**Introduction to Organometallic Chemistry**
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**Lecture - 20**
**Oxidative Coupling with C-C Bond Formation**

Today, we will discuss a reaction which is popularly called the olefin metathesis reaction and this reaction is almost magical reaction of difference can be reacted with one another in the presence of a metal complex to yield a variety of different olefins. Many of them are reissue of these olefins are thermodynamically determined and it allows the synthesis of very complex and very interesting molecules.

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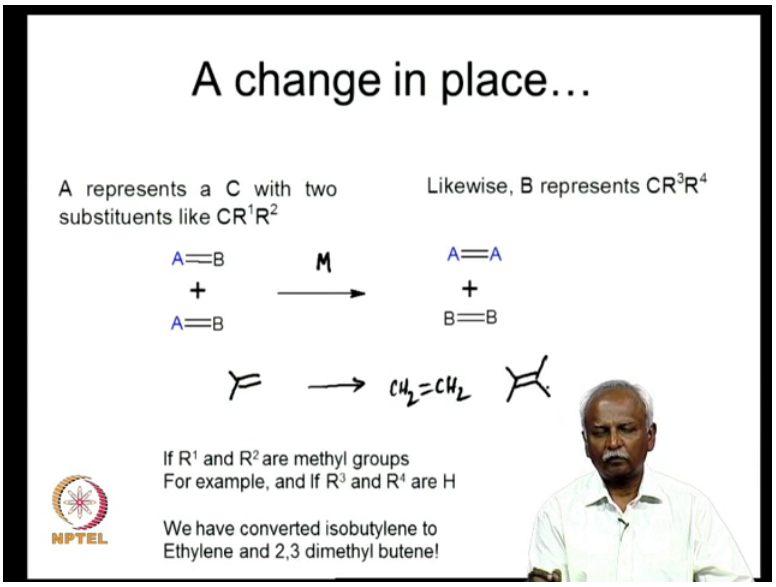


So, metathesis clearly means the change in place, so if we represent this schematically an olefin as A B we take two molecules of the A B and react them together in the presence of a metal complex. So, the metal is a catalyst and you will get molecules of AA and BB, so you can imagine the scenario when A B and C D are reacted at least four different olefins can be generated from this reaction.

Now, we have the possibility of converting, for example isobutylene which is very simply written this molecule to a variety of olefins including epithelial and 2, 3 dimethylene butane. So, you can get various molecules starting with the simplicity of olefins.

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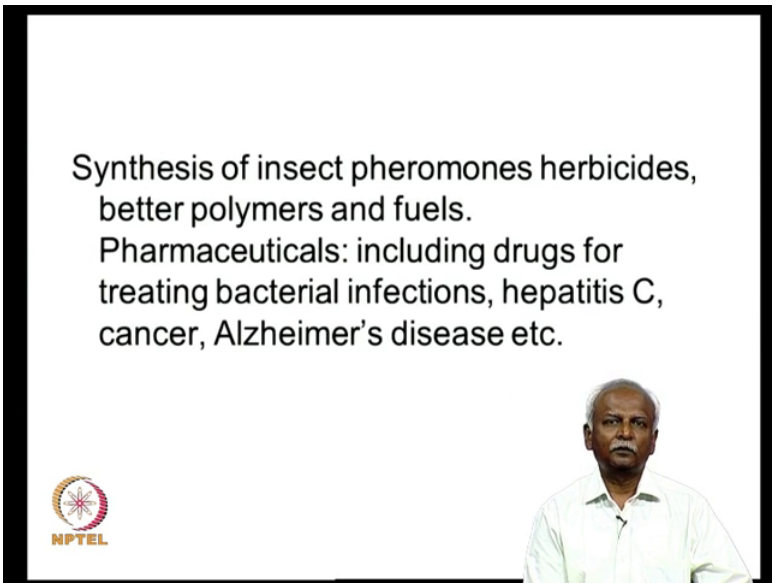


This has led to an enormous spurt in the organic synthetic chic people have been able to use it effectively for making pheromones are besides better thalamus and polymer additives and fuels, especially in the field of pharmaceuticals. It has helped in the synthesis of very complex molecules, which can be used as drugs for bacterial infection separators cancer and Alzheimer's disease et cetera.

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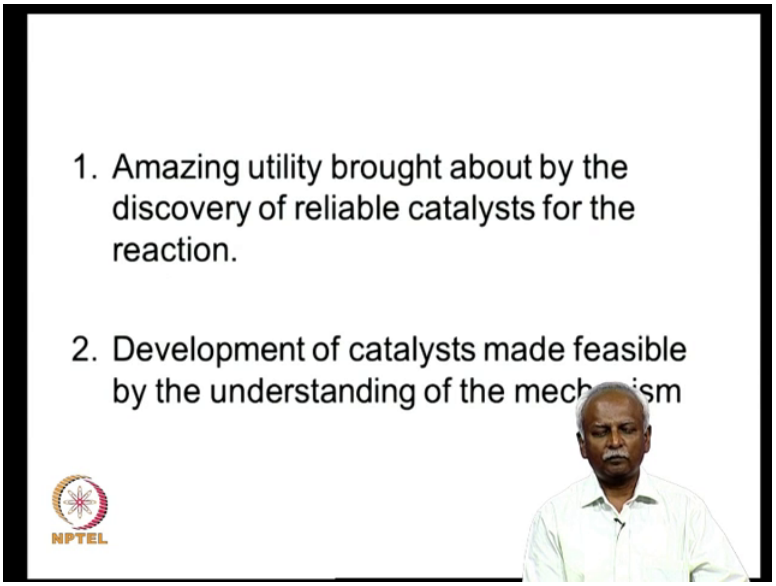


At first sight, this reaction seems to be a really difficult one to handle, because you can get a mixture of olefins and how it can be used for making specific molecules need to be

considered. This amazing utility has been brought about by the discovery of reliable or not only is a reaction something which needs to be adjusted so that you get only useful products. You also need to synthesise catalysts, which need to be reliable and this development of catalyst built only because one could understand the mechanism of this reaction.

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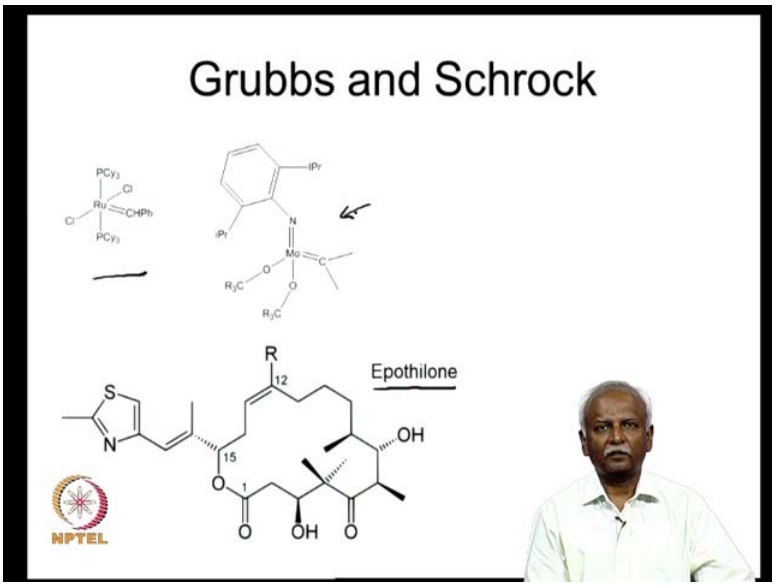


So, the main players in this whole game were to process Robert Grubbs and Richard Schrock and they contributed immensely to the development of this field. As a result complex molecules like cairo, which is basically it is basically a drug molecule, which is a drug molecule and it could be synthesised in a remarkably efficient synthesis using this metathesis catalyst. The catalyst themselves some of them the standard ones are pictured here though pentacle related ruthenium complex is the one which is synthesised and popularised. Grubbs and Schrock synthesised this molybdenum complex and both of them later anonymous spurt in the amount of organic synthesis schemes, which could be carried out using that metathesis reaction.

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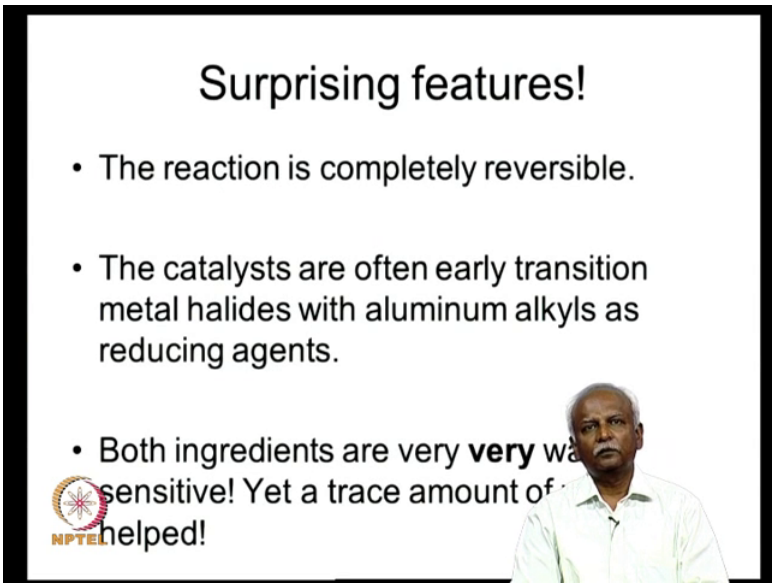


This reaction is got some surprising features as I mentioned earlier, reaction is completely reversible and this makes it easy for one to synthesise thermodynamically more stable products will easily. If you want to go uphill in a thermodynamic makes sense, you need to adjust the reaction conditions carefully. What is interesting is also the fact that early transition metal helmets were originally discovered as the ones which are suitable for carrying out this reaction in the presence of aluminium molecules which were primarily thought to be reducing agents.

Now, it turns out that both aluminium molecules both aluminium alkalis and the transition metal helmets early transition metal helmets are very water sensitive and yet a trace of water appear to be beneficial for the reaction. There was an initial waiting time for the catalyst to become active and those were shortened significantly when a small amount of water was added to the reaction mixture, these are some surprising features of the reaction.

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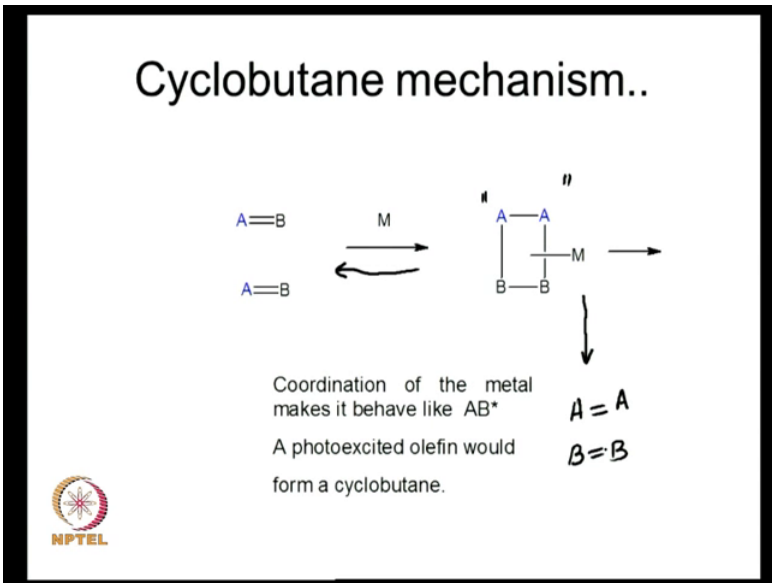


Any mechanism that one proposed should explain some of these difficulties very well. In the beginning of this talk, I will explain to you some of the mechanisms which were proposed, which seem to be ferried reasonable, but still they do not stand the test of time and the test of scrutiny. Let us take for example the cycle butane mechanism this is one of the earlier mechanisms that was proposed and grows quite attractive. What one proposed was a fact that in the presence of the metal two molecules of olefin can react together to form a cycle butane, which although transiently could be formed in the coordination sphere of the metal.

So, the cycle butane was not stable intermediate could be a transient intermediate which could be found in the coalition sphere the metal and subsequently it would undergo the reverse reaction and form the two olefins again. So, this is the proposed mechanism the reverse reaction could also happen and if it formed, it proceeded in a productive fashion if it formed two molecules of A B, then it would not be protective effect from two molecules of AA or BB.

Then, we say it is a productive reaction and the reaction is carried out on metathesis, which means the changing positions of A and B with respect to one another. Now, how can one propose such a reaction mechanism, if you remember we said that when our olefin is coordinated to a metal electrons are depleted from the ground. The highest

occupied molecular and they are pushed into the lowest unoccupied molecular orbital or the lump of the olefin.

So, in a sense they behave as if the photo excited molecules and if you recollect your organic chemistry, you will realise that photo excitation can lead to a two plus two close to cyclone addition reaction. That is exactly what we are proposing because of this reaction, so you are suggesting the formation of a cycle butane in the coalition sphere of metal and its secular version.

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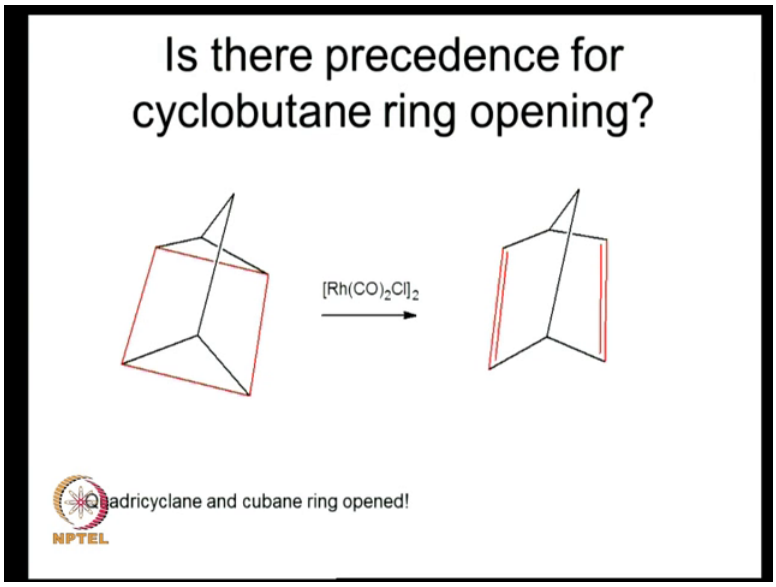


Is there any precedence have such a cycle butane opening and cycle butane formation, so that is a question that we have to answer. Next, this is a reaction which was known in the literature recycling reopened in the presence of rhodium one complex. It resulted in the formation of non volatile and use one imagines the interaction of rhodium to recycling the cycle butane training, which is marked in red cycle butane ring is marked in red and that drink in tracksuit rhodium. Then, the ring opening would lead to another so clearly you do have a possibility for a metal catalysed ring opening of a cycle butane training to two olefins.

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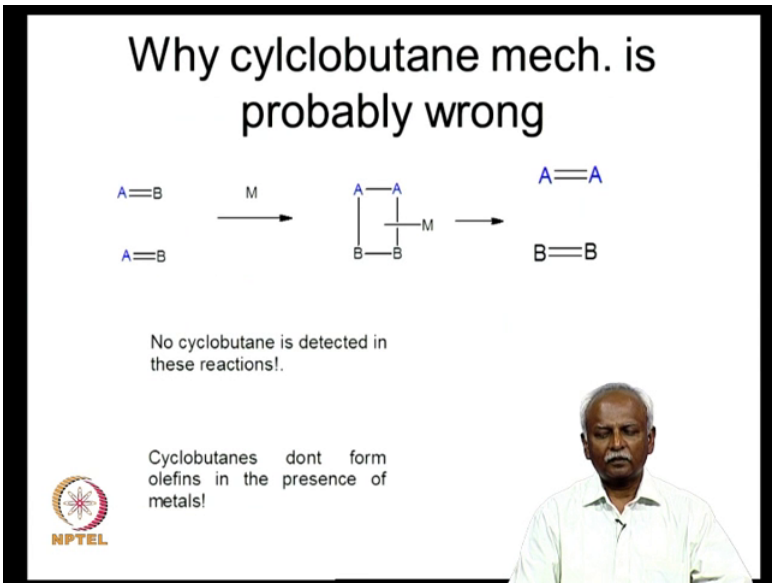


Now, having said that we should quickly say that no cycle butane is ever been observed in these reactions, so it is highly unlikely that these are intermediates that not observing an intermediate is no reason to discount it.

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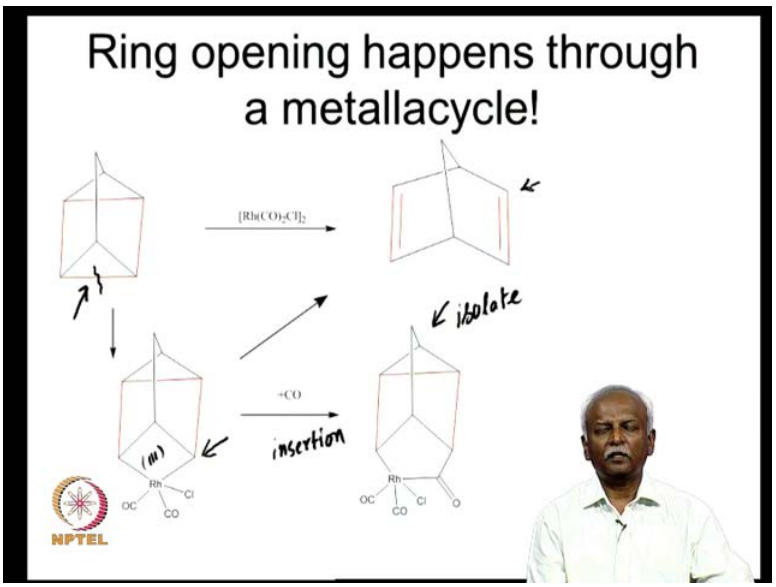


So, let us look at some other reasons why the discount is mechanism of them is a fact that after you do this reaction in the presence of carbon monoxide is possible to isolate the product, which is clearly formed as a result of an insertion detection. The insertion has been carried out on a species, which is most likely formed due to insertion of

rhodium into this carbon, carbon bond. So, if this carbon, carbon bond breaks, if this breaks and if the metal inserts itself between the two carbon centres, then one would end up with an intermediate, which I have pictured here this intermediate can undergo an insertion reaction.

If carbon monoxide is present and one can isolate a new organometallic species show first rhodium undergoes insertion reaction and becomes a rhodium 3 intermediate this rudimentary oxidative addition product now undergoes an insertion step. So, subsequent to the insertion the isolate an organomegaly compound, which is stable and that is indicator was suggestive of the fact.

You indeed have the formation of a insertion oxidative addition product to start with and oxidative addition product can also reopened in order to form the two different product the non volatile which we have. This is a product that is isolated in the absence of carbon monoxide, so this is suggestive of the fact that it is not a cycle butane which is coordinated to rhodium. This undergoes a cyclone version reaction it is unlikely that that is in fact the mechanism of the reaction.

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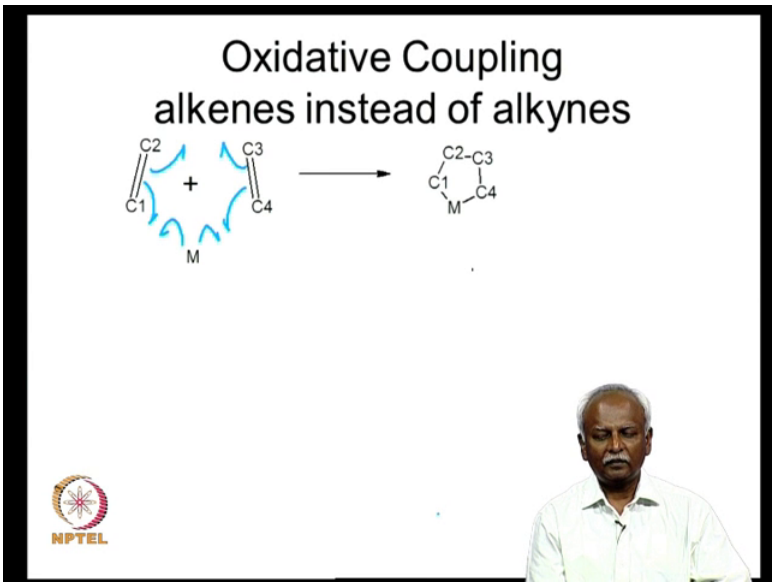


Now, that leads to another interesting possibility and that is a possibility, which we discussed in the coupling of kinds showing servile kinds, if alkanes can be reacted with a metal in such a fashion that you have oxidative addition and carbon, carbon coupling. Let us highlight with highlight the new bonds that have been found, so if one electron is

given, here one electron moved in this direction. Then, you will have three new bonds being formed and history new bonds with can see that they will be formed between C 2 C 3 and C 4 and an C 1 and that would result in a metal cycle and dismantle a psyche which will the remove these lines.

They seem to be confusing sure if this motorcyclist cyclone at Metho cyco pentane family, then this can undergo a discontinued involved in the cyclone version of this can be involved in the formation. A cyclone version reaction shows better setup entails form and it undergoes adverse reaction you will end up with the olefins.

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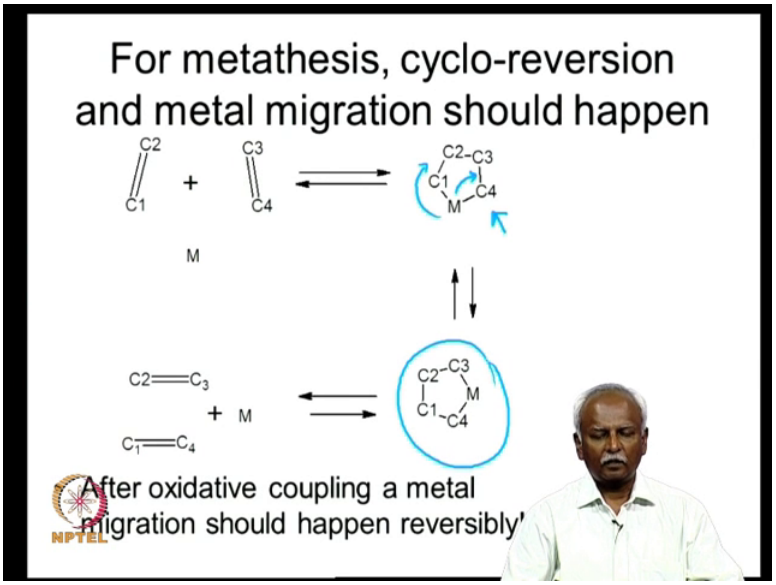


Now, in order to carry metathesis, however one has to carry out an isomerisation of the metal cycle contain sure the metallocyclopentane, which is indicated here has to undergo a migration disobeying between C 1 and C 4. It has to come between C 4 and C 3 or C 1 and C 2 can migrate into different ways that either way if it goes between C 1 and C 2 little to different matter cycle content, but if it moves between C 2 and C 4 and C 3, it will give you this product. So, migration between C 4 and C 3 is what gives you this product and now cyclone ovation will give you two different olefins. So, we are carried out the metathesis reaction after oxidative coupling of the metal that is what really looked at oxidative coupling of metal were metal is given to electrons. So, it is undergone oxidation state changed and it has become plus 2 and this after this reaction, now gives you a metathesis reaction.

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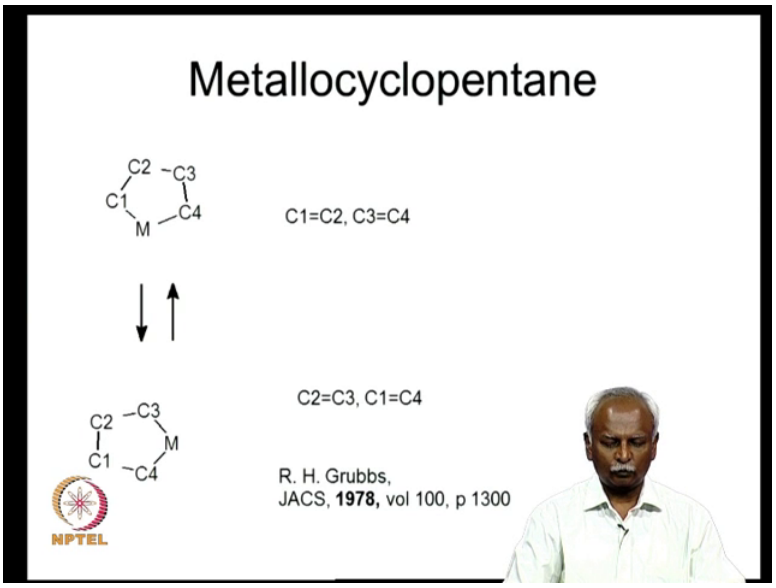


So, metal cycle paintings have to undergo this isomerisation, either they have to go between C 4 and C 3 between C 1 and C 2 one person who tested this possibility was Grubbs the person who studied the metathesis reaction extensively. This is described in the journal of American chemical society paper and it is the page 1300.

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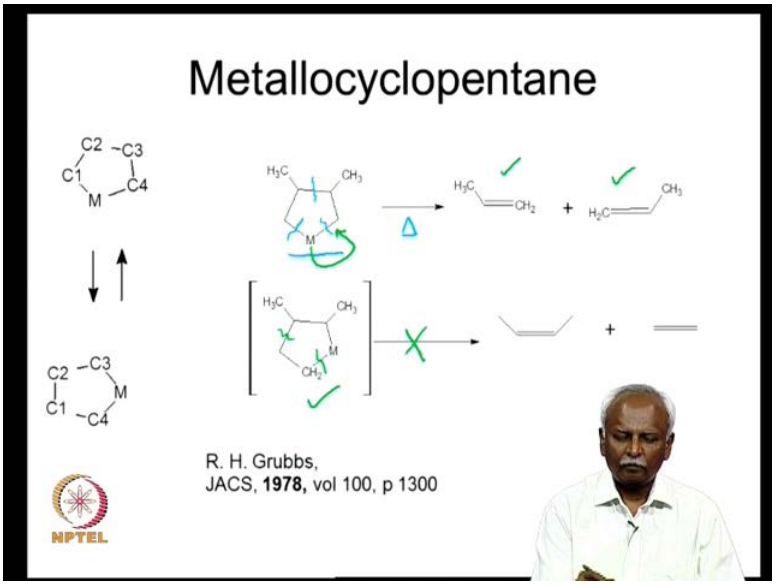


Now, let us take a look at how he tested out this possibility in order to test the possibility of this isomerisation, He in fact made a metallocyclopentane. So, let us take the matter cycle printing which is served pictured here this is a matter cycle contain him made using

a 2 and to hurricane lithium is a dilithium around 14 dilithium butane. So, that gives you the metal cycle contain, if you feel this, if you think this reaction mixture and end up with a formation of two olefins and that seems to be formed by breakage of the students. Then, you get this particular product, now if metal cycle pentane carries out an isomerisation reaction and the metal migrates that is market in a different colour.

Now, if the metal migrates to this position, then you will end up with this product features to this intermediate page is listed here if you feel that then you should be able to get the metathesis product, which is shown here. In fact, this reaction was not happening we did not get these products. So, this intermediate is not being formed, so this is not being formed and so Grubbs showed that this reaction is possibly the metaphysics reaction is not possibly going through a metal cycle contain.

There exists this faint possibility that these are thermodynamically favoured olefins that are found in this reaction. So, thermodynamically this favourable to break response window placed have shown with no colour and breaking the bonds in this particular fashion as I have shown as an showing here may not become economically favourable.

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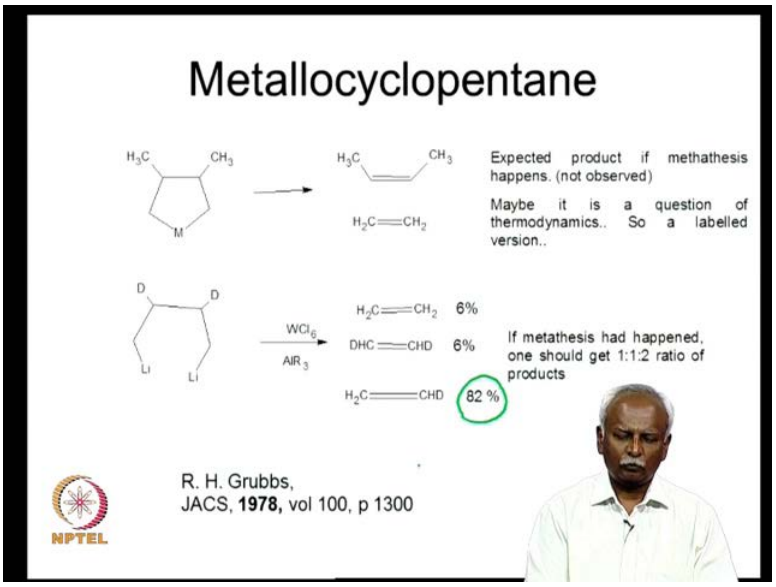


So, to rule out this possibility, Grubbs carried out a very interesting mechanism very interesting reaction he carried out a very interesting reaction, where he treated a duty to liberate the ether compound with the capitalist way. He used tungsten hexafluoride as a catalyst in the presence of your last three and then initiated the cycle of entertainment

metallocyclopentane. He observed that there was only one type of elephant being formed predominantly and that was and that was formed in 82 percent yield. This is clearly indicative of the fact that this reaction system is not carrying out metathesis metal cases that happened.

Then, the product should have been formed in one list to one based to the nation, so you should have in fact formed double the amount of CH DCH, the answer that was not being formed. So, it is unlikely that metathesis was in fact happening in this reaction, so Grubbs was instrumental in discounting the metallocyclopentane pathway.

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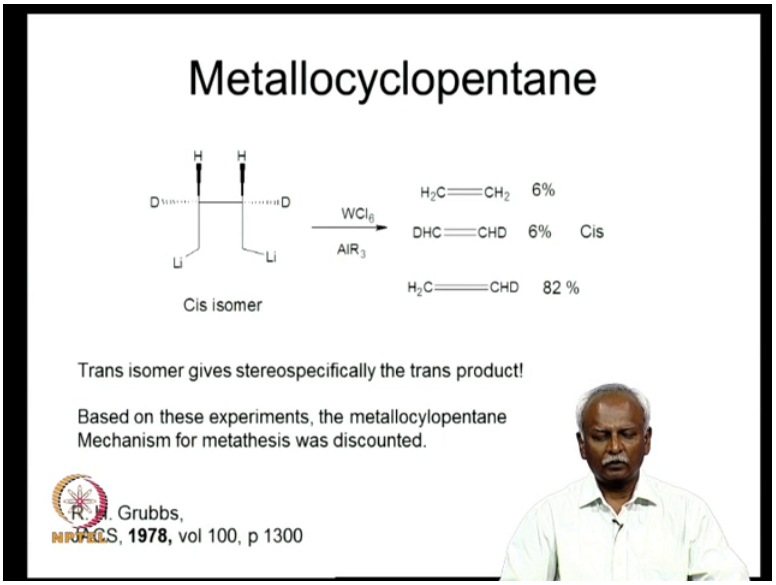


So, based on his experiments in new mechanism had to be discovered and during this time she Grubbs also showed that this reaction was still you say specific in the sense that if you took the transcendental labelled compound. You got only the translatable project and refute the process labelled compound were only cist labelled product and that it clearly showed that the metallocyclopentane mechanism was not operating.

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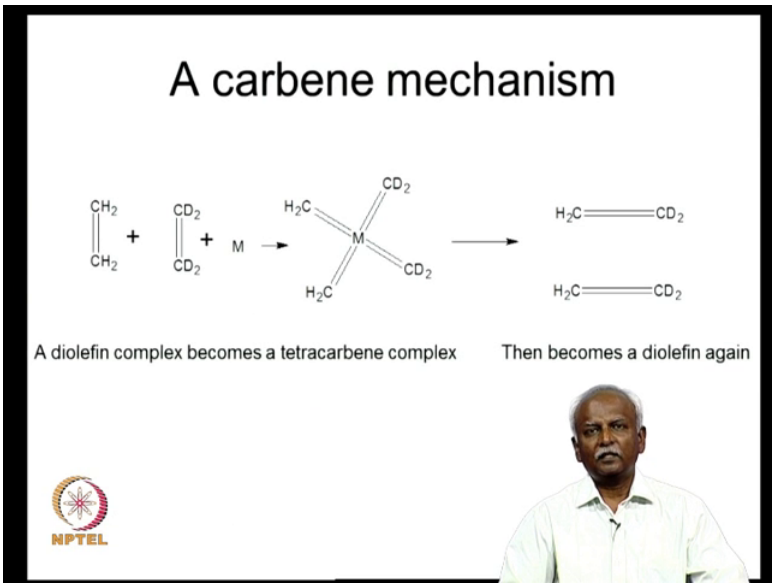


Now, during this time there was also another mechanism which is called at the alkali mechanism that this mechanism was based on a tetra carving, if you have a diverse and complex, you could in fact generate etcetera.

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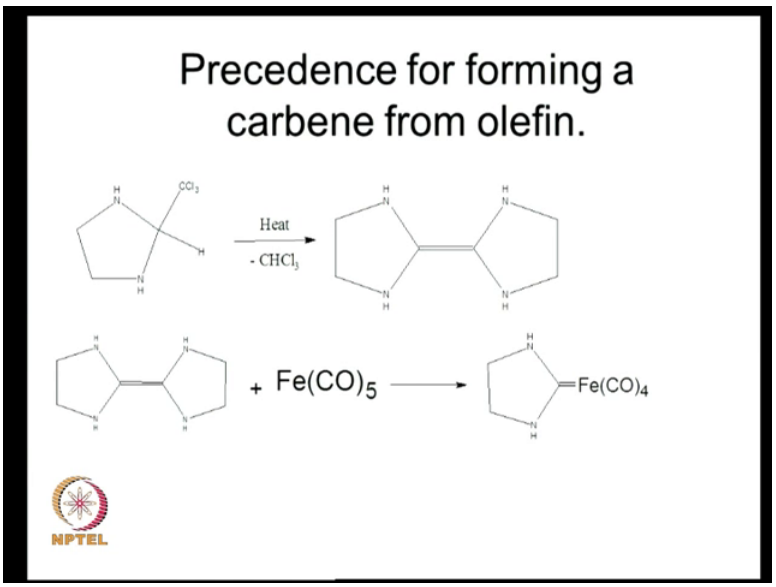


Although, this sounds unusual we should remember that it was possible to make or break a coalition into two halves by treating it with a metal complex. This is a reaction, which we looked that when we looked at the synthesis of card beans and so a similar path could

have been envisaged. A similar path could be envisaged and the formation of a tetra carving may not be unreasonable.

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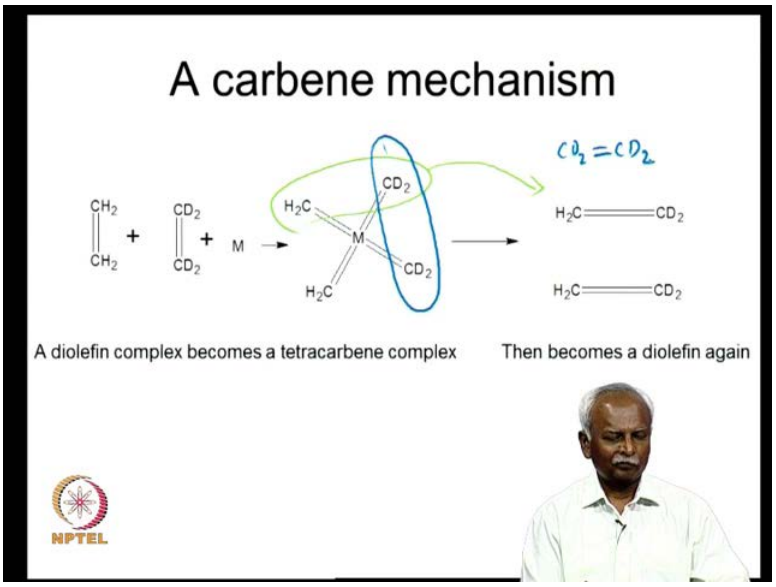


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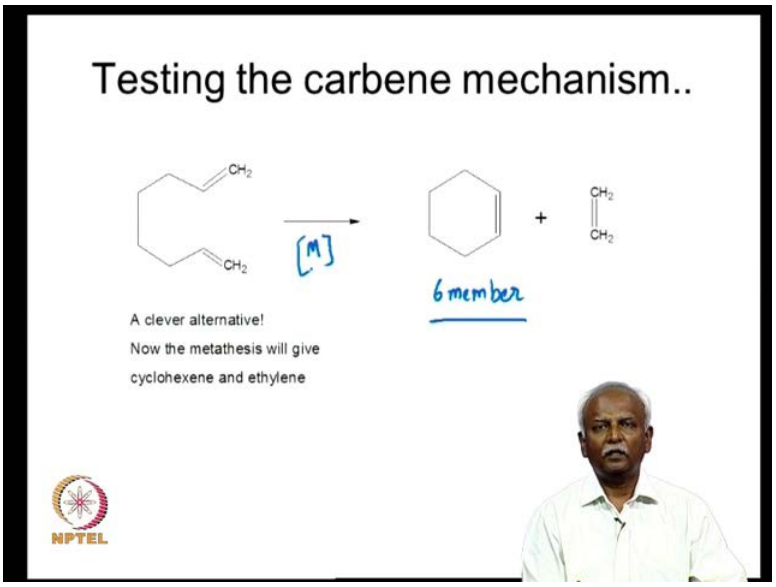


If this is the case then from the tetra carving runtime, in fact isolate from different solutions based on which two olefins will react. So, let us take a look at how this can happen, so usual compassionate in this fashion you would end up with CH 2 C D 2. If you combine it, you combine it in this fashion one can formed in fact seem to have an C

D to suit metathesis can happen when if you use a tetra carving, so it remains to be seen whether this is indeed feasible or not.

So, testing this has been mechanism of the tetra carving mechanism a very interesting experiment was carried out and this involves the use of 7, 6 have to die. In certain, this particular compound is got a compensation of the time, so it is one 7, 9 that was used. If you carry out metathesis under the conditions reaction conditions one ends up with forming cyclohexane exclusively and 80.

So, this turns out to be a case where you have read reactants positioned in such a fashion that the formation of a six member ring is easy and formation of the six member ring. This formation of the six member ring turns out the favourable and easy. So, this is the only product that is formed in the course of this reaction, so if you have a metathesis catalyst you get only the cyclohexane and ethnic.

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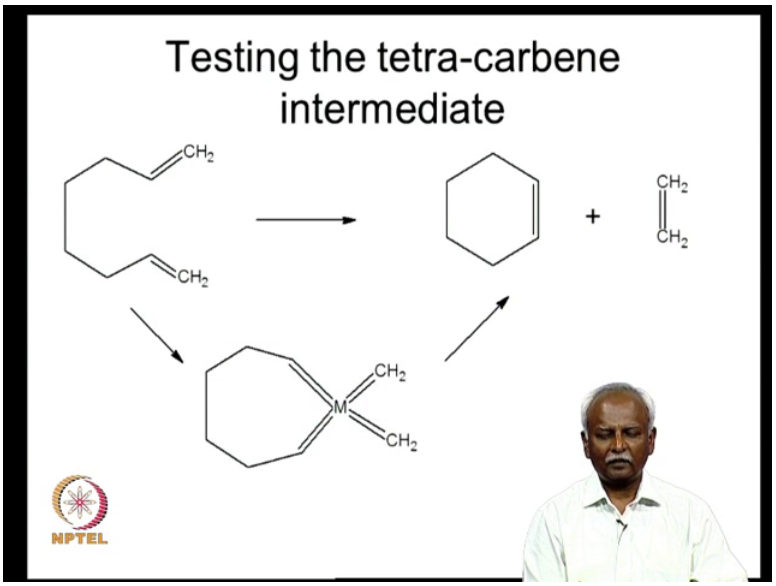


Now, if you have a tetra carving that is formed one can understand the formation of an intermediate to which is pictured here and this tetra carving can now decompose to give you these two products.

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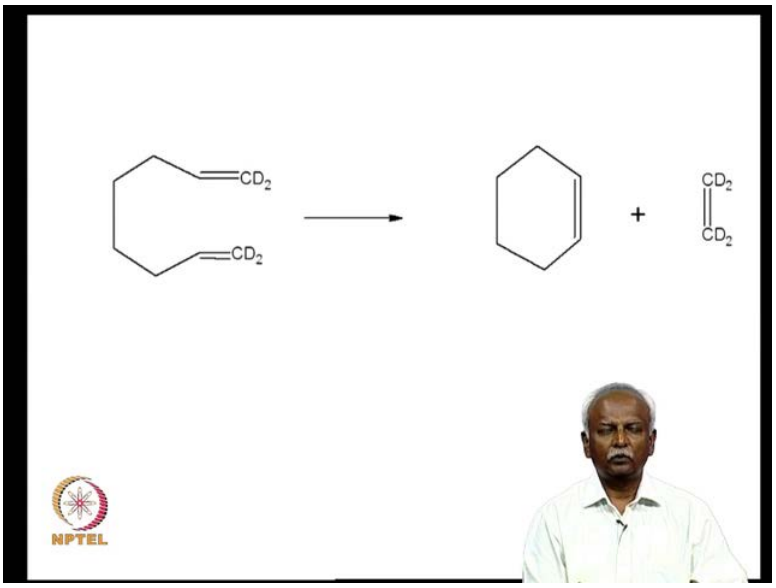


Let us imagine now if you carry out labelling experiment you use C D 2 an C D 2 to visit to terminal, then you would exclusively get tetra decorated with him and cyclohexane is the only products that are found in this reaction. On the other hand, if you have the non mutated variety, you would get only cyclohexane.

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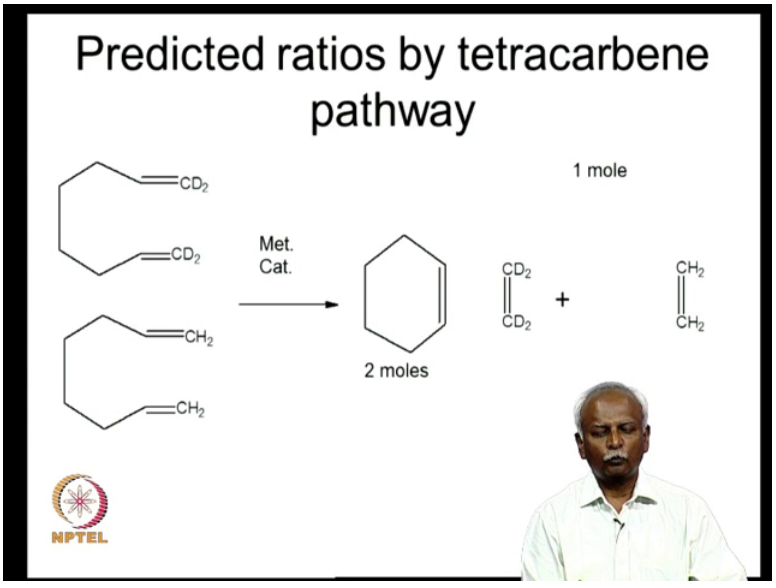


What would happen if you have a mixture of eastern show you take service to use the tetra carving intermediate is in fact the favoured pathway one should get only 72 C D to buy a the reaction of the few do the tetra carving mechanism. It is only silly to C 2 which

will give you cyclohexane and selection give you one of that. If you have one of each of these mutated and not degraded starting materials with wanderlust C 2 and you would get starting with this. You would get one world normally between, on the other hand if any other mechanism was operating, then you would get a mixture of products.

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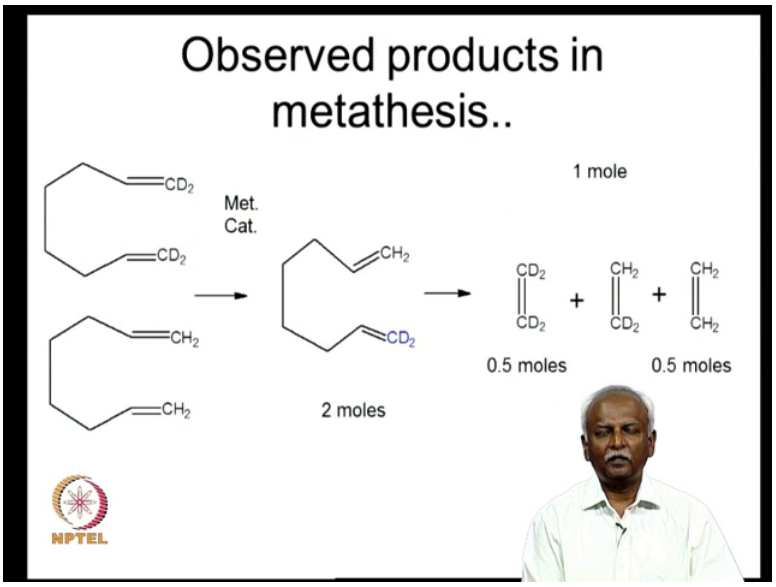


In fact this was in indeed time and the mixture of these olefins was used for the metathesis reaction and what want found out at the end of reaction was that you got only 5 moles of C 2 and one will of CH 2 C D 2. Surprisingly, this can happen only if you interchange only if you interchange the two reactants and mixed them together. So, it looks as if you go through the intermediate C, you go through the intermediate CF a compound that this is also found in the reaction pathway.

So, how can you account for the formation of species like this, so this is in fact not acceptable for the tetra carving if that are being intermediate was only intermediate, then this cannot be informed. So, one mole of the degraded a reactant and wanderlust and not degraded reactant should give is only the non mutated ethylene and fully degraded anything cannot result in the formation of the coalition which is 50 percent nutrition.

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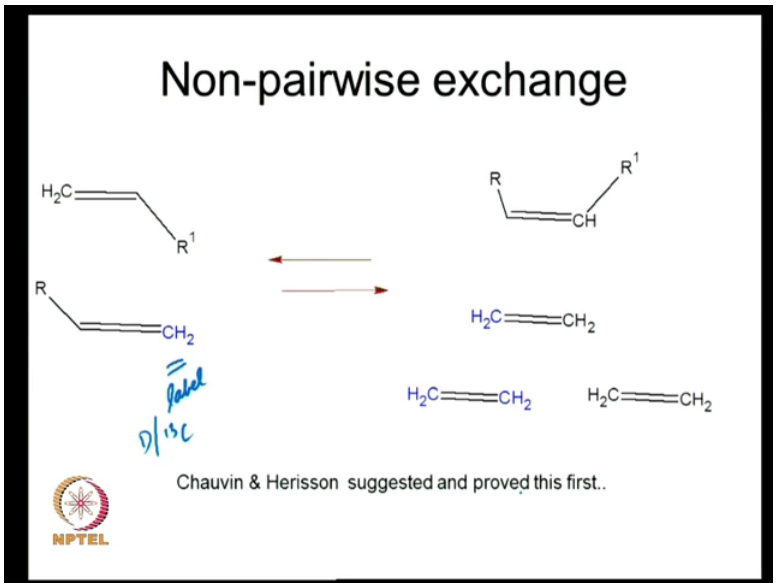


This is clearly indicating the fact that the non televised exchange solutions is being carried out. So, I have shown here what is and is not suggested by Charmaine and Vincent and the advance who shoot this particular mechanism was happening. The non pairwise mechanism is only one which will account for the fact that you can have a mixture of 18, which is labelled an unlabelled in a statistical ratio starting with two olefins, which are given here Mr Bartlett said labelled elephant. So, if this is a labelled elephant and deliberate NBC 13 or it can be pretty, and you will notice that you have such labelled products, which are not possible unless you have a non privileged exchange.

Now, what you understand what the non-pairwise exchanges to invoke the mechanism in which a car been metal carving is used this is also a metal carving intermediate have involved the reaction. In this case, a metal carving reacts with an in order to form a metal cyclo butane, so elevate proposed to metallocyclopentane, this is a full member drink. So, this is a metal is attributing, now imagine the formation of a metal cyclo butane and this metal cyclo butane can now reopen in two different ways. If it really happened in the way in which it formed it would end up with the formation of the same materials as a starting material.

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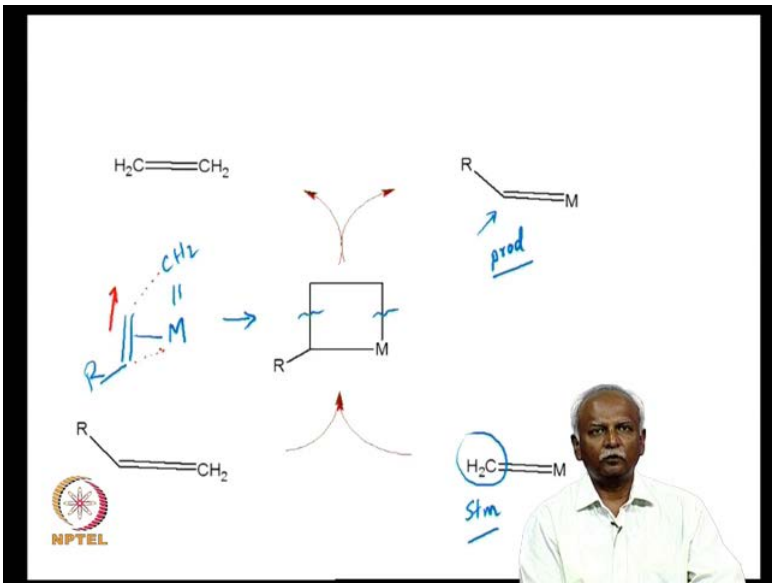


This means it would end up with only the starting position, on the other hand it can also undergo a ring breakage in a slightly different fashion and so let us break telling in a slightly different fashion which means I will break it. Then, I would end up with a metal carving, which is different from what we started out with starting material, this is a starting material and this is a product metal containing product. So, you can see that a new carving can be generated and the new coalition can be generated, but we have done.

So, in a non pairwise manner, in other words we're not taken to olefins in exchange and we have taken one carving and exchanged only the methylene groups through a metal cyclo butane, how can this reaction happen, this is in fact an example. Then, you have two neutral species, one is which is attached to the metal and the other is an olefin show and intermediate, where you have an CH 2 with car been coordinated to solution.

Let this can react together and form a metal cyclo butane can one do that you only have to slide this elephant in this direction. So, let us slide this elephant in this direction and then you can follow blonde in such a fashion so that you end up with the metal is attributing sure this metal cyclo butane. Then, reopen by breaking two different blogs which are indicated to hear these two bonds, which are indicated to an already generated new olefin.

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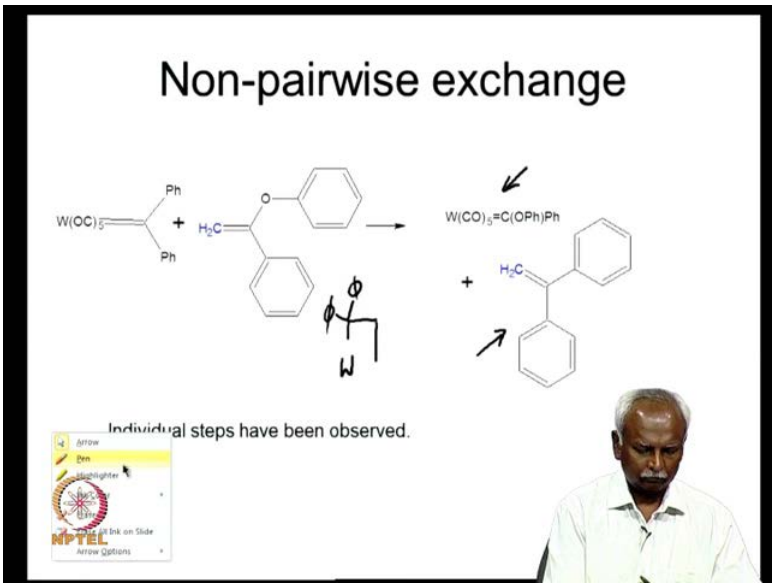


For example, you can think of a coalition which is primarily ether and pictured here are the winery and this wine either canned exchanged with a tungsten carving complex, which is brought to female groups carbon. If you react these two species, you end up with the final product which is diphenyl ethylene non epithelial, which is pictured here this is a non military and no stable car been tungsten complex, which is pictured here.

This is the 1, 1 diphenyl ethylene, so these two products clearly suggest that you can have a non privileged exchange of the olefin. Once you fan of compound in which wants you from this compound was reform this compound, where you have a metal cyclo butane lunches metal cyclo butane. Then, the metal cyclo butane can fingerprint in such a fashion that you get the more stable carving which is what I have listed here and the diphenyl thing.

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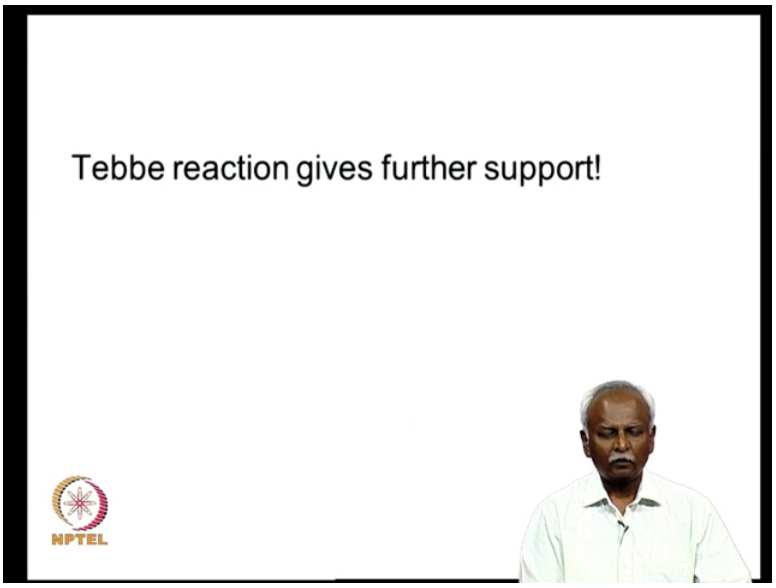


So, the Tebbe reactionary further support her this mechanism will take a look at the table reaction.

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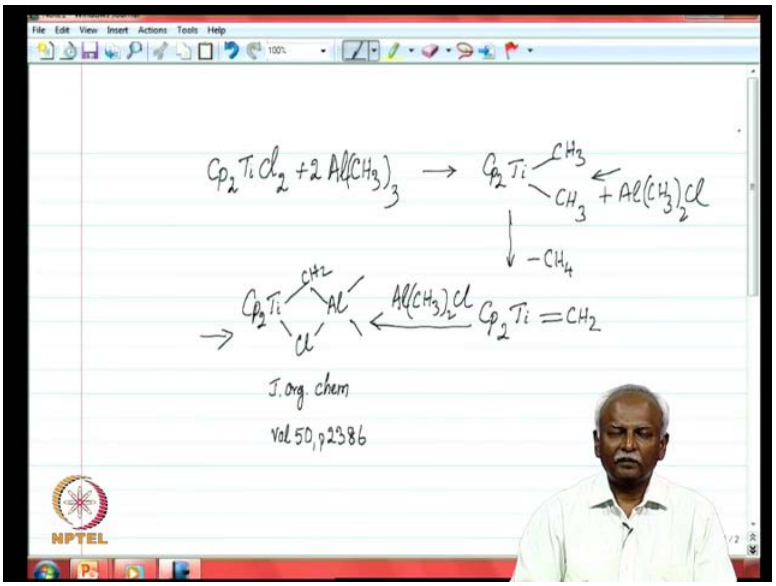


The Tebbe reaction involves the reaction of the cyclo content tiny titanium dichloride with site alkyli in is an early transition metal reacting with human kind. So, that is typical of the metathesis reaction conditions and under those conditions, it is known that the methylation of trans methylation of titanium chloride leads to a dimethyl titanium compound. So, here is a dimethyl titanium compound this is a dimethyl titanium

compound which is formed as a result of the trans methylation. You can eliminate a molecule of methane from here by the reacting one of these hydrogens, which is present on; one hydrogen from the methane and want metal group are eliminated as methane.

So, you end up with a car been complex which is the titanium carving complex, this titanium carving complex reacts with the aluminium alkyl compound that was as that was formed in this reaction. So, here you would end up with a real CH streetwise serial as a product and this reacts with your car being intermediate and from sustainability bimetallic species and this bimetallic species has got both titanium and in the product.

So, this turned out to be a very useful agent and is called being which is now performing a bridging function between two metals. This is a main group element alone and the other is titanium which is a transition element and discount this compound was called a division after its discoverer.

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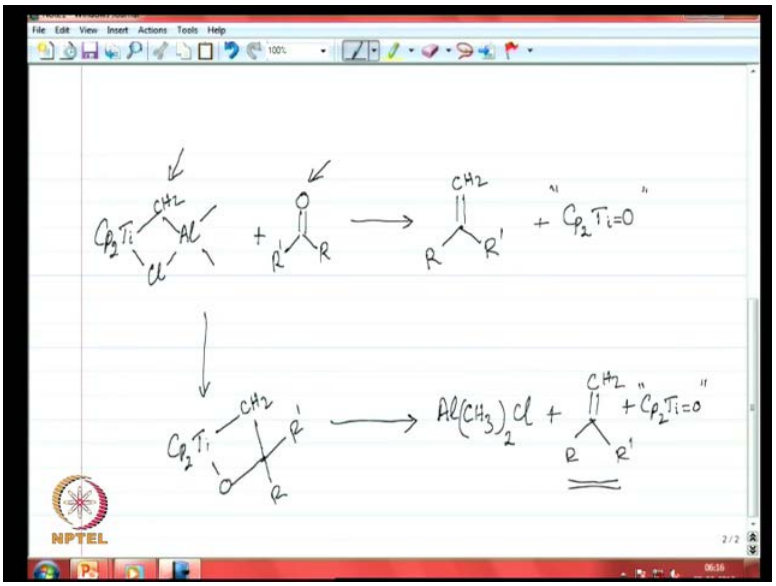


So, the Tebbe regent which we have shown here can react with a variety of treatments to form a coalition and that happens to go through an intermediate. This I have drawn here and clearly shows that a metal cyclo butane can be a possible intermediate in these reactions. So, once again this reaction is driven by the thermodynamics of this process, which results which is because of the favourable formation of titanium oxygen bond in favour of a titanium carbon bond titanium. So, aluminium real CH streetwise Cialis

formed is eliminated in this process and you can have the formation of a very stable version.

You can see that your exchange, now you use this methylene group will use this methylene group which have pictured here and here taken that and transferred it to this position on the ketone. You have transferred the oxygen from the carbon to the titanium, so this turns out to be a useful way of carrying out the definition of methylene transfer reaction. This has been used extensively, but this also tells us that it is possible now to carry out such reactions in solution with organometallic compounds. So, whatever we are proposing with the metal cyclo butane mechanism must be reasonable in terms of the metathesis catalyst.

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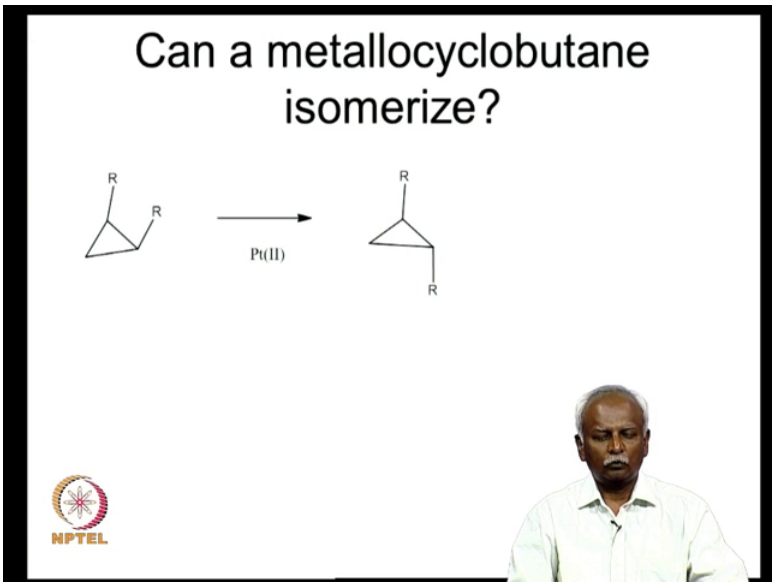


So, let us get back to the reaction the method raises reaction videos on reaction, which was studied which also seem to give some indication that a metal cyclo butane is possible. This was a reaction which was studied with platinum, now although it is not a main group element of early transition element, it is an element which carries out a isomerisation of cyclo propellants. If you take this is liberal cyclo propane, it could be converted to the trans subsidiary using a platinum to compound.

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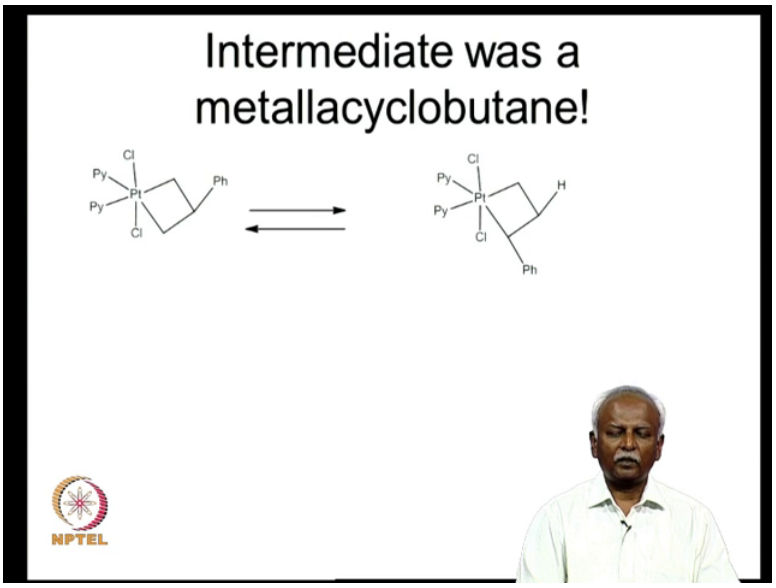


Now, this was going through an intermediate in this particular instance, it was possible to isolate intermediate and it was shown that the intermediate that was formed as a metal cyclo butane. The two species were actually in equilibrium conceded pictured on this projection here, you have both the compound when you have a phenyl group up and down and those possibilities the compounds are indicated in equilibrium.

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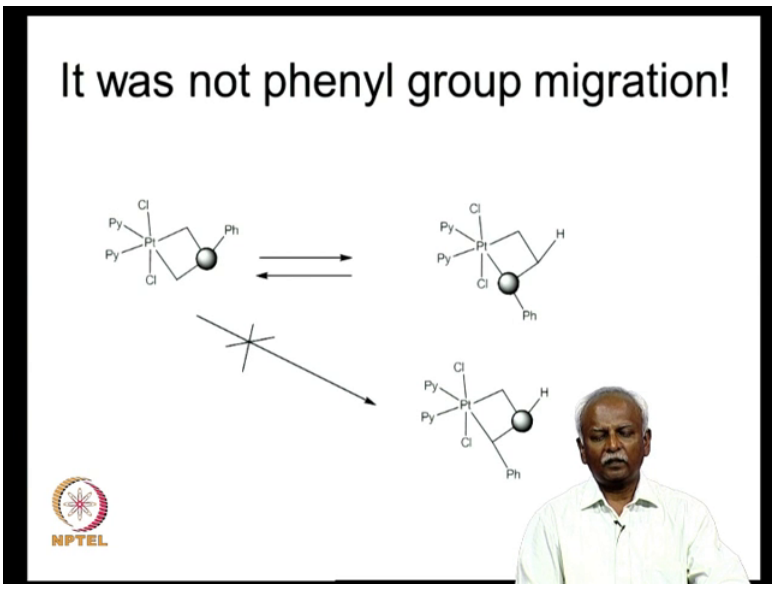


By labelling studies, it was shown that it was not a phenyl group which is migrating in the metal cyclo butane if you label the carbon, let us say with carbon 13 and that is

pictured here as well as a highlighted blog. So, this is highlighted here as a label and then if the phenyl group migrates one could in fact find out that it is it should have given us this product, where the label carbon and the phenyl group are separated.

However, it was found that it was not going through it was not going migration and it was completely migrating because the carbon itself is moving from this position to this position. So, that would be indicative of a migration of whole carbons and the phenyl group to a different position and wish to Veronique them, so you can start with either one of the metal cyclo butane's and summarised to the other product.

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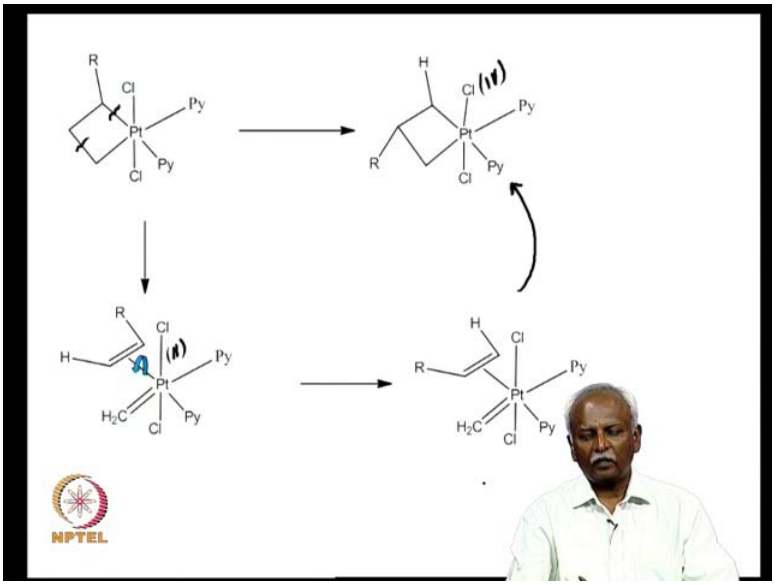


So, what is a possible mechanism by which this reaction can be going social is one possibility which is in support of the metathesis reaction that was a carving mechanism for the metathesis process. So, if you have a car being clever metal cyclo butane and if it breaks up to give you a car been an evolution, so here is a carbon and will thing that can be formed. If you break the bonds in this fashion, break these two bonds, then would end up with an wonderful which is pictured here.

The methane platinum complex, so this with him platinum complex can now rotate around this metal pollution ground sure if this metro boundand that rotation axis is shown here in blue collar. Then, you would end up with a different bluefin platinum complex and that can in fact be pictured here and it would result in the formation of a metal pollution complex which can reform the metal pollution complex can factory farm.

In order to generate the isomerise catholicity butane were the phenyl group called the group is trans the platinum initially to assist to the platinum and holidays, because of the way in which it rotated coalition rotated about the platinum.

So, this kind of the observation also lends support to the fact that you can in fact from the car and revolution and this carb can to oxidative addition reaction. You will notice that this is a platinum to centre is a platinum to centre and this now is a centre because you have to alkyl groups and unconditionally attached to the platinum your platinum frozen cherries, neutral groups revolution and carving. So, it is a platinum, surely platinum to become the club of the centre through an oxidative addition and a carbon, carbon bond formation, so this is an oxidative coupling reaction which is happened.

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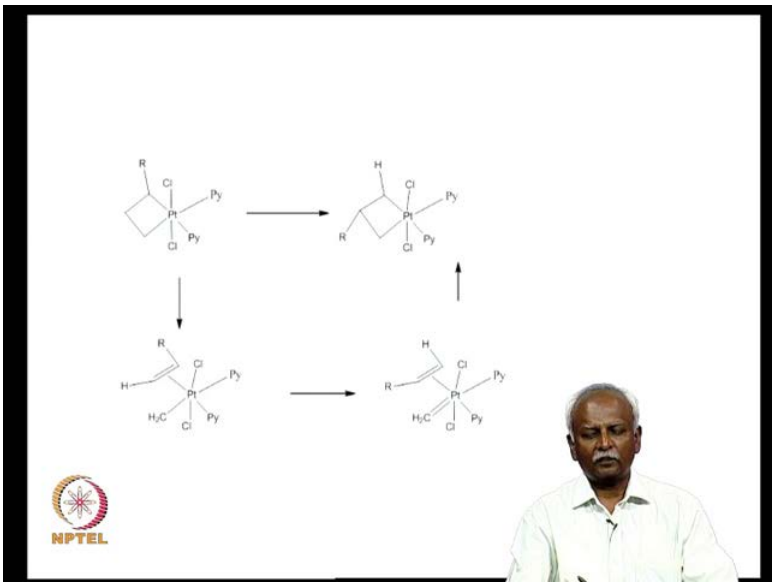


So, this oxidative coupling reaction also allows you to explain not just this isomerisation support to the metathesis reaction through a metal cyclo butane intermediate.

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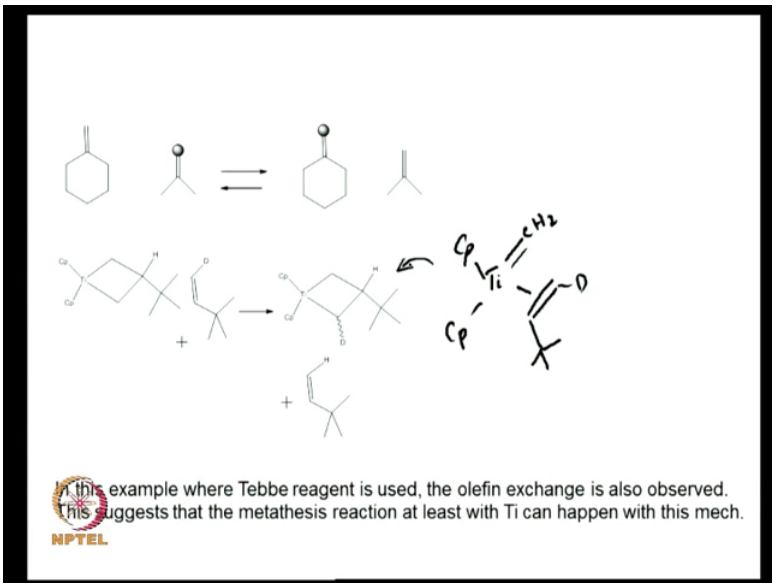


So, in the in the previous example, we have shown some proof for the existence of catholicity butane and it isomerisation, it was not possible to show that in the cases where you do not have the concoction arranged. It is possible to find the metal cyclo butane in the case of early transition is the first proof of that came when one could carry out metathesis reactions using the modified matter cyclo butane, which an alternative impulsive. Here is an example, it was possible to prepare a site titanium cyclo butane matter cyclo butane and reacted with another pollution. It turned out that they could isolate the project in which this catholicity butane exchanged olefin, which is present in solution and the new leaf.

This was generated in the reaction mixture, because they used a rebuild olefin and the could show that the label was present in the final product is those very clear indication that such kind of metal cyclo butane skin exchange olefins. In fact, it is an intermediate car been should have been involved in this case, one can write this intermediate in such a fashion it is cheap city coordinated to CH 2 and the pollution.

So, if this is the elephant intermediate titanium pollution car been intimated that is formed, this can very easily generate the product which is indicated here. So, this clearly indicated that all the steps involved the metathesis reaction could be substantiated through external reactions symmetric reactions.

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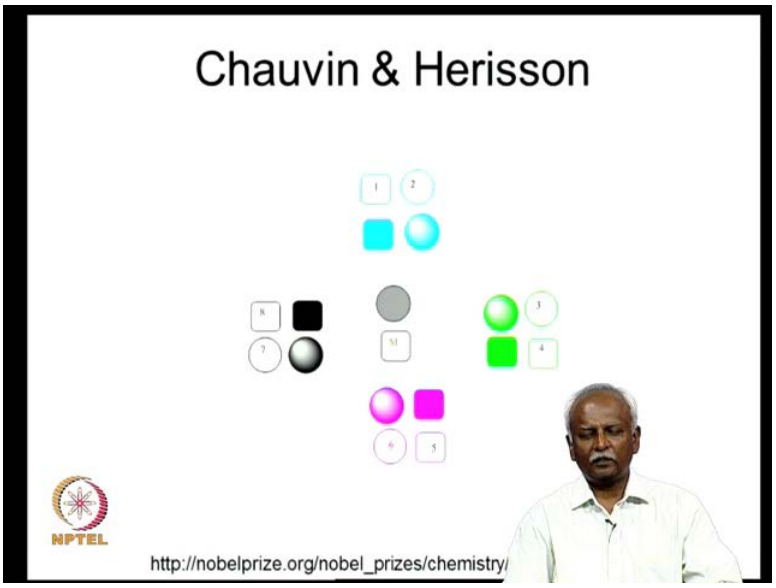


So, the catalytic cycle obtained a very strong support, now what this means is the mechanism suggested by shoving and Harrison, even now the early days was in fact correct and what they suggested was not always exchange. In order to understand the non privileged exchange, it is in fact possible to have a small demonstration of this non privileged exchange in webinar show this in this movie were we have. So, only fence sitting around a metal catalyst the solutions are labelled ingredient to magenta and black and as we have the metal exchange card games what happens is new olefins are generated.

The carvings are completely scrambled and we can see this as being pursued in this reaction the metal carving keeps changing, initially it was a great car been amalgamated car been green. Then, it becomes magenta and then in the subsequent steps will become and it will also become the new showroom a complete scrambling of community groups can happen through, the sequential and random scrambling of the car beings which are present in the medium. So, if you have four different olefins then all possible combinations can be observed and you can have the non airways exchange powerful offence very easily using to complete randomisation of the car beings and the olefins.

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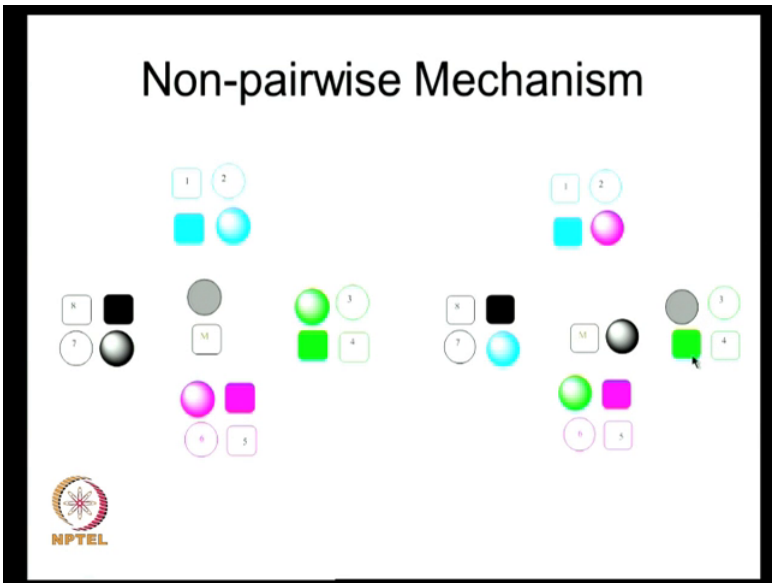


If you watch the video carefully, you do not notice that to start with we had this great metal carving catalyst and at the end of the reaction, you ended up with a different metal carving catalyst. The great species quickly carving was in fact transferred to another olefins and each one of these olefins has now a different car been one of the carbons has been completely exchanged with some other pollution. So, this is the starting point this is your starting point and this is your ending point. So, it is possible to have complete randomisation of the olefins through this particular mechanisms on pair wise mechanism proposed by shoving and Harrison was finally, accepted.

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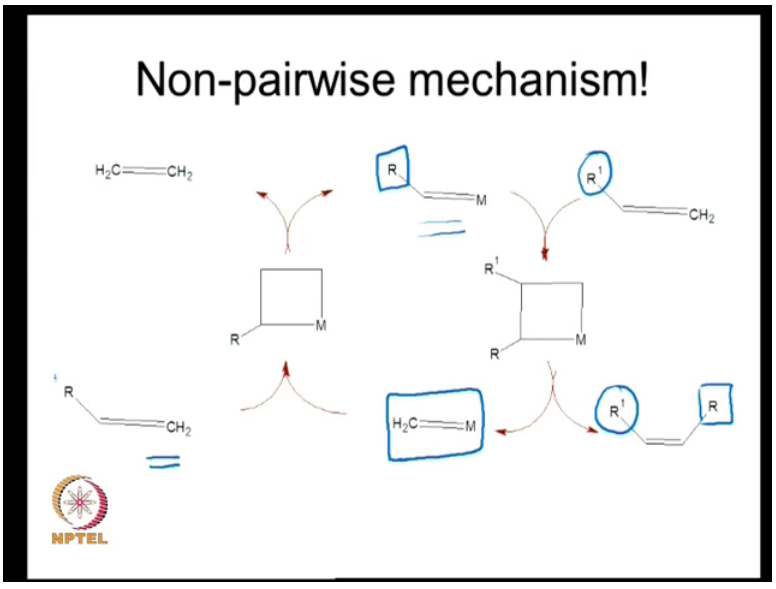

In the mechanistic detail allowed want to make a variety of different metal complexes, so generally clear that the metal carving complex is necessary and this is the essential this is the essential starting point. This is your starting point for the formation of different olefins in the reaction mechanism, so research now concentrated on the synthesis of car beings which could be stable catalyst, which could be used for the metathesis reaction. This was in fact done by schlock and gloves and that is a reason, why it all three of them, in fact were honoured with the democrats.

So, let us take a look now at a non airways exchange with real molecules, so if I have our CH 2, which have pictured here I can end up with a new car been metal carving. That new metal carving can convert a different model functionalised elephant having an our one group of this is our one group as opposed to an art group and you can connect this are one and these. So, this are warned and this art has now been combined to give you a new position starting with our one CH CH 2 and our CH CH 2. So, this is an on pairwise mechanism, which turns out the right mechanism of the transfer of the formation of the metathesis reaction.

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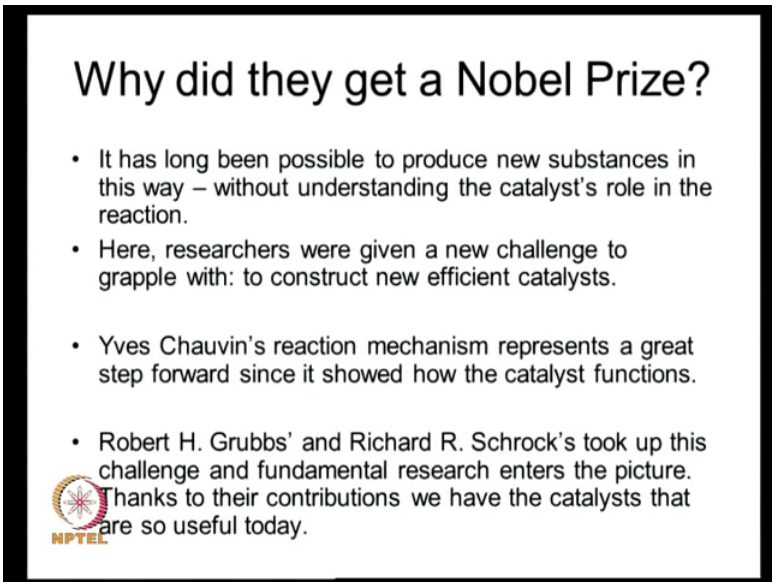


Now, one needs to think about this fact while debate all three of them got the Nobel prize that is because a lot of time it has been possible to produce new compounds using metathesis is not long before. It was fully understood, but even when they did not

understand that understand the mechanism of action people were able to use it that struggling to use proper capitalists and wants the will of the catalyst was understood.

It was possible to move very rapidly and use it in reactions, which lead to formation of very interesting compounds and the catalyst could be designed such that each in each case. There was a substrate which poses special problem, it is possible to generate a catalyst which would carry out reaction efficiently. So, shotguns mechanism was extremely useful in furthering it and it was Grubbs and schlocky made the catalyst and made it possible for this free to move forward.

Here, the researchers were given a new challenge to grapple with that was to construct efficient captains and it was only because your vision shop a shower and discovered the mechanism. They could in fact make the Grubbs and schlocky took up this challenge and the fundamental research in this area was furthered significantly because of the catalyst that will discover.

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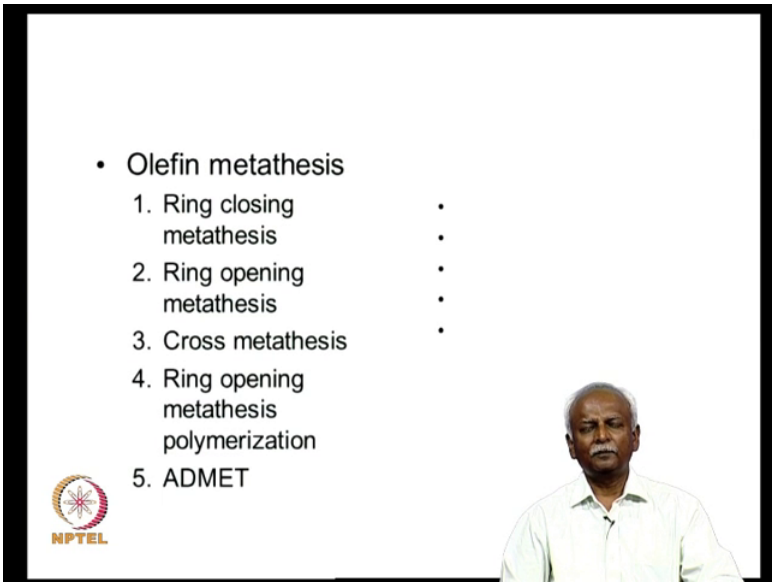


So, in the next lecture we would in fact be discussing how evolution metathesis can be carried out in a variety of different ways and we can use it for carrying out projects that would lead to rings. So, that turns out building closing metathesis, they can also have ring opening metathesis were strange things are opened, we can have several reactions were taken carry out ring opening polymerisation reactions. So, people must made an

cost metathesis is something that we have discussed extensively in today's lecture also necessary plus that is reaction and had met is another method.

We can have types of polymerisation reaction is carried out, so let me conclude by saying that today lecture in web metathesis reactions that addresses the change of place between carving units in an old friend. This reaction ultimately leads to a large number of olefins all possible olefins, if you start with two different olefins and the ratio of the products that are formed actually quickly control. So, by controlling the reaction conditions one can find very interesting new coalition products starting with a mixture of olefins this turns out to be a key feature for utilising this reaction.

Now, it turns out that schlocky and grounds were instrumental in making capitalists which were now well and also they were able to design catalysts which would suit substrates. So, that new reactions could be generated, so it was very obvious that the combination of a fundamental mechanistic study, which was based on various aspects of metal car beings and automated chemistry. This led to furtherance of the metathesis reaction and utilisation of metaphysics reaction in the industry which leads to synthesis of new anti cancer drugs molecules which are pheromones. This can be used showroom bioactivity, and so many different possibilities are made me because of the discovery of metathesis reactions.