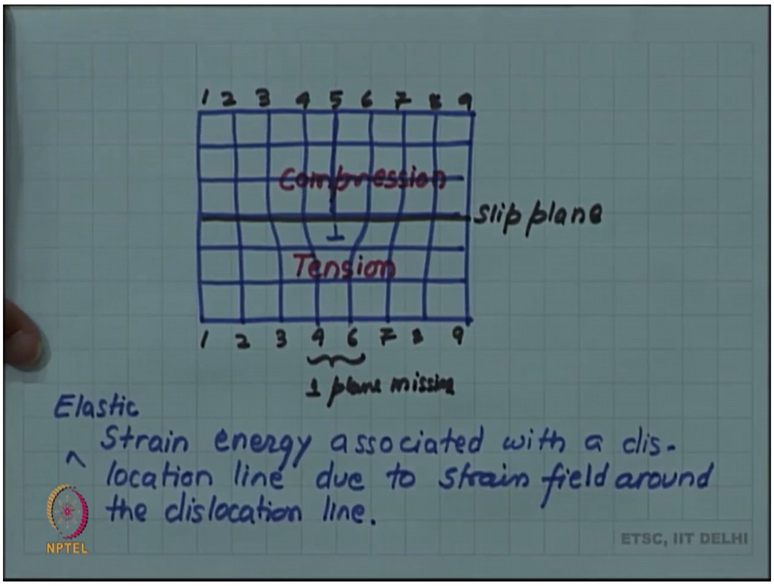

When we have a dislocation so here we are showing the edge dislocation diagram again, this is the extra half plane, so there is a dislocation line here. Now, because there is an extra half plane above this and this is the slip plane. So, above the slip plane you have more 1 more plane. So, in this case for example, 1, 2, 3, 4, 5, 6, 7, 8, 9 planes, whereas below you have only 1, 2, 3, 4, 5 is missing 6, 7, 8 and 9, so actually only 8. So, 1 plane is missing here.

So, this leads to it is a intuitively we can feel that the planes above will be squeezed in. So, there will be a compressive stress field here, there will be a compression here, whereas the planes will be further apart below the slip plane. So, below the slip plane there will be a tension. So, above the slip plane there is compression and below the slip plane there is a tension and in a more accurate description and evaluation of the stress and strain field. Then finally, gives us a result that there is a line energy there is energy associated we can call it a strain energy or elastic energy or elastic a strain energy let me call a elastic strain energy associated with a dislocation line due to strain fields around it, atoms are disturbed and atoms are moved away from their equilibrium position around the dislocation line.

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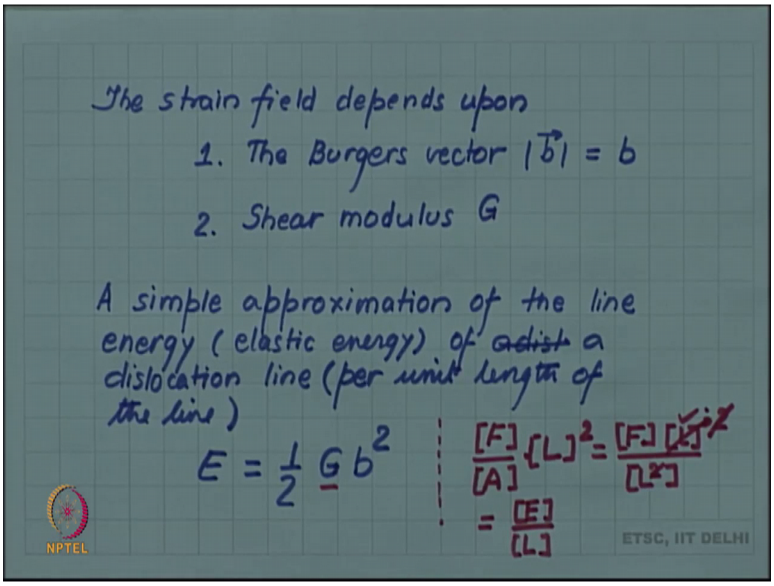

This strain field depends upon the burgers vector; magnitude of the burgers vector and it will also depend upon the elastic modulus of the material in particular the shear modulus and an approximate simple formula can be written for both edge and screw dislocation. Although, there is some difference between the strain energy of edge dislocation and a screw dislocation and detailed formula or detailed elevations have been made for them. We will take a simpler; a simple approximation line energy sometimes called line energy of a dislocation line per unit length of the line is given by if I write E has the elastic energy per unit length of the line and this is given simply by half of the shear modulus times the a square of the magnitude of the burgers vector.

You can see the dimensions shear modulus, we will have the dimension force per unit area and b square has the dimension square of L, we can then write this as F into L divided by area is L square, we can cancel this sorry and this is L square, so I am only cancelling the L square. So, F into L becomes the energy and there is an L in the denominator, so it is energy per unit length. This simple energy calculation will help us in deciding the equilibrium burgers vector for many crystal a structures, so that we will do next.