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Grignard reagents are *extremely useful* organometallic compounds in the field of organic chemistry. They exhibit strong nucleophilic qualities and also have the ability to form new carbon-carbon bonds. Therefore, they display qualities that are also exhibited by organolithium reagents and the two reagents are considered similar.

When the alkyl group attached to a Grignard reagent is replaced by an amido group, the resulting compound is called a Hauser base. These compounds are even more nucleophilic than their Grignard counterparts.

What are Grignard Reagents?

A Grignard reagent is an organomagnesium compound which can be described by the *chemical formula* ' $R-Mg-X$ ' where R refers to an alkyl or aryl group and X refers to a halogen.

They are generally produced by reacting an aryl halide or an alkyl halide with magnesium.

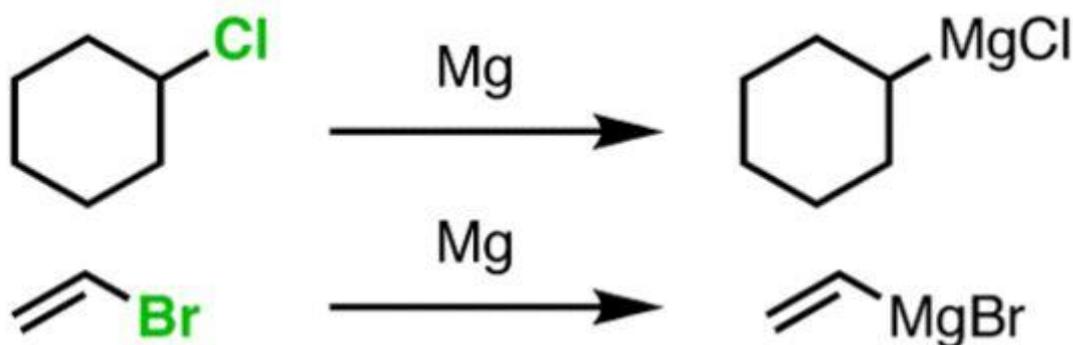
These reagents were discovered by the French chemist Victor Grignard, who won the Nobel Prize in Chemistry in the year 1912 for his work on these compounds.

Preparation of Grignard Reagents

The process of preparing Grignard reagents is described in the points provided below. It can be noted that many of these reagents can also be purchased commercially.

1. These reagents are prepared via the treatment of magnesium with organic halides such as alkyl or aryl halides.
2. This is done with the help of solvents comprising of ethers (which are described by the formula $R-O-R'$) because the ligands provided by these solvents help in the stabilization of the *organomagnesium compound*.
3. Water and air are very harmful to this synthesis and can quickly destroy the Grignard reagent which is being formed via protonolysis or via oxidation of the reagent. Therefore, the process must be carried out in air-free conditions.
4. Alternatively, the magnesium can be activated to make it consume water when wet solvents are used with the help of ultrasound.
5. After the slow induction period of the reaction, the process can be quite exothermic. This is a very important factor to consider while industrially producing the Grignard reagent.
6. *The organic halides used in these reactions include aryl or alkyl chlorides, bromides, and iodides*. Aryl fluorides and alkyl fluorides are not very reactive and are hence not commonly used. However, with the help of Rieke metals, the magnesium can be activated to make the fluoride more reactive.

An illustration detailing the preparation of these reagents is provided below.



Preparation of Grignard Reagent

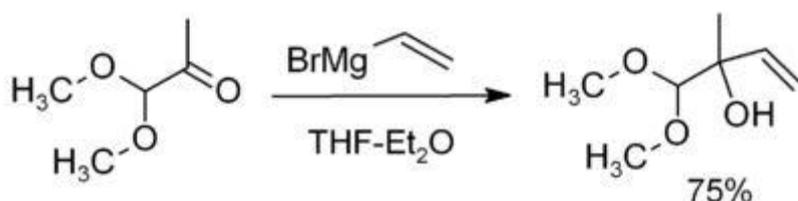
The quality testing of the synthesized Grignard reagents is done via titrations involving protic reagents that do not contain water (since these reagents are highly sensitive to oxygen and water) and a *color indicator*. One suitable compound for these titrations is methanol.

Reactions of Grignard Reagents

Grignard reagents are very important reagents in organic chemistry since they can be reacted with a wide range of compounds to form different products. Some of these reactions of these reagents are listed below.

1. Reactions with Carbonyl Group

These reagents form various products when reacted with different carbonyl compounds. The most common reaction of Grignard reagents is the alkylation of ketones and aldehydes with the help of R-Mg-X.

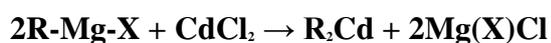


Reactions with Carbonyl Group

This reaction depicted above is also referred to as the Grignard reaction. The solvents that are used in this reaction include tetrahydrofuran and diethyl ether.

2. Reactions with Non-Carbon Electrophiles

For the *formation of new carbon-heteroatom bonds*, *Grignard reagents and some organolithium compounds are very useful*. These reagents can also undergo a transmetalation reaction with cadmium chloride, yielding dialkyl cadmium. This reaction can be written as follows.



Alkyl chains can be attached to many metals and metalloids with the help of these reagents.

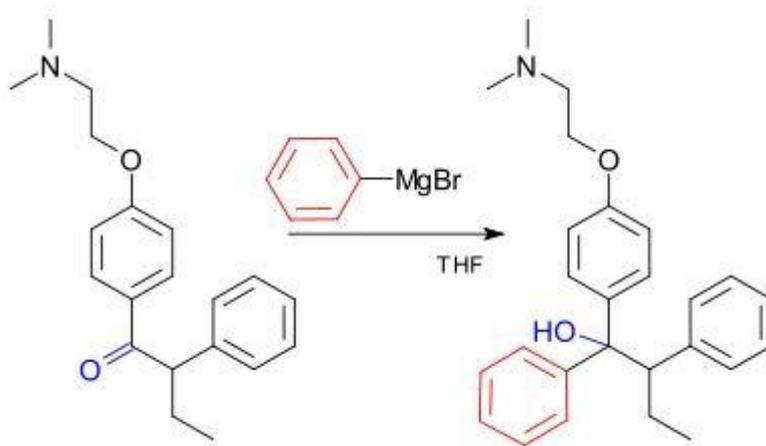
3. Reactions with Organic Halides

Typically, these reagents are quite unreactive towards [organic halides](#) which highly contrasts their behaviour towards other halides. However, carbon-carbon coupling reactions occur with Grignard reagents acting as a reactant when a metal catalyst is introduced.

An example of such a coupling reaction is the reaction between methyl p-chlorobenzoate and nonyl magnesium bromide which yields the compound p-nonyl benzoic acid in the presence of the catalyst – Tris(acetylaceto) iron(III).

4. Industrial Reactions

For the production of Tamoxifen, a type of medication used to prevent and treat breast cancer, the Grignard reagent is a vital part of the non-stereoselective process.



Industrial Reaction of Grignard Reagents