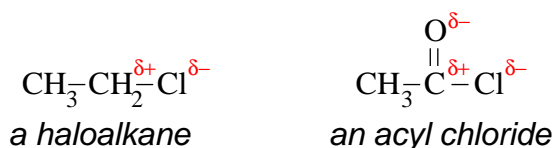


## FRIEDEL-CRAFTS REACTIONS - AN OVERVIEW

### General thoughts

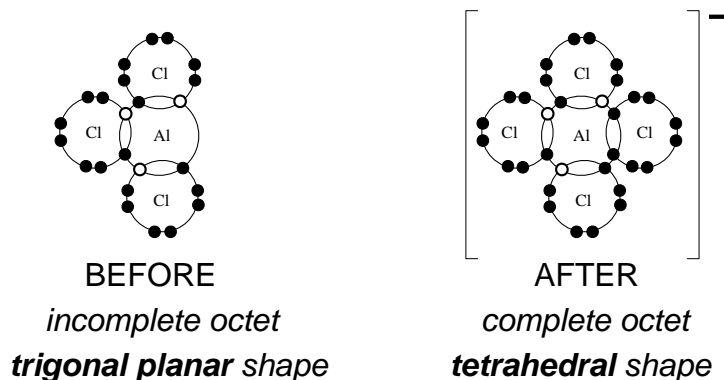
- Friedel-Crafts reactions involve **electrophilic substitution** of aromatic rings
- there are two types - **Alkylation** and **Acylation**
- alkylation involves the substitution of alkyl groups such as  $\text{CH}_3$ ,  $\text{C}_2\text{H}_5$  and  $\text{C}_3\text{H}_7$
- acylation involves the substitution of acyl groups such as  $\text{CH}_3\text{C}=\text{O}$
- in both cases a catalyst is needed
- this is because the attacking species isn't a strong enough electrophile
- it hasn't enough positive character to persuade benzene to react
- haloalkanes and acyl chlorides have polar bonds but the C isn't positive enough



- the catalyst makes the attacking species more positive
- **anhydrous** aluminium chloride is the catalyst
- it works because it is a **Lewis acid**
- in  $\text{AlCl}_3$  the aluminium is **electron deficient** - it has 6 electrons in its outer shell
- in both cases the reagent has a polar C-Cl bond
- the carbon atom has a  $\delta+$  charge but it isn't enough to tempt the benzene
- the aluminium chloride increases the charge so that benzene become interested

### Action of $\text{AlCl}_3$

- the aluminium atom is electron deficient with only 6 in its outer shell
- it acts as a Lewis acid as it can accept a lone pair to make up its octet



- it can do this by attracting a chlorine atom away from a C-Cl bond
- the more the Cl is attracted by the  $\text{AlCl}_3$  the more polar the C-Cl bond gets
- in the extreme case it pulls the chlorine right off leaving a  $\text{C}^+$  behind



- the aromatic ring will now attack and electrophilic substitution takes place

**Alkylation** substitutes an alkyl (e.g. methyl, ethyl) group

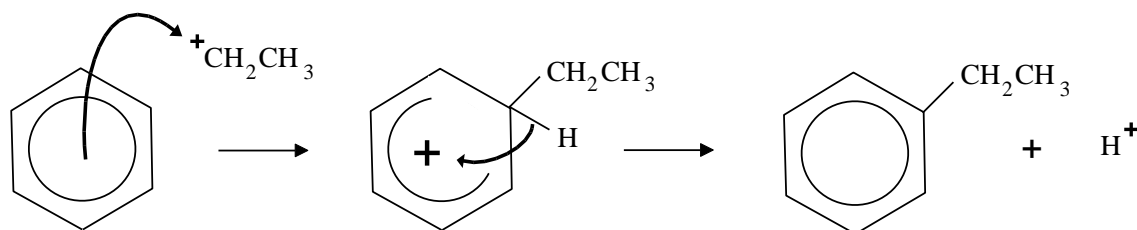
*reagents* a haloalkane (RX) and anhydrous aluminium chloride  $AlCl_3$

*conditions* room temperature; dry inert solvent (ether)

*electrophile* a carbocation  $R^+$  (e.g.  $CH_3^+$ )



*mechanism*



*Industrial method*

The industrial preparation of similar compounds is slightly different. Alkenes are used instead of haloalkanes - see other notes

**Acylation** substitutes an acyl (e.g. ethanoyl) group

the aluminium chloride catalyst acts in the same as with alkylation

*reagents* an acyl chloride ( $RCOCl$ ) and anhydrous  $AlCl_3$

*conditions* reflux  $50^\circ C$ ; dry inert solvent (ether)

*electrophile*  $RC^+=O$  (e.g.  $CH_3C^+=O$ )

*product* carbonyl compound (aldehyde or ketone)



*mechanism*

