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Organometallic Compounds

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Abstract:

Organometallic chemistry is a branch of chemistry that deals with compounds that contain an organic part on one side and a metal on the other. These are distinguished Organometallic compounds are formed by direct contact between carbon and metal, and many of them have been observed to be highly effective. Given the importance of these organometallic compounds in industry, agriculture and medicine, and their increasing importance in recent years in particular, the attention of researchers has been directed primarily towards this branch of chemistry. It has developed rapidly over the past years. Recently, this type of chemistry has been widely exploited in many organic preparations. One of the most important methods used in preparing organometallic compounds is a reaction in which the resulting compounds are continuous or non-organic halides with metals. ongoing. The association of organic compounds with metals will lead to a complete change in these compounds. Because of the reflection of the nature of the carbon attached to the metal, it is a searcher for electrons and a detector that searches for the nucleus, and therefore the reactions that it enters will be different from the reactions that free organic compounds undergo. Examples of continuous organometallic compounds include cyanide salts, carbonates, and carboxylic acids. As for organic lithium and magnesium compounds, they are considered very effective, as they react with oxygen, carbon dioxide, water vapor, and even with very weak acidic compounds such as alcohols. Because they contain active hydrogen, these compounds must be preserved in inert organic solvents. Diethyl and tetrahydrofuran are considered among the best solvents used in preparing and preserving them.

Introduction

Historical development

The first organometallic compound was synthesized (4H2C3KPtCl) by the Danish pharmacist William C. Zeise in 1827 AD, which was often referred to as Zeise's salt. At that time, Zeise had no method to determine the composition of this new compound, but now it is known that the compound It contains an ethylene molecule (CH=HC). Since the 1950s, the field of organometallic chemistry has become an active field with the discovery of new compounds of this type, with detailed knowledge of their chemical and structural properties and their applications as

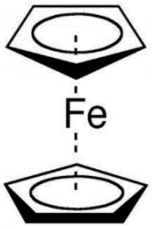
intermediates and synthetic catalysts in industrial processes. It is linked via the carbon atom to the Pt atom in the center, which is linked to three chlorine atoms. As for the positively charged potassium ion, it exists to equalize the charge of the compound.

Another major event in the development of this field was the discovery of tetracarbonyl nickel by the German-educated British chemist Ludwig Mond and his assistants in 1189. Two of these compounds are found in nature. They are vitamin B12 coenzyme (12B vitamin), which contains a bond between carbon and cobalt (Co), and the second is dimethylmercury (3CH-Hg-C3H), which is produced by bacteria to get rid of mercury. In general, the compounds do not exist. Organometallic substances are commonly used in biological processes. The structure of vitamin B12 coenzyme contains 5 bonds between the nitrogen and cobalt and one bond between carbon and cobalt.

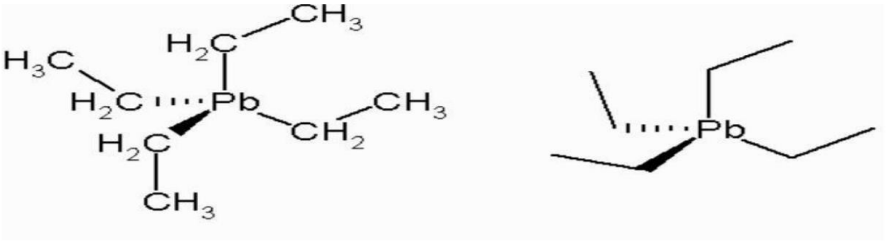
Organometallic Compounds

A type of compound whose molecules contain one carbon-metal bond on the allele, this type of vehicle includes: Carbon is part of an organic group And Tetraethyl lead and ferrocene.

Organometallic compounds constitute a large group of substances that play a role Prominent in the development of chemistry, they are widely used as catalysts and Reactions that occur in laboratories



The compound tetraethyl lead (pb4Et) has been used as an antiknock agent for automobile gasoline, and its use has even been banned so far in the United States.



Properties of organometallic compounds

1. The bond between the metal and the carbon atom is often highly covalent in nature.
2. Most organometallic compounds exist in solid states, especially compounds in which the hydrocarbon groups are aromatic or have a helical structure.
3. Compounds that consist of highly sensitive metals such as highly volatile sodium or lithium.
4. They can undergo spontaneous combustion.
5. These compounds can act as reducing agents.

It can be noted that the properties of organometallic compounds differ among themselves based on the properties of the minerals of which they are composed. In many cases, organometallic compounds have been found to be toxic to humans (especially compounds that are volatile in nature).

The importance of organometallic compounds

1. It is considered higher in chemical activity and chemical activity than other organic and inorganic compounds. This is due to the existence of medical ingredients, and many of these compounds are continuous and used as pesticides and medical preparations, in addition to their use in obtaining a sample of metals, as they can be isolated from a sample of a compound that contains the required metal. In the chemical industry, such as halides, compounds
2. Important organometallic compounds: Organic magnesium compounds known as Grignard agents, which are widely used in preparations of organic chemistry. Organic lithium and boron compounds and alkyl aluminum compounds are also used in preparations. Organic compounds are used with titanium salts as important catalysts in the polymerization process, Unsaturated hydrocarbons such as alkenes and alkynes, where titanium atoms interact with pi bonds (double or triple).
3. Organometallic compounds containing lead, mercury, and mercury are of commercial importance. For example, many organometallic compounds are used as medicines, pesticides, and polyvinyl chloride stabilizers and prokinetic inhibitors
4. Of the organometallic compounds, they are formed by the reaction of carbon monoxide with metals to form metal carbonyls (such as nickel tetracarbonyl, which is one of the first organometallic compounds that were discovered. Metal carbonyls are used as catalysts in many reactions in the petrochemical industries.

Classification of organometallic compounds

Organometallic compounds can be named on the basis of structure or the position of the metal in the periodic table.

- **Simple organometallic compounds**

These are compounds that contain only a hydrocarbon atom or a hydrogen atom, which is directly bonded to a metal

- **Mixed organometallic compounds**

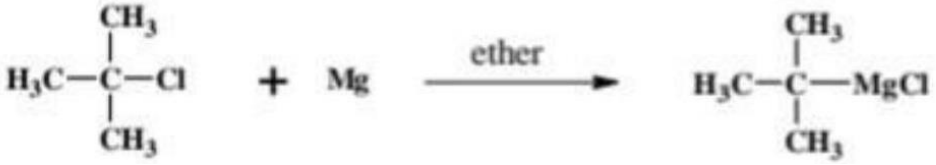
It can be divided into two types:

- Compounds of metals of the main elements (representatives), which include the formation of bonds with the participation of electron orbitals of type (&S). (p) in bonding with carbon in organometallic compounds. In general, the group of represented (main) elements is covalent bonds of the Sikmah type between the metal and carbon, excluding alkali metals and metals earth alkaline, which are generally Ionic compounds (ionic bonds).
- Compounds of elemental metals

Which includes the formation of bonds by sharing electronic orbitals of type (d) and (f) In combination with carbon in organometallic compounds. The elements that form a type of bond are known as deficient electron bonds (they are lithium, beryllium, and aluminum, Al).

Preparation of organometallic compounds:

From the reaction of alkyl halides with metals: with Alkyl halides from metals



It is considered one of the best laboratory methods for preparing Greenbard reagents and lithium

compounds. It is done by treating the metal with an alkyl halide with the presence of a dry ether or a hydrocarbon. It is noted in this reaction that it is not homogeneous and occurs between two different phases, as the liquid alkyl halide reacts on the surface of the solid magnesium, and therefore the surface area and the nature of the material Solid has an effect It is large in reaction speed, and the reaction speed of organic halides with magnesium varies, as alkyl halides react more quickly than aromatic halides. In some cases, mild halides do not react with magnesium directly, in such cases the mixture is heated at the beginning of the activity or a crystal of iodine is added to it to help start the reaction. Most of the reactions in the formation of Grignard reagents are exothermic and require external cooling to prevent the loss of a quantity of ether. The reaction mechanism takes place in two steps

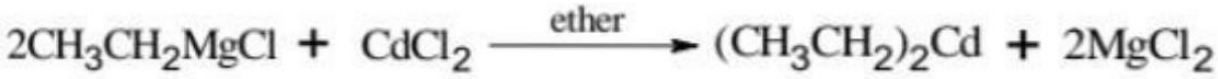
The first step: the reaction of the alkyl halide with magnesium, where the halide bonds with

the magnesium and forms the free alkyl radical

The second step: The alkyl radical attacks the magnesium halide radical to produce alkyl halide.

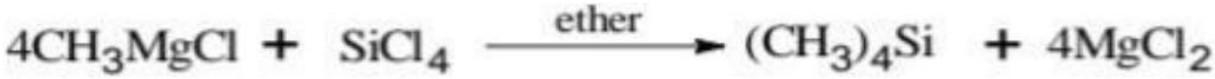
• From the reaction of an organic compound of a metal with the metal salt with the highest reduction potential:

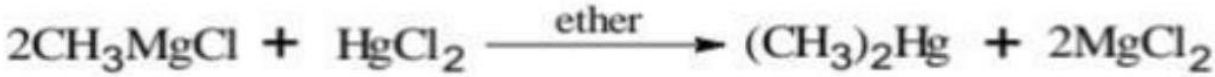
Such as the reaction of Grignard reagents (alkyl magnesium halide) with cadmium chloride.



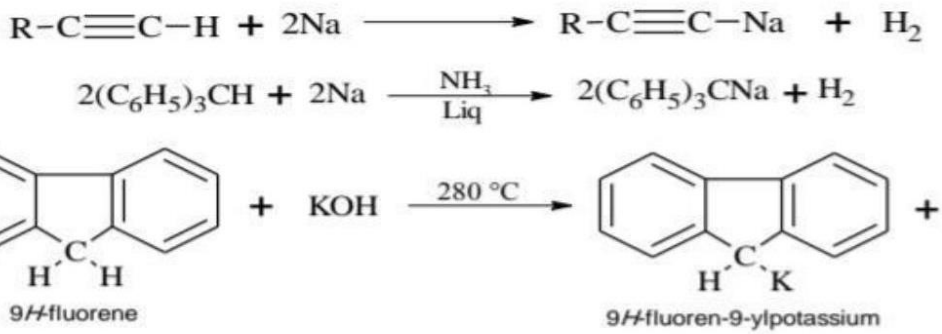
In the same way, Grignard reagents can be used to prepare tetraalkylic silicon and dialkyl mercury.

• From the reaction of hydrocarbons with metals and their derivatives

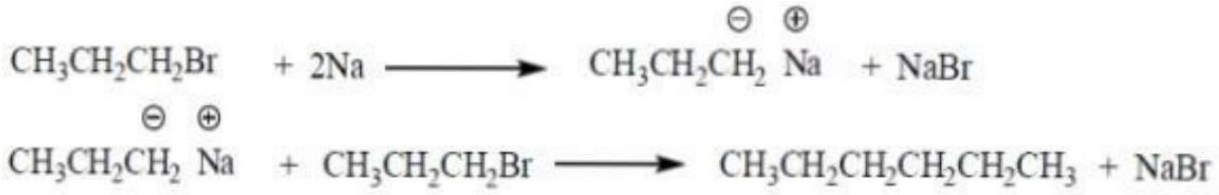




Some hydrocarbon compounds that contain (acidic hydrogen) that can be decomposed, such as acetylenes and triphenylmethanes, can be converted to their metal derivatives by reacting with sodium or potassium. A solution of sodium in ammonia is used as a suitable medium for preparing sodium derivatives and the member.



Organic sodium and potassium compounds:



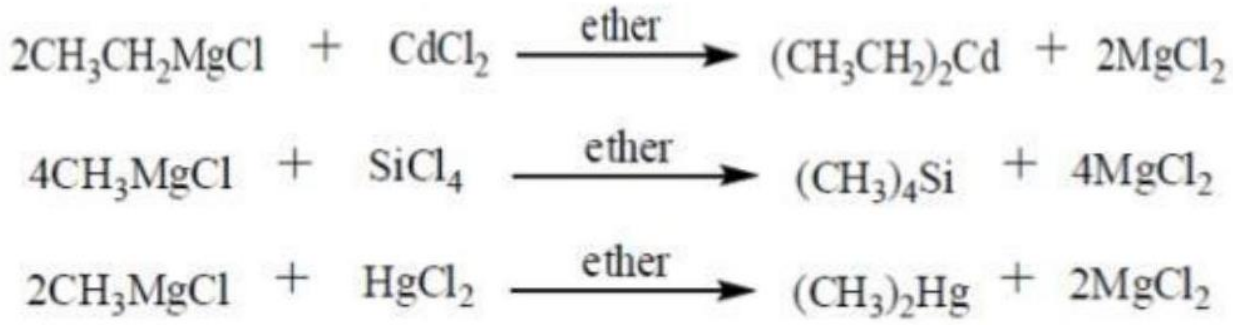
When organic halides react with potassium or sodium, alkyl potassium or sodium is formed as a very effective intermediate product. If it is formed, it reacts with another molecule of the alkyl halide to produce an alkane, which is known as the Wwartz reaction.

There are other ways in which sodium alkyl can be prepared, which is by reacting sodium metal with... Alkyl mercury or Grignard's detector.

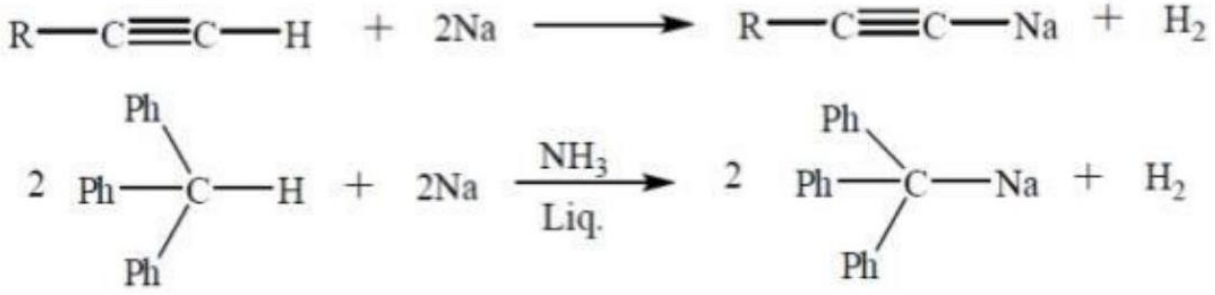
(1) The reaction of the organometallic compound with the metal salt with the highest reduction potential:

An example of this is Grignard reagents, alkyl halide (magnesium) with cadmium chloride.

In the same way, Grignard reagents can be used to prepare tetrakyl silicon.



(2) Hydrocarbon interaction with metals and their derivatives: some compounds Hydrocarbons, which contain an acidic hydrogen, which can decompose it, such as acetylates, which contain a triple bond (phenyl methane and fluorene), which can be transformed into their metallic derivatives by reacting with sodium or potassium. A solution of sodium in ammonium is used as a suitable medium in the reaction to prepare Organic sodium additives.

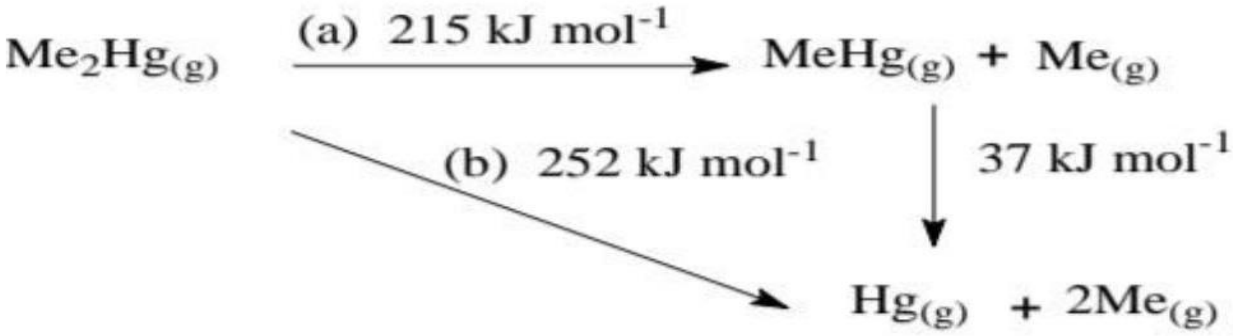


Stability of organometallic compounds

If it is thermally stable, the organometallic compound is considered stable to chemical changes such as oxidation and hydration, and many of these compounds maintain their stability when preserved in specific containers under nitrogen or argon gas.

1_ Thermal stability

The thermal stability of any compound is linked to its heat of formation (delta H), and the study of methyl compounds of the elements of the first row of the periodic table of the elements, specifically the heat of formation, showed that they have an increased bonding length, The compounds N3Me and C 4Medecrease in these elements under political conditions, and this indicates the stability of compounds such as Si4Me and B3Me are thermodynamically at room temperature, although other compounds such as Hg2Me and TI3Me are more stable than them, meaning they are endothermic:



2- Consistency towards hydration

This nucleophilic attack by which water flows on an organometallic compound is repelled by hydration, and it is easy for it to occur in the presence of empty orbitals of electrons. Therefore, compounds of the first, second, and third groups, specifically aluminum and gallium compounds, are more susceptible to hydration. The rate of hydration depends on the nature of the bond between the carbon and metal atoms, and so the rate is gradual. From very high aluminum volume to stable at room temperature, as is the case for the compound B3Me, which is not affected by water, despite the presence of the empty p2 orbital in the boron atom because the bond is non-medical and is considered compounds, The fourth group is the most resistant to nucleophilic attack, as it surrounds the silicon atom with a shell full of electrons. The table shows the difference in electronegativity between the carbon atom and a number of gaseous atoms, to clarify the picture more about the differences between compounds in their resistance to hydration.

3-Stability to oxidation

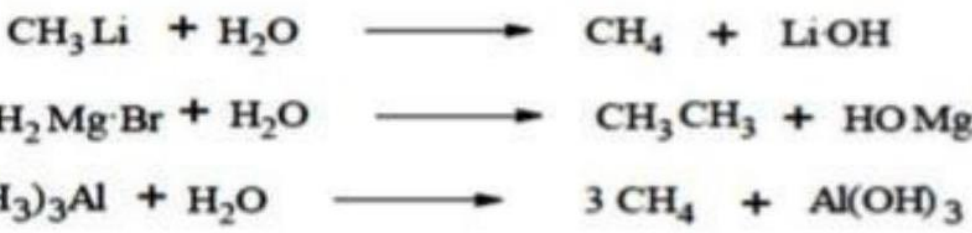
Organometallic compounds - in general - are unstable to oxidation, and many of them are

kinetically unstable to oxidation at room temperature. What increases the instability to oxidation is the presence of empty orbitals of electrons in the central atom, for example the two compounds (ln3Me, Al3Me), and what is observed in the aluminum compound, for example, is the speed of ignition in the presence of any slight trace of air, and the other factor for instability is the presence of the free electron pair on the central atom, as is the case in the antimony compound (Sb3Me). Other types of organometallic compounds are described as being stable to oxidation, and perhaps the clearest example is the saturated silicon compound (Si4Me), which does not meet either characteristic.

Chemicals of organometallic compounds:

1-Hydrolysis

Organometallic compounds react with water to form the corresponding hydrocarbon compound and metal hydroxide. The interaction activity of these compounds with water increases as the negativity increases. Therefore, the electrolytic compounds of lithium, magnesium, and aluminum interact strongly with water.



These compounds react with alcohols and carboxylic acids

The decomposition of organic zinc and cadmium compounds is slower, while the decomposition of bimolecular compounds occurs in one stage (silicon, oxide, mercury, and lead).

Organic is not affected by water, but tolerates acidic solutions.

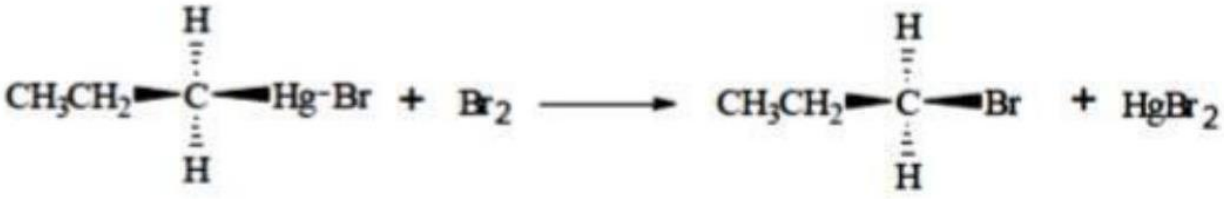
2 - Interaction with halogens

Most organometallic compounds react strongly with chlorine or bromine, forming halides Alkyl and salt. These reactions are not considered important in organic preparation because the resulting corona halides are raw materials used in preparing these compounds.

In these reactions, the halogen interacts as an electrophilic substance, and the reaction mechanism appears to occur in two ways, one of which is SE (single-molecular electrophilic substitution), which takes place in two stages and is in organometallic compounds in which the (MC) bond is

highly ionizing, and the second is SE (substituent). The two-molecule electrophile, which is carried out in one stage)

3-Oxygen with Reaction



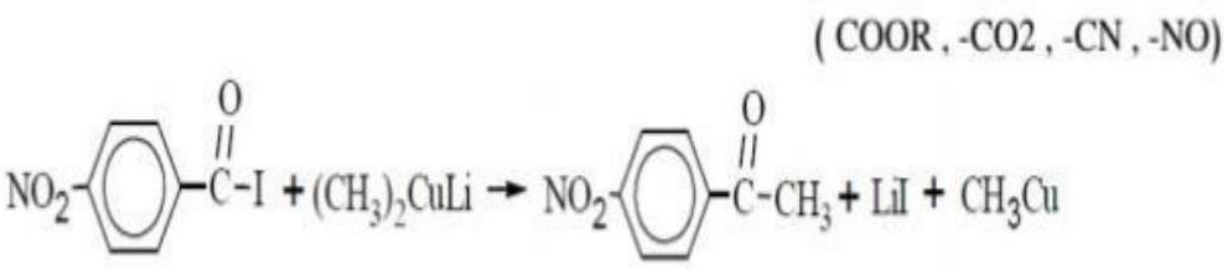
Most organic compounds react quickly with oxygen, and some of them are very active,

Alkyl boron, for example, ignites in the air. Therefore, caution must be taken when dealing with compounds, and all reactions of organometallic compounds must be carried out in the presence of gas. Carrier, such as argon or in the presence of nitrogen.

4- Reaction with some organometallic compounds

There are many reactions that take place between organometallic compounds, the most important of which is the reaction of alkyl lithium with alkyl copper to form compounds called lithium dialkyl copper, for example:

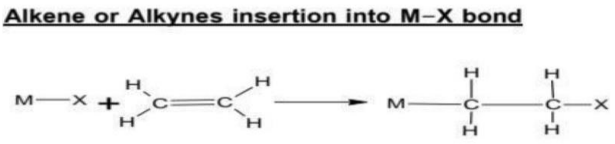
Lithium-alkyl copper compounds have increasing applications in organic preparation and them importance is highlighted by their combination with other reagents. It is more effective and more affinity than Grignard reagents and organic lithium compounds, and it has the ability to form carbon-carbon bonds easily. It reacts with halides and with halides of carboxylic acids to give ketones. Alkyl to form alkanes, while Grignard reagents and organolithium compounds do not react with all organic halides, and their reaction with halides of carboxylic acids gives alcohol. Also, despite the high effectiveness of lithium dialkyl copper compounds, they do not interact with the side functional groups.

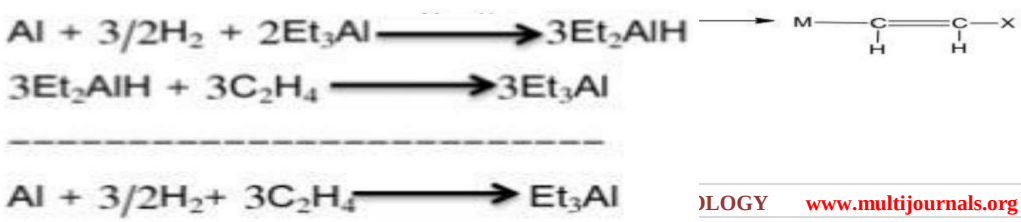


5- **Compounds that contain organometallic complexes**

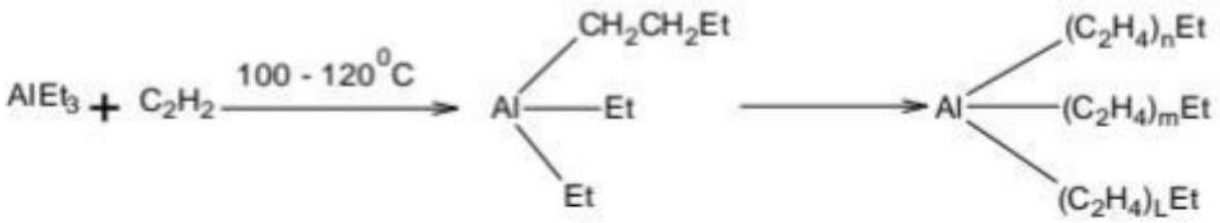
This reaction is known as alkhalide anion carboxylate metal (introducing alkene compounds or alkynes to the chain (XM)

This reaction is useful in preparing some materials industrially, for example preparing alcohols that contain multiple carbon atoms (fourteen carbon atoms). These alcohols are used in detergents.

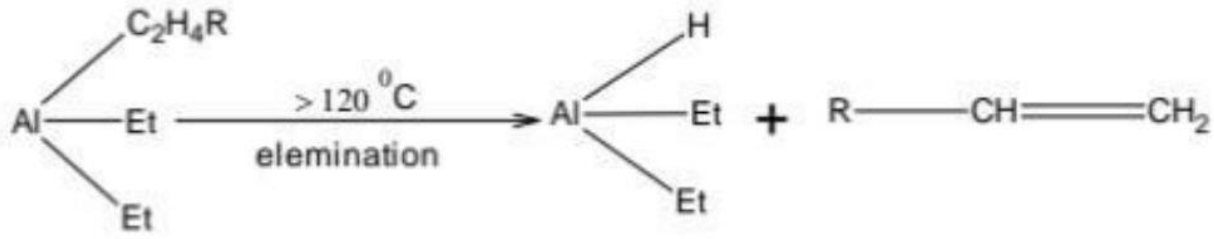




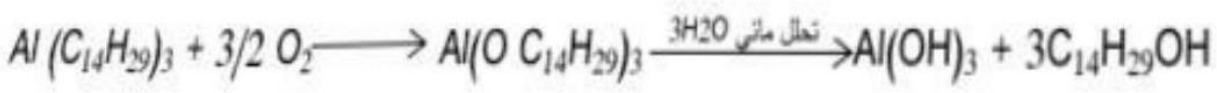
This process is greatly affected by temperatures, as follows: Therefore, temperatures must be controlled:



If the temperature is increased to above 121, the process becomes Elimination and not Insertion as in the following reaction.



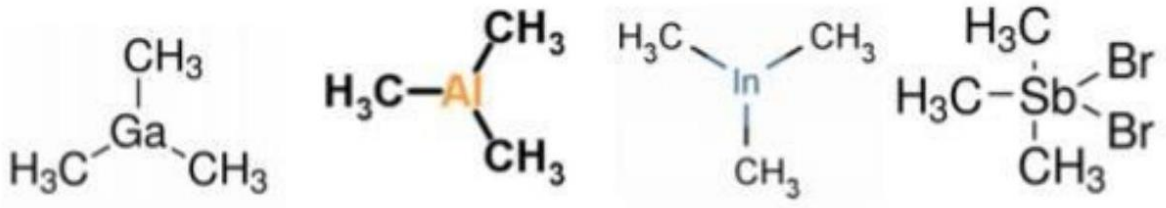
If the reaction is slowed to the point of 3(29H14C) Al and we introduce this compound into the next reaction, this is the required product (an alcohol with a high number of carbon atoms)



Applications of organometallic compounds

Organometallic compounds have a wide range of applications in chemistry. Below are some of them

- In some commercial chemical reactions, organometallic compounds are used As homogeneous catalysts.
- These compounds are used as stoichiometric reagents in industrial chemical reactions.
- These compounds are also used in the manufacture of some semiconductors, which It requires the use of compounds such as trimethylcalcium, trimethylaluminium, trimethylindium, and trimethylantimony.



- Used in the production of light-emitting diodes (LEDs).
- These compounds are used in bulk hydrogenation processes such as margarine production.

- These compounds are used as catalysts and reagents during the synthesis of some compounds
- Organometallic complexes are useful in facilitating the synthesis of many organic compounds

Compounds that do not contain organometallic complexes

1- Carbide: It is a compound consisting of carbon and an electrical element, such as calcium carbide, silicon carbide, and tungsten carbide. Carbide does not belong to the organic metallic materials. For example, steel is an alloy of iron and carbon is not considered among the organic metallic materials. 2- Sodium acetate does not belong to organometallic compounds despite the quality of the methyl group and the presence of a metal atom, because the compound does not contain a direct C_Na bond. 3- Both chlorophyll and hemoglobin are not organometallic compounds due to the presence of a direct bond between the element carbon and magnesium

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