Introduction to Materials Science and Engineering
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Lecture – 128
Recrystallization

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We have seen that when a deformed material is heated, then a process called annealing happens, where the property of the deformed material is restored to values prior to deformation. And this process of annealing happens in stages of three stages of recovery, recrystallization and grain growth, we have looked at recover. Now, let us look at recrystallization.

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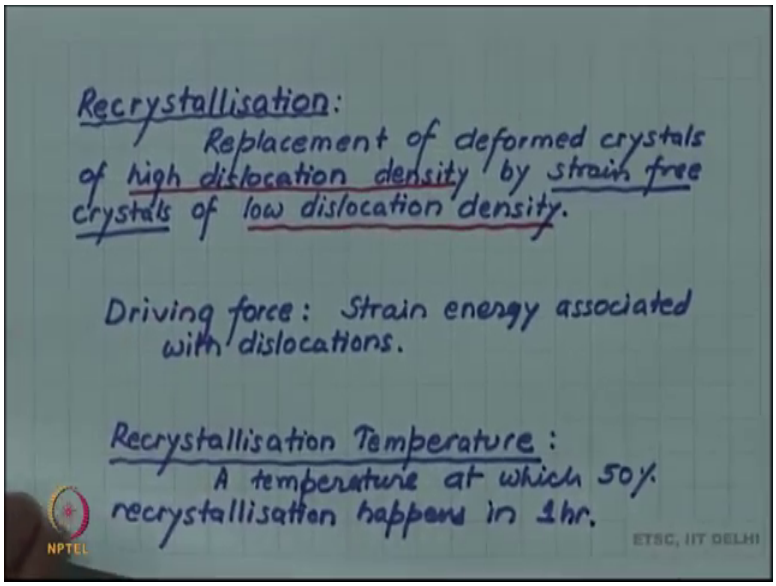

So, recrystallization is replacement of deformed crystals of high dislocation density by a strain free crystals of low dislocation density. So, you are going from high dislocation density to low dislocation density, there was some lowering of dislocation density in the in during the recovery stage, where dislocation of opposite signs and I came together and annihilated. But it still dislocations are left in the crystal and there is a driving force because of the high density of dislocation. So, the driving force for recrystallization is the strain energy associated with dislocations strain energy.

So, new strain free crystals; new strain free crystals form and grow into the material and gradually replace all the deformed crystal. When all the deformed crystals are replaced, we will consider that to be completion of recrystallization. One defines a recrystallization temperature. Now, recrystallization process is actually temperature dependent and it depends exponentially on temperature.

So, the amount of time required for recrystallization to complete will depend upon the temperature. But still for practical purposes; one defines recrystallization temperature as a temperature as a temperature at which 50 percent recrystallization means 50 percent of the volume of the material is recrystallised. So, 50 percent recrystallization happens in 1 hour.

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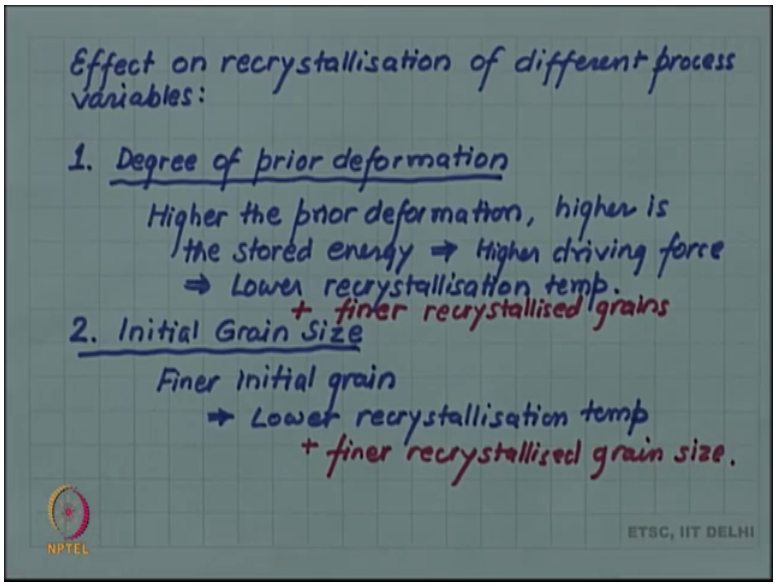

Now, let us look at the effect of different variables, different processing variables different process variables on recrystallization. So, one such variable is the degree of prior deformation; how much we have deformed before we have started the annealing or recrystallization process.

So, higher the deformation; higher the prior deformation; higher is the stored energy. So, this will give to higher driving force, which will then lower the recrystallization temperature. Since driving force is more, recrystallization can happen at a lower temperature, which essentially means recrystallization rates are higher because of the higher prior deformation, it will also because of this; you will also get final recrystallised grains.

Now, if you start with a finer grain material fine grain material, if the initial grain is fine will also lead to more because it is the initial grain boundaries which act as nucleation sites for recrystallization. So, finer is the initial grain size more is such grain boundary sites and so, recrystallization rate is higher and so, you will again get lower recrystallization temperature and finer recrystallised grain size.

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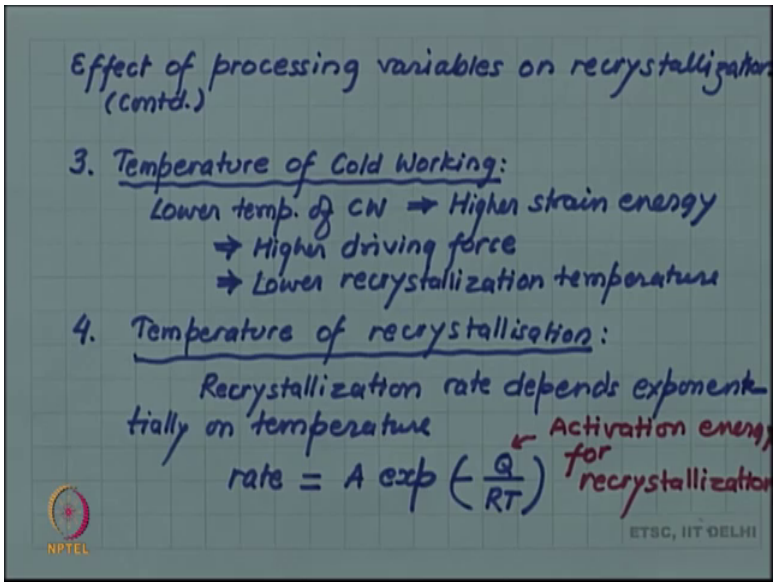

Then comes the temperature of the cold working at what temperature the material was deformed. So, lower is the deformation temperature, lower temperature of cold working will store higher strain energy in the material. So, which will mean, higher driving force and thus lower recrystallization temperature, and then the temperature of recrystallization at what temperature, you are keeping the deformed material for recrystallization.

So, it is seen that the recrystallization rate recrystallization rate depends exponentially on temperature choice a various kind of law; the rate is some A exponential minus Q by RT where as useful Q will be the activation energy for the process in this case, activation energy for recrystallization.

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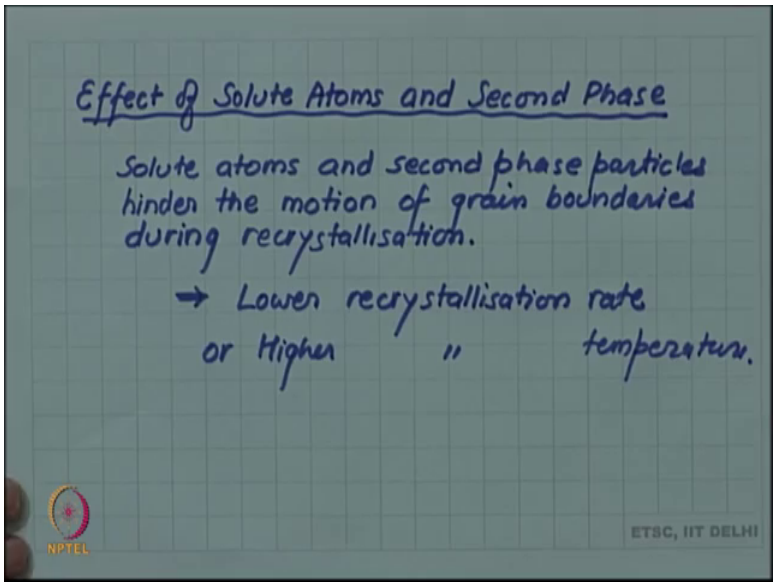

During recrystallization; as we saw new grains form new strain free grains form and grow into the deformed matrix. So, the migration of these boundaries is affected by the presence of solute atoms and second phase. So, both of them solute atoms and second phase particles hinder the motion of grain boundaries during recrystallization. So, they lower the recrystallization rate lower recrystallization rate or in other words, higher recrystallization temperature.