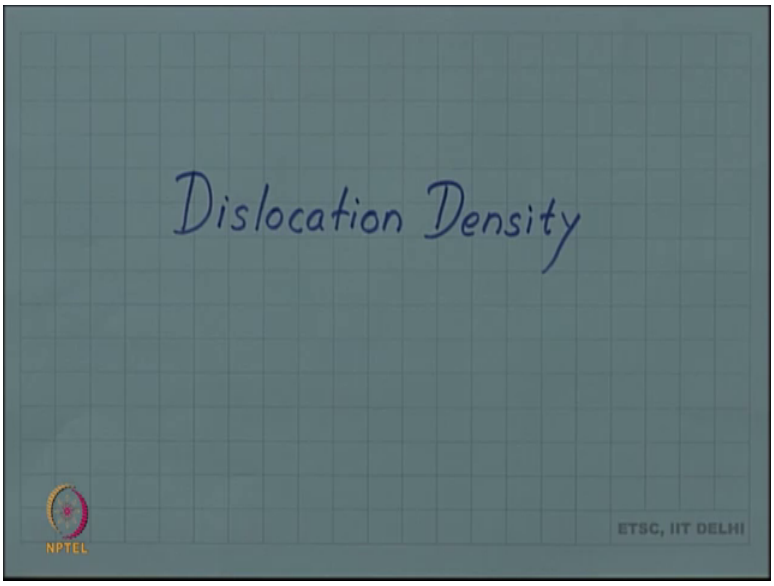
**Introduction to Materials Science and Engineering**
**Prof. Rajesh Prasad**
**Department of Applied Mechanics**
**Indian Institute of Technology, Delhi**

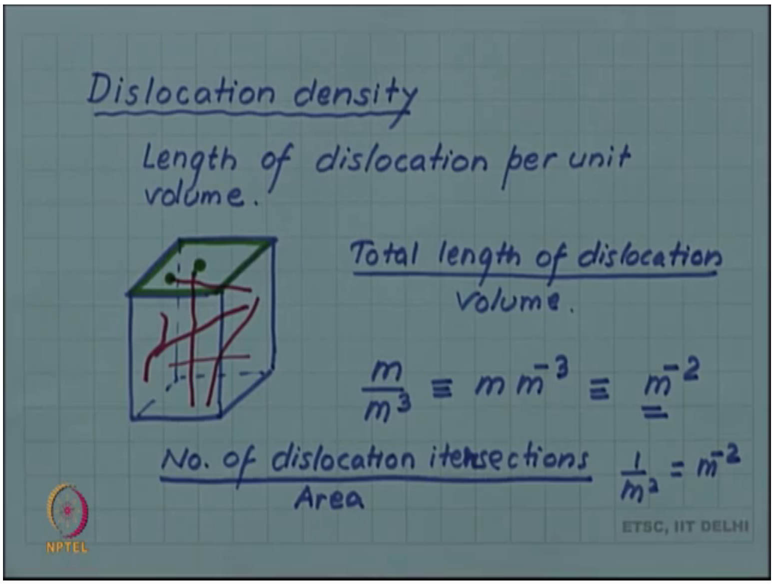
**Lecture – 116**
**Dislocation Density**

(Refer Slide Time: 00:05)




Let us look at dislocation density.

(Refer Slide Time: 00:09)

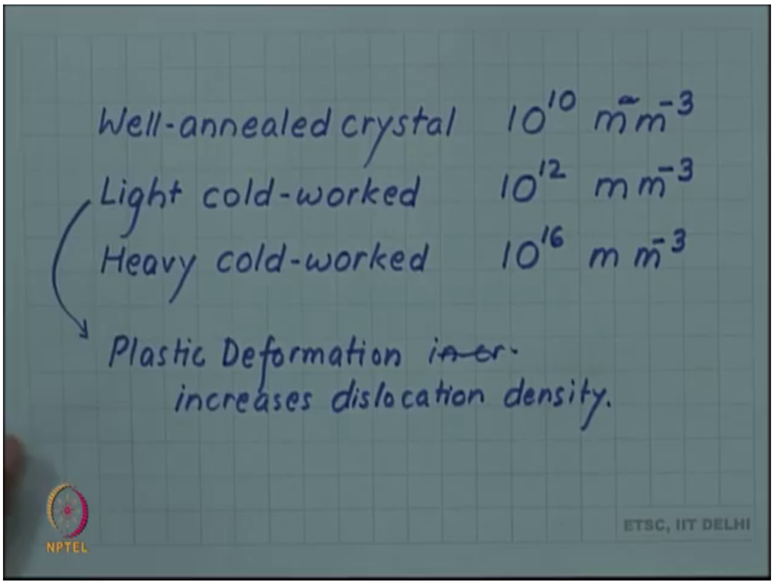


Dislocation density is defined as length of dislocation per unit volume of the material. You can think of a block of material and when we were discussing, dislocation theory we were usually discussing single dislocations, but in reality in one crystal there may be many dislocation and they may be in various orientations and in various directions and so on.

So, the total length of dislocation line divided by the volume is called the dislocation density. It is unit of course, will be meter divided by meter cube. So, sometimes it is written as meter per meter cube or sometimes even simply as per meter square, cancelling one meter from numerator and denominator you can write it simply as per meter square; but there is another interpretation of this per meter square, that other way of defining the dislocation density is number of dislocation intersections number of dislocation intersections per unit area on a test surface.

So, this obviously, the number is dimensionless. So, this will directly give you 1 by meter square per meter square as the dimension. Here essentially what we are doing is that we are counting suppose this is a test surface. So, we are counting the number of dislocations, which are intersecting that surface and we divide then by the area of the test surface; both definitions are used and statistically the two are related.

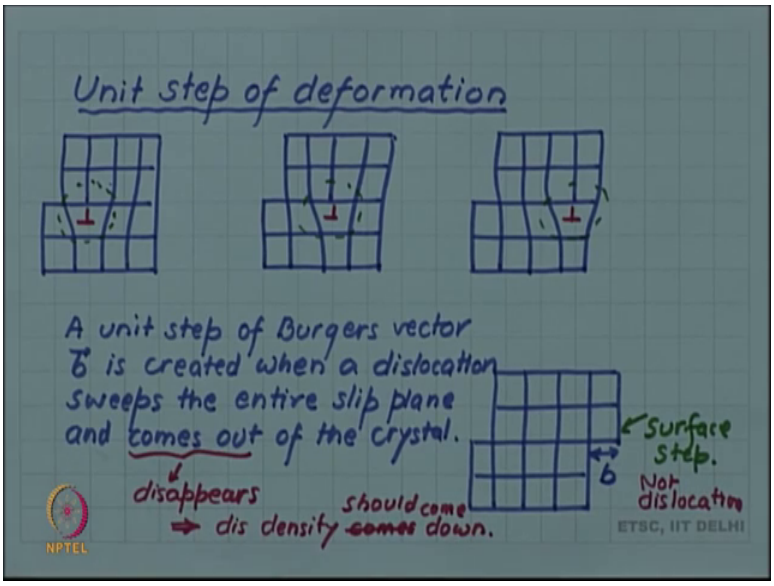
(Refer Slide Time: 03:11)




Now, in let us look at how the dislocation density varies during various kind of processes. In well-annealed crystal means a crystal which has been made and is has been heated above a certain temperature for a long time, in such processes the dislocation density comes down. So, you have a very low dislocation density, but still that is not anywhere close to 0, it is 10 to the power 10 per meter square or 10 to the power 10 meters per meter cube.

If you lightly cold-worked; cold-worked is essentially plastic deformation plastic deformation. So, plastic deformation increases the dislocation density. So, a light plastic deformation will increase by a factor of 2, sorry by a order of 2, 10 to the power 12 and if you do heavy cold-working the dislocation density can increase a million times and can go to 10 to the power 16. So, plastic deformation increases the dislocation density plastic deformation.

(Refer Slide Time: 05:04)




Now, let us look at the picture, which we had seen last time, that how by continuous progress of an edge dislocation we can create plastic deformation. So, an edge dislocation which was on the second plane here now moves to the third plane, to the fourth plane and finally, comes out. But when it comes out we are not calling this dislocation you can see, that in all these three situations there were deformation surrounding the dislocation. The region around the dislocation was disturbed.

But once the dislocation comes out and the plastic deformation is complete, then the planes are now straight and there is no deformation. So, this will not be considered as a half plane and a dislocation. This is just a surface step; this is not a dislocation. So, this means that a dislocation has to come out and disappear to create a unit surface step. In the dislocation terminology you remember that, if a dislocation comes out it creates a step of Burgers vector b.

So, a unit step of burgers vector b is created, when a dislocation sweeps the entire flip plane and comes out; of the crystal and this coming out this coming out is disappearance of dislocation. This will indicate that as plastic deformation progresses and as more and more deformation happens; so more and more such steps are created the dislocation density should come down.

But we have already seen that actually in plastic deformation the dislocation density is increasing. So, these two views are seems to be in contradiction that; for plastic deformation the dislocation has to come out. So, the dislocation density should come down, but experimentally we see that the dislocation density is increasing. Dislocation density let me not write comes down, but should come down. Dislocation density should come down, but actually is increasing and this is the problem or puzzle which was solved by another proposal which we will discuss in the next video.