

Reactions of Amines and Epoxides

Preparation of Amines

Amination of alcohols: Polyalkylation is a serious problem for tertiary hydroxyl group



A summary of Ring-Opening Reactions of Epoxides with Strong and Weak Nucleophiles



Bond Types, Strength, Length, Polarity and Dipole Moment

Two different bond types

There are two types of bonding: **ionic bonding** and **covalent bonding**

- **Ionic bonds** are formed by the transfer of electrons from one element to another (ionization potential) and electron affinity. Examples:



- **Covalent bonds** are formed by sharing of electrons between two atoms.



The Relative Electronegativity of Atoms



Bonded and Unbonded electron pairs



Electron movement



There are two main categories

1. Definition of electron pair



Sigma (σ) and pi (π) bonds

Covalent bonds are classified in **sigma (σ) bonds** and **pi (π) bonds**

- **Sigma bonds** are formed by head-on (frontal) overlap of orbitals.
- **π bonds** are formed by side-on overlap of orbitals.
- **Any single bond** is a **sigma bond**.
- **Any multiple bond** consists of one **sigma** and **π** bond(s).



π bonds are stronger than σ bonds.

Polar and Nonpolar Covalent Bonds

Depending on the difference in the electronegativity values, covalent bonds can be **polar** and **nonpolar**.



- If the difference in electronegativity is **less than 0.5**, the electrons are shared equally (nonpolar) between the two atoms, forming a **nonpolar covalent bond**. Most important examples are the **C-H** and **C-Cl** bonds.

- If the difference in electronegativity is **between 0.5 and 1.7**, we have a **polar covalent bond**. Most important examples are atoms for carbon is bonded to **N, O, F** and other halogens.

- A difference of **1.7 or higher** can be high that the electrons are not longer shared and a **ionic bond** is formed.

Dipole Moment

The polarity of a bond is described by the **dipole moment (μ)**.



- The **dipole moment** is always a vector pointing from the less electronegative to toward the more electronegative atom.
- The more electronegative atom has a partial negative charge (δ⁻) and the less electronegative atom has a partial positive charge (δ⁺).
- **δ⁻** (delta minus) indicates an electron deficient atom.
- **δ⁺** (delta plus) indicates an electron rich atom.

Molecular Dipole

To determine the **molecular polarity**, the vector sum of the dipoles is used.

The geometry of the molecule is important. Symmetrical molecules are nonpolar, polar cases for dipole moments are considered. A good example is carbon dioxide.



Cancel the vector as the other pointing point in the same way.

Bond Length and Bond Strength

As the bond length increases, the bond strength decreases.

Bond	H-H	H-Cl	H-Br	H-I
Length	109 pm	127 pm	141 pm	154 pm
Strength	436 kJ/mol	431 kJ/mol	366 kJ/mol	298 kJ/mol

Smaller electron more bonds overlap, closer to the nuclei and a stronger bond.

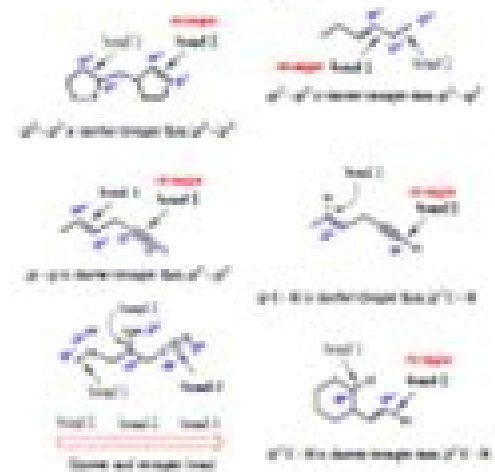


As the bond length increases, the bond strength decreases.

Average values of C-C and C-H bonds depending on hybridization			
C-C Bond	sp ³ -C-C	sp ² -C-C	sp-C-C
Hybridization	sp ³ -sp ³	sp ² -sp ²	sp-sp
Length	153 pm	134 pm	121 pm
Strength	376 kJ/mol	611 kJ/mol	591 kJ/mol
Hybridization	sp ³ -sp ³	sp ² -sp ²	sp-sp
C-H Bond	sp ³ -H	sp ² -H	sp-H
Length	109 pm	108 pm	106 pm
Strength	413 kJ/mol	505 kJ/mol	548 kJ/mol

Higher s character = stronger and shorter bond

Examples



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Ensheng Dong



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