Introduction to Materials Science and Engineering
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Lecture – 112
SCHMID'S LAW

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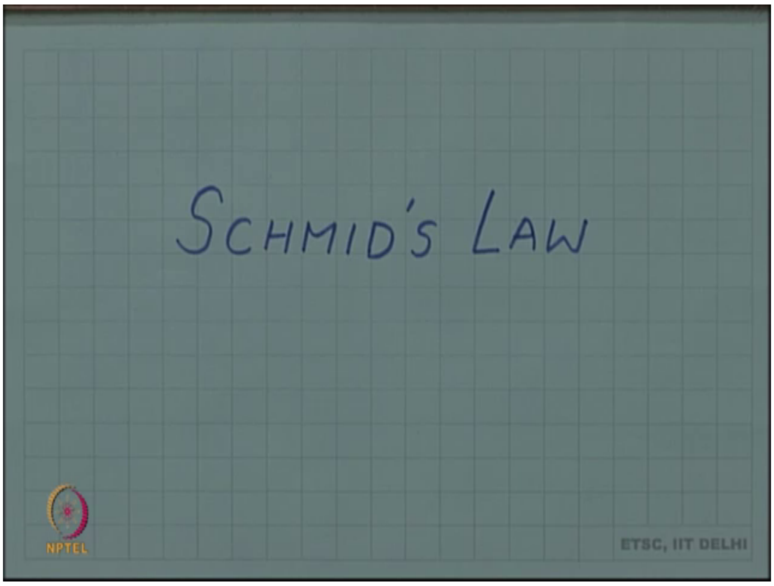

So, in the last video we discussed the important concept of resolved shear stress and critical resolved shear stress. Related to this critical resolved shear stress there is a very interesting law called Schmid's law.

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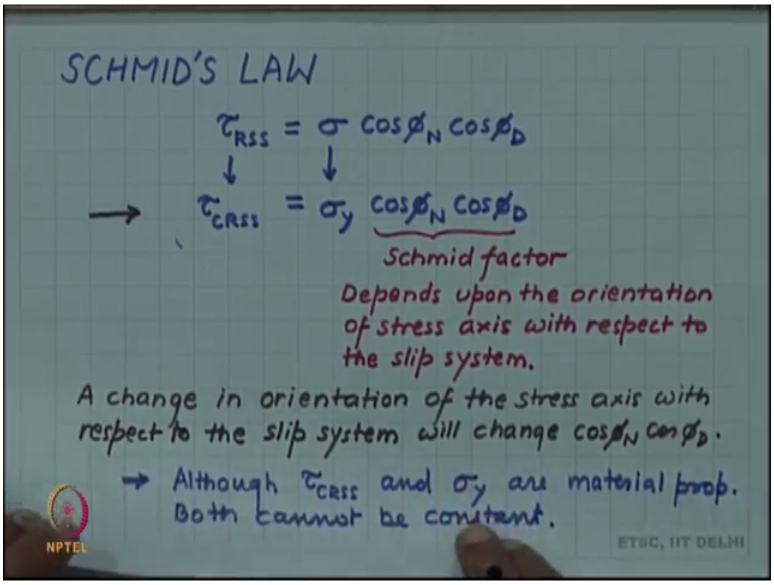

Let us look at that now essentially what we saw that the resolved shear stress is given in terms of the applied tensile stress times, a geometrical factor cos phi N cos phi D. Now, when sigma when the stress applied tensile stress reaches yield stress sigma y, the resolved shear stress reaches its critical value critical resolved shear stress cos phi N cos phi D.

Now yield stress appears to be a material property. So, does the critical resolved shear stress at what stress so critical resolved shear stress can be thought of as a microscopic yield stress macroscopically we are applying a tensile stress and at a critical value of tensile stress yielding happens. Similarly microscopically on the slip plane in the slip direction we are applying resolved shear stress which reaches its critical value, critical resolved shear stress at the point of yielding.

Now, if we look at this relationship this particular factor which we call the Schmid factor, this depends upon phi N, note what is phi N phi N is the angle between stress axis and slip plane normal. And phi D is the angle between stress axis and slip direction. So, this factor depends on the orientation of a stress axis from the orientation with respect to the slip system.

So, if I change my orientation if I change the orientation of the stress axis this factor will change, a change in orientation of the stress axis with respect to the slip system that is the slip direction and the slip plane will change the Schmid factor..

Then what will happen what will happen to this equality if both CRSS and sigma y are constant then by changing cos phi and cos phi D I cannot maintain this equality, but the equality has to be maintained at the point of yielding. So, this means since cos phi N and cos phi D can be independently varied by choosing my stress axis both CRSS, and sigma y cannot be constant.

Although they are material property, but they cannot both be constant, both cannot be constant. So, the question now is which of these is constant which remains constant and which vary is a important question.

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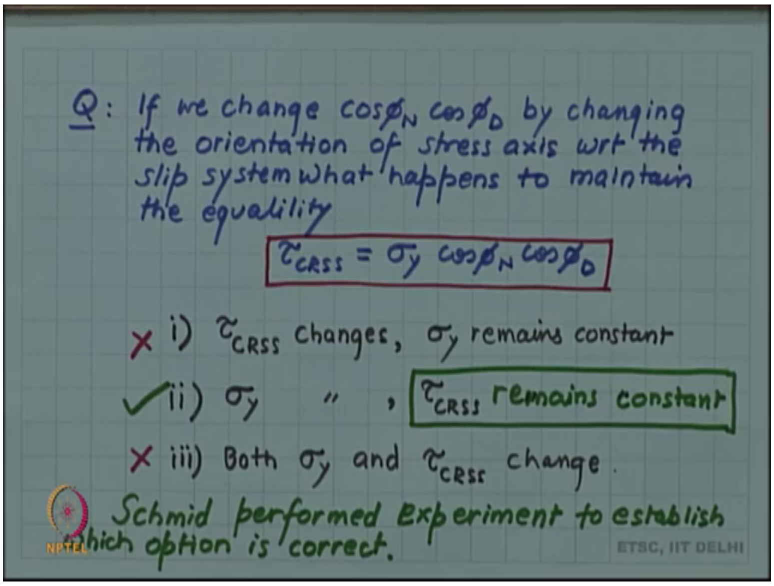

So, the question if we change cos phi N cos phi D by changing the orientation of stress axis with respect to the slip system what happens slip system what happens to maintain the equality tau CRSS is equal to sigma y cos phi and cos phi D.

So, let us write down the options tau CRSS changes sigma y remains constant the other option can be sigma y changes tau CRSS remains constant or there can be a third option that both sigma y and tau CRSS change which of these options is right.

Again we are this is also similar to the question which we had raised regarding the crystal structure change that these questions cannot just be answered by thinking logically or philosophically. These questions are question of science and question should be put finally, to the nature that is we have to do proper experiments to establish what is happening and these experiments the person who did the experiment was Schmid Schmid performed experiments.

So, one has to perform very careful experiments to establish which option is correct and his experiments indicated that actually it is the option 2 which is right. The experiments showed that critical resolved shear stress remains constant whereas, sigma y changes so this is what is called Schmid's law. So, let us write it as a law Schmid's law.

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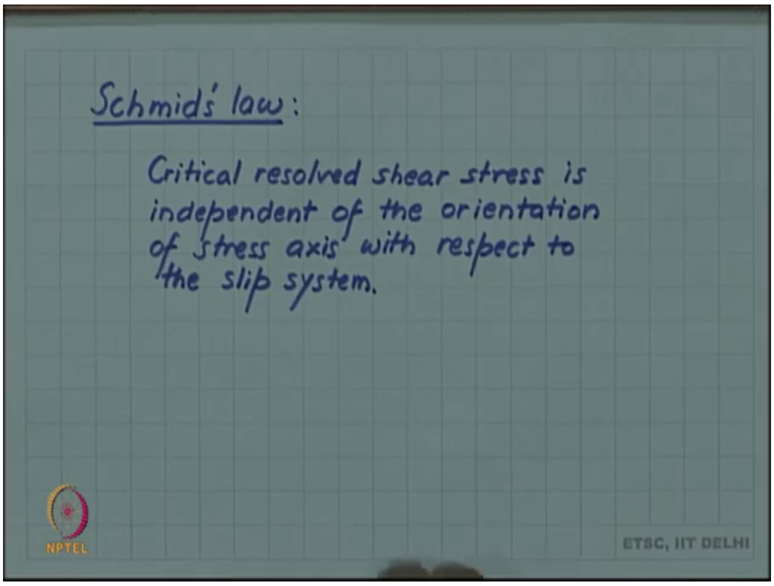

So, essentially the content of the Schmid's law is that the critical resolved shear stress; shear stress is independent of the orientation of a stress axis with respect to the slip system.

As you change your stress axis with respect to the slip system cos phi and cos phi D changes, but critical resolved shear stress will not change, quite often this actually quite often mistakenly this relationship itself is taken as Schmid's law.

But note that this relationship is only relating the yield stress to the critical resolved shear stress this does not tell that critical resolved shear stress will remain constant or yield stress will remain constant if you change cos phi and cos phi D that was Schmid's contribution, Schmid perform careful beautiful experiment to establish this and that is why we honor him by naming this law after him. So, critical resolved shear stress is independent of the orientation of a stress axis with respect to the slip system.

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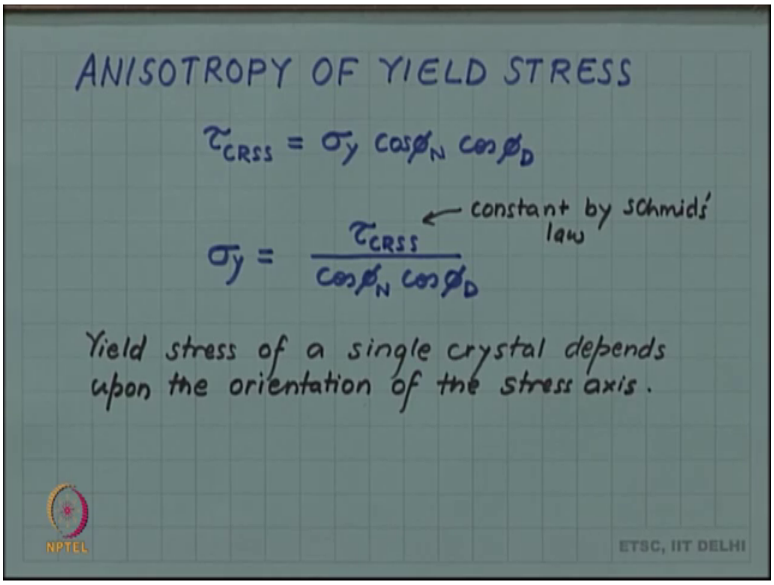

So, a consequence of this is obvious that the yield stress becomes an isotropic because recall the relationship we had tau CRSS is equal to sigma y cos phi and cos phi D. Now if I change the orientation of the stress axis cos phi and cos phi D will change if tau CRSS remains constant by Schmid's law then sigma y has to change.

So, we can write this as sigma y tau CRSS by cos phi N cos phi d. So, yield stress of single crystal this is constant by Schmid's law. The yield stress of a single crystal depends upon orientation of the stress axis or in other word yield stress is an isotropic. Because cos phi and cos phi D will depend upon the orientation of the stress axis.