Introduction to Materials Science and Engineering
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Lecture – 40
Tacticity

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Let us discuss tacticity or stereoisomerism this is an important feature of polymer structure.

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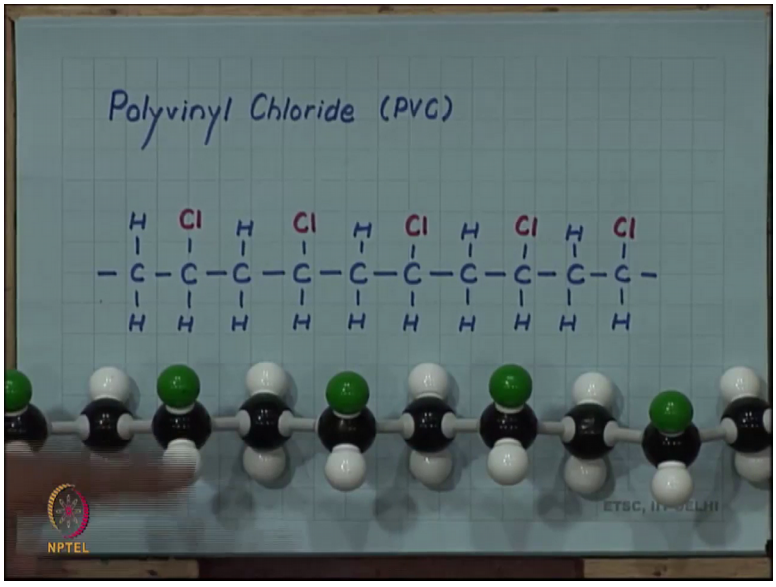

Let us consider polyvinyl chloride. So, in the polyvinyl chloride, I have a molecule of polyvinyl chloride here, let us say and we can see that all the way I have made the model or the way I have drawn the structure here all chlorine atoms, chlorine atoms are appearing on alternate carbon atoms, 1 carbon atom has both the hydrogen atoms and the other carbon atom has 1 hydrogen and 1 chlorine atom.

So, the various structure is made here, all the chlorine atoms are appearing on 1 side of the carbon-carbon backbone. So, all of them are appearing let us say on the left, if I am following along this line all of them are appearing on the left, this is called this kind of a structure is called Isotactic PVC.

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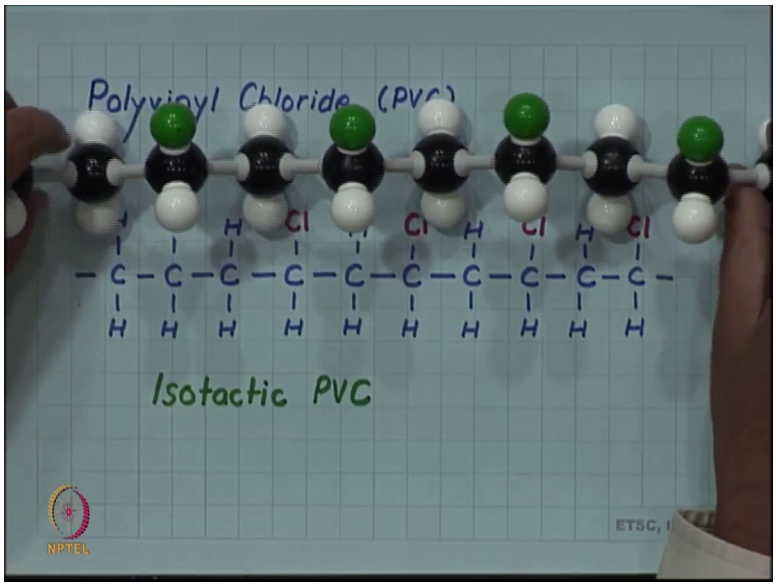

It is possible to have chlorine atoms.

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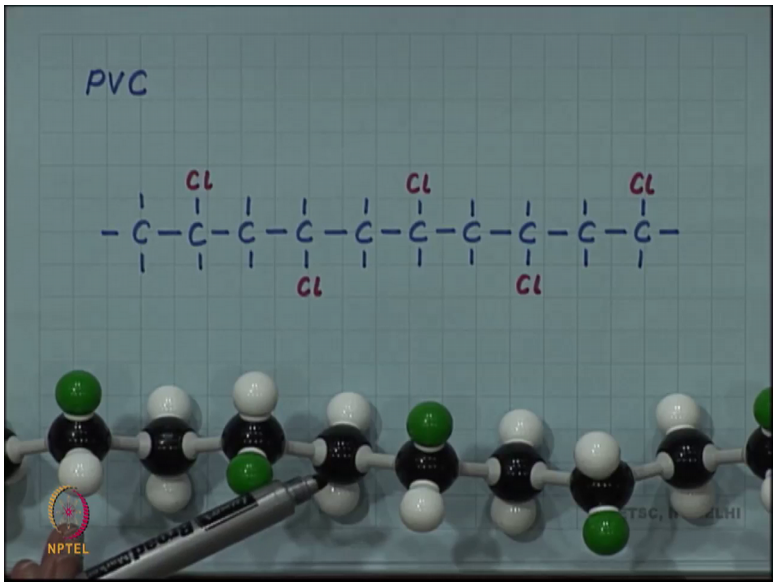

Not on all, on the same side, but on the alternating sides. So, here is the model, so you can see, now if I am following the carbon-carbon backbone as my path, once the chlorine comes on the left, the another chlorine comes on right in this left and right. So, if such alternating positions of chlorine is there, then we will call such a structure as Syndiotactic, this is a syndiotactic polyvinyl chloride.

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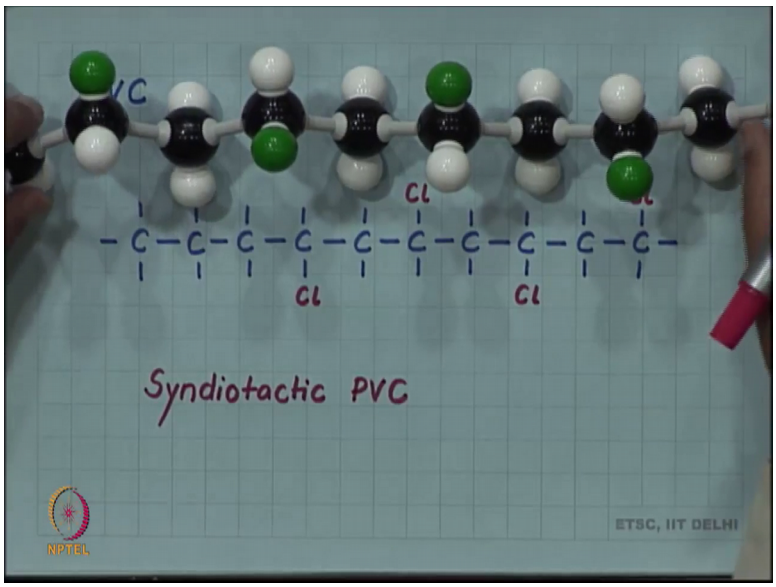

So, we have isotactic, we have syndiotactic, you can imagine that you can also have some sort of random arrangement of chlorine molecules.

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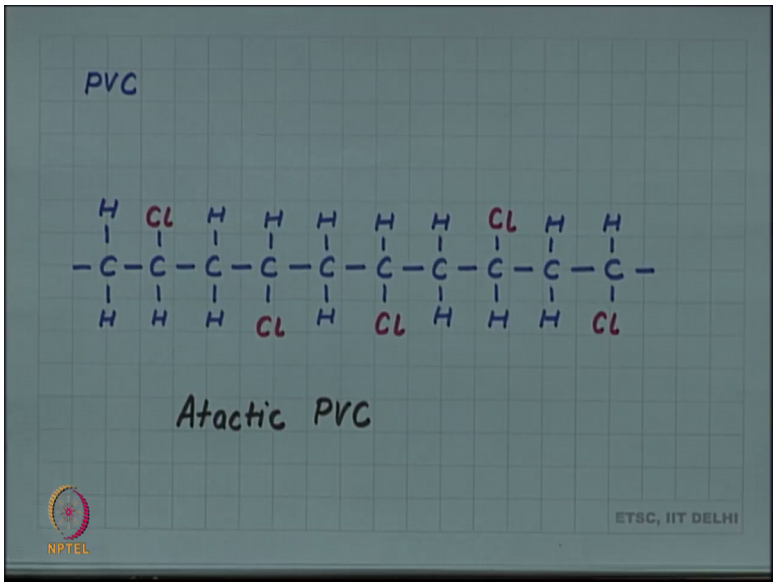

So, it came on the left here, here it is coming on the right, the next 1 still comes on the right, then it goes on the left. So, if there is no such particular order, then this is called Atactic PVC. You can see that they are all of the same chemical composition; the chemical composition of such PVC is exactly the same. There are 2 carbon, in the monomer there are 2 carbon atoms, 3 hydrogen atoms and 1 chlorine and this is what repeats. So, 2 carbon, 3 hydrogen and 1 chlorine is the fixed composition of this PVC, but still the structure of atactic, isotactic and syndiotactic are different in this subtle way.

Another thing is that, if I take the syndiotactic molecule I cannot, just by you remember that we had rotational degree of freedom. So, we may that is called conformation.

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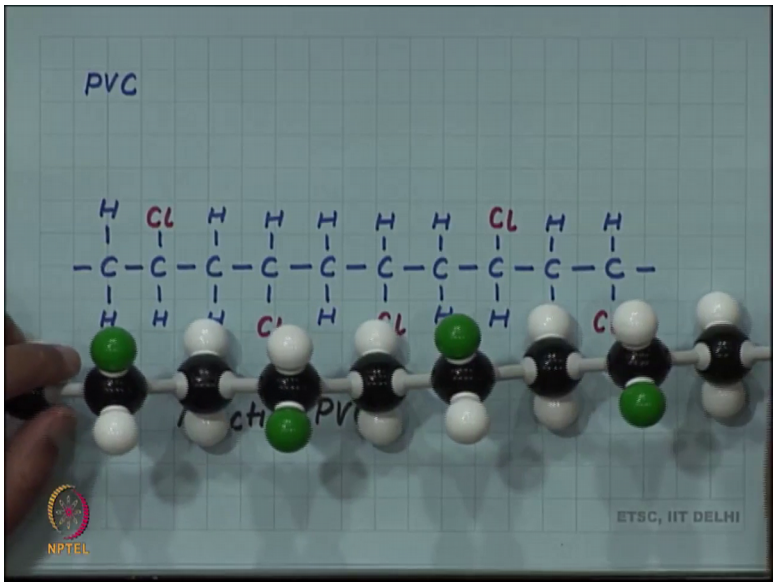

So, if I think, that I if I just rotate this, so and to bring it on the same side. So, it has come on the same side, but still now the molecule has changed it is shape in a different way, if I put it in a straight, if I make it a straight backbone then I can always find out that it is a 2 syndiotactic and not isotactic. So, the configuration or the tacticity cannot be changed by simply rotation or changing the conformation of the molecule, whatever it is conformation a syndiotactic molecule will remain syndiotactic.

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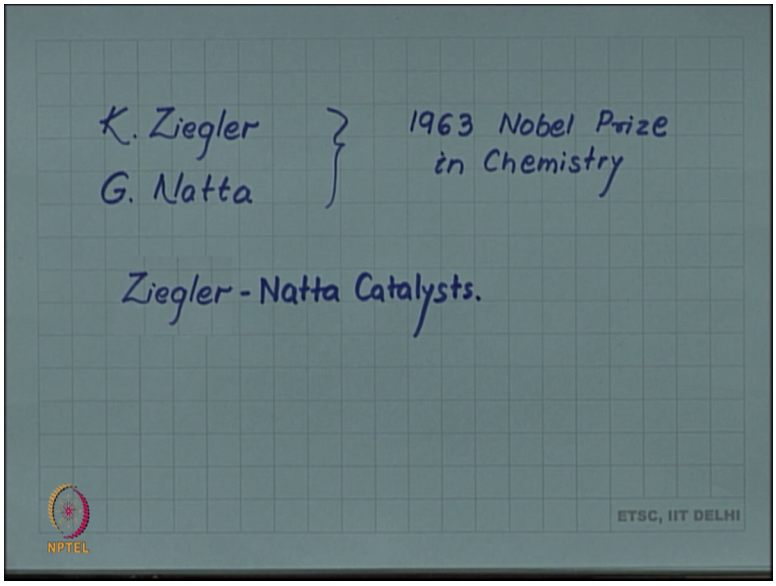

The question is how to form these different configurations or different tacticity? So, Ziegler and Natta actually attain or achieve this success in trying to obtain different kinds of polymers, the atactic, isotactic or syndiotactic depending on the control of catalysts and these catalysts are called the Ziegler-Natta catalysts. So, different catalysts give you different kinds of tacticity. In the 1963, Nobel Prize in Chemistry was given to these 2 scientist for this achievement.