Transition Metal Organometallics in Catalysis and Biology
Prof. Prasenjit Ghosh
Department of Chemistry
Indian Institute of Tth tzechnology – Bombay

Module No # 08
Lecture No # 40
Olefin Polymerization (Part – 1)

Welcome to this course on transition metal organometallics in catalysis and biology we will be talking about olefin polymerization in today's lecture. We have started this topic in the previous lecture where we had just given a brief introduction about olefin polymerization reaction. To being with this important to note that as per as the olefin is concerned they are oligomerization as well as polymerization are both very important industrially in terms of large scale synthesis for various applications the ranging from anti knock reagents to detergents to even materials polymers for materials applications.

So as far as the olefin is concerned they are both the process is oligomerization as far as polymerization are of substantial interest. Now in this context we have discussed various forms of oligomerization reaction in the previous lectures and then started moving on to olefin polymerization. Now with regard to the olefin polymerization what we have learnt that this is very big scale industrial process where about 70 mega ton of polymers are produced annually.

Now these polymers are produced annually using olefin polymerizations are very diverse and require a detailed understanding of structure activity relationship a SAR structure activity relationship in order to design catalyst better suited in our delivering polymers of particular need and demand. Now the last thing which we had discussed in the last lecture is also about this mobility segment mobility which is related to the extent to the branching of cross linking present in the polymer back bone that sort of defines the type of material that one becomes.

So larger amount of segment mobility are branching could lead to development of software polymer materials whereas linear long chain polymers would give rise to brittle and hard polymers. Now in today's lecture what we are going to take a do first used to look at the various classifications that have been reported for this olefin polymers and then gradually go over the types of polymers that are known or have been named based on their different properties and classified this domain properties and then slowly we will move on to various kind of ethylene based poly olefin based polymers and then to poly propylene based polymers and then based on the classification and then we will look into the mechanism and examples related to this polymerization reaction.

So being with let me just talk about various kinds of classifications of polymer that are conventionally used.

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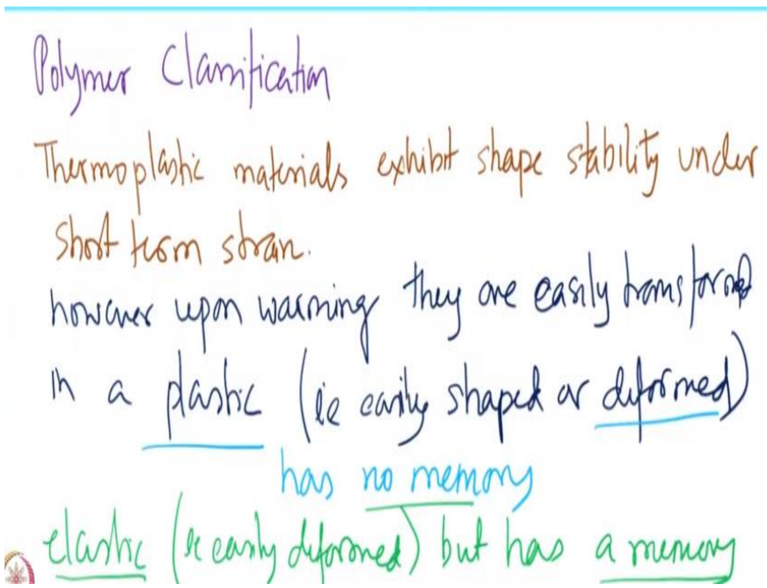

The first one is thermoplastic materials exhibit shapes stability under short term strain. However upon warming they are easily transformed into plastics now what is plastic in polymer (()) (05:49) plastic means easily shaped that is we can be changed to a shape of desire without much strain. So that means they can be formed and once deformed this plastic material sort of retain the final shape easily shaped or deformed.

So what is plastic mean that plastic material are easily deformed can easily changed into another shape. So that means that plastic material do not have much memory of their own. So they cannot come back to the original state after the deforming force is released. Whereas reverse of plastic material are elastic material are the material which can be deformed easily however once the deforming forcing is taken off elastic materials as a memory as it comes back to its original shape.

So difference between elastic and plastic is that plastic material as no memory however elastic material can easily deformed but as a memory that means when the deforming force is taken way and elastic material could remember its original shape and gets back to it. Whereas the plastic material can also be deformed easily however when the deforming force is taken off it retrains the deformed shape it has no memory that means it does not go back to its original step.

So at higher temperature this thermo plus or plastic and this change is reversible thermo plastic materials are built from linear or slightly bleached polymers.

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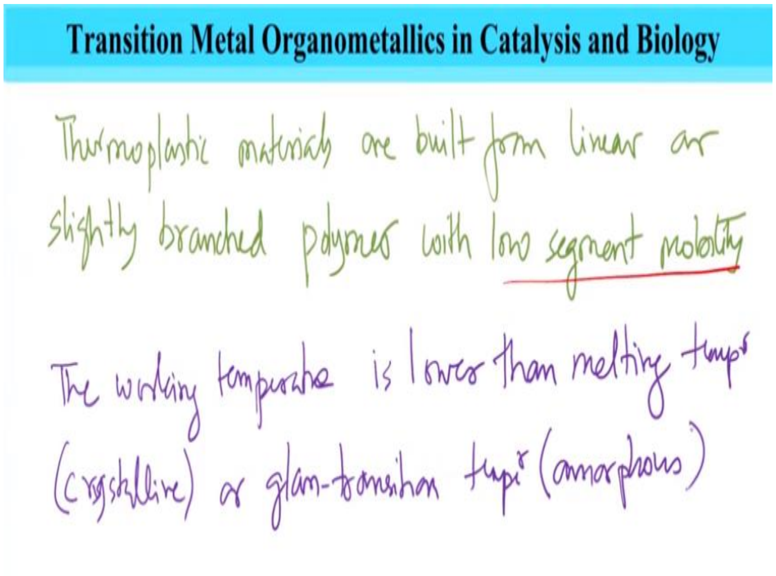

The plastic materials are built from linear or slightly branched polymer with low segment mobility and so these are this thermoplastic material are not branched or slightly branched are mostly linear so they are segment mobility is kind of not too much and usually are low and for this material working temperature is lower than melting temperature that means the crystalline part phase of it or lower than melting temperature or glass transition temperature that is the amorphous nature.

Now at this point it is to be noted that polymers are large molecules and they are different from small molecular monomers. For example for a small molecule it is important that this small molecule will have a unique molecular weight as well as unique melting point and often melting point is a method is often used to characterize the purity of small molecule compounds by looking at this melting point if the melting point transition is sharp it is assumed that the compound is pure and also the melting point is characteristic of the compound.

However these 2 properties that is the molecular weight which is unique to compound as well as the melting point also unique to a small molecule compound are however different when it comes to polymers. Now one thing which is primary difference is polymer for a polymer does not have a single molecular weight usually the polymer produced have a range of molecular weight and their usually given as a statistical distribution in terms of weight average molecular weight or the number average molecular weight.

So here is the first distinction between a polymer molecule and a small molecule compound that are small molecule compound will have a unique characteristic melting point whereas polymer molecule will have a range of melting points and melting points may be differ different depending on how you measure them. One can one range of melting point can rise from their weight average molecular weight and the other range of melting point can arise from there number molecule average weight.

So polymer as may have many molecular weight at least 2 molecular weight sometimes they if the measurement is done through density then the density average molecular weight. So there are no unique molecular weight to polymer the way it is there for small molecule. Secondly the second difference is that the polymer chain may have regions which are crystalline in nature that means the chains are stacked up an ordered fashion whereas there may be regions where the polymer chains are random and completely disoriented.

Now depending in this region where the region in which the chains are very ordered and crystalline so they show a transition phase transition which is called melting temperature and the region where and this melting temperature is sharp for crystalline region sharp phase transition whereas the region which is amorphous where the polymer chains are not oriented in any particular direction or more random and disoriented.

They do also show a particular transition and this are non-very sharp but generally broad and these are called glass transition temperature. So unlike a small molecular which can either be crystalline or amorphous in nature polymer can be both polymer can have both crystalline domain as well as amorphous domain and polymer may exhibit 2 transition temperatures one is melting temperature the other is glass transition temperature.

And the third thing is the fact that the glass transition usually occurs that low temperature than that of the melting temperature. So these are some of the unique features are attributes of polymers which distinguish them from monomers. Now thermoplastic conditions for working for use of thermoplastic is that the working temperature in this context is to be noted that the working temperature for thermoplastic material is lower than both the melting temperature as well as the glass transition temperature of the polymer.

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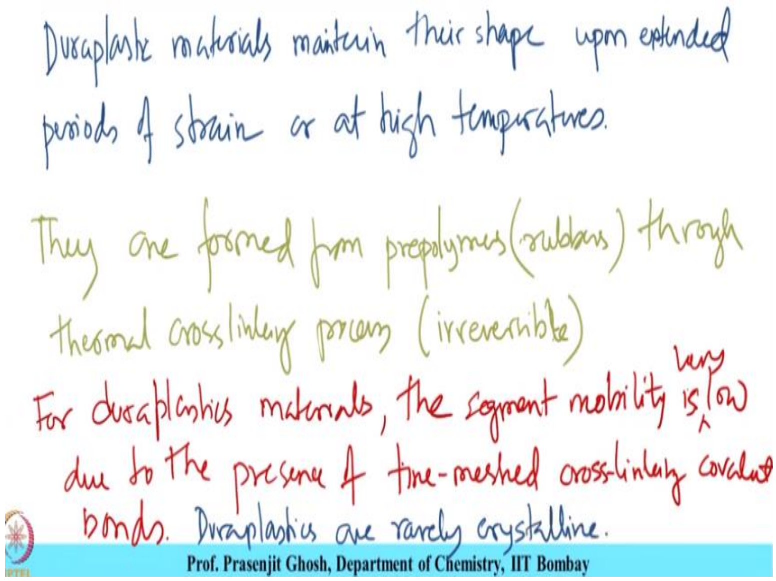

So we come to the next classification which is dura-plastic materials these dura-plastic materials maintain their shape upon extended period of strain or at high temperatures they and these duraplastics are usually formed from P polymers which are (()) (16:49) is a pre-polymer some naturally occurring like rubber and so on hence so forth which can or cross linked are joined together through cross linking process called cutting and these are also called as thermo materials.

They are formed from pre-polymers like rubber's through thermal cross linking process and this process is the irreversible. So if we take some per-polymers and heat them then they become cross linked and they become dura-plastic materials and this process is usually irreversible these cross linking of pre-polymers to give dura-plastic is usually irreversible file process. For dura-plastic also for dura-plastic material the segment mobility is very low due to the presence of fine meshed cross linking covalent bonds.

And because of this reason dura-plastics or often amorphous and rarely crystalline so the first we had seen thermoplastic material then we come across this duro-plastic material the mechanics they maintain the shape upon extended period of strain or at high temperatures they usually are formed from pre-polymers to thermal cross linking process also this dura-plastic material has low segment mobility due to the presence of fine mist cross linking covalent bond.

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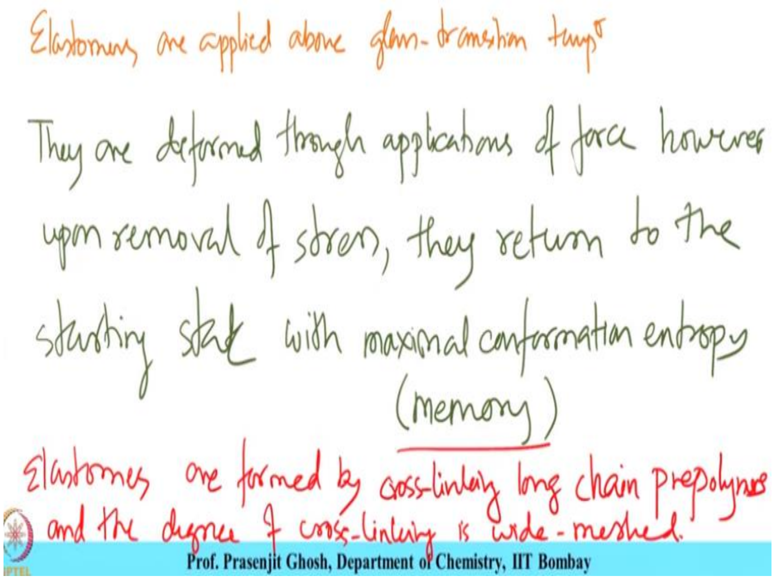

However duraplastics are rarely crystalline polymers next in this classification comes elastomers are applied above glass transition temperature and they are deformed through applications of force. However upon removal of stress they return to the starting state with maximal confirmation entropy. So this is what we just discussed that they sort of have a memory so the different between elastic nature and the plastic nature is that like plastic nature elastic materials are easily deformed through application of force however upon remember of stress they return back to the starting state with maximal conformational entropy as if they have a memory of their initial state and their they come back to that shape when it comes to these elastomers.

Elastomers are also are formed by cross linking pre-polymers long chain pre-polymers and the degree of cross linking is wide meshed. And so what is the different between the elastomers and duraplast is that duraplast are also formed by thermal cross linking of pre-polymer however in case of elastomers this thermal cross linking of long people long chain pre-polymers are done and the other difference is for duraplast that this cross linking is fine meshed whereas the degree of cross linking is wide meshed in terms of elastomers.

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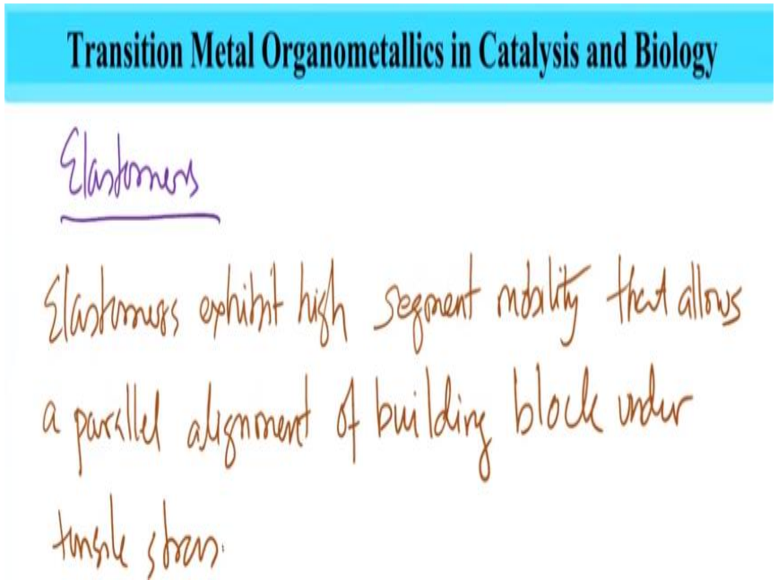

Another important attribute of elastomers is that elastomers exhibit high segment mobility elastomers exhibit high segment mobility that allows a parallel alignment of building blocks under tensile strength stress. So now the last important property or different between elastomer and the duraplast is the duraplast has very low segment mobility on the contrast elastomers are very high segment mobility that allows a parallel alignment of building blocks under tensile strength.

So with these the we come to the conclusion of today's lecture in today's lecture what we have done is we have looked into classification of olefin polymer polymeric material based on the properties and to begin with we had covered 3 different kind of polymer classification one is called thermo plastic material this is the material that exhibit their shape under short term strain upon higher temperature they become plastic then we have looked at duraplast material maintain their shape upon extended period of strain or at high temperature.

And lastly we looked at are elastomers which operate above glass transition temperature these are usually deformed but upon removal of the deforming stress they go back to the original configuration and retain their shape. So we have seen how these materials are formed usually by forming cross linking between pre-polymers by heating and then we have also looked at how finally they are meshed in order to which in the retain the classification that it belong category that it belongs to.

So with these I come to the end of today's discussion we are going to talk more about the classification of polymers before we look into poly olefin and polypropylene in terms of synthesis and mechanism so there is a lot of excitement ahead in this topic of olefin polymerization. So with these I again thank for being with me in this lecture and I look forward to discussing more on olefin polymerization when we meet next few till then good bye and thank you.