

Reactions of Amines and Epoxides

Preparation of Amines

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



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 (electron).



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



The Relative Electronegativity of an



Bonded and Unbonded electron



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.
- **One single bond** is a **sigma bond**.
- **Two multiple bonds** consist of one **sigma** and **π** bonds.



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 bond).
- If the difference in electronegativity is **between 0.5 and 1.7**, we have a **polar covalent bond**.
- If the difference in electronegativity is **greater than 1.7**, we have an **ionic bond**.

A difference of 1.7 or higher can be high, but the difference can be higher (shared) and a lower bond is formed.

Dipole Moment

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



- The dipole moment is defined as a vector pointing from the less electronegative to 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, even if the dipole moments are present. A good example is carbon dioxide.



Consider the vector sum of the dipoles pointing from the positive to the negative end.

Bond Length and Bond Strength

The longer the bond, the weaker the bond.

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

Double bonds are stronger than single bonds, and triple bonds are stronger than double bonds.

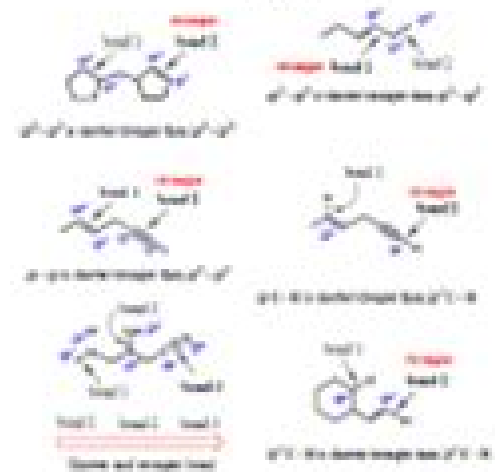


The longer the bond, the weaker the bond.

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	154 pm	134 pm	121 pm
Strength	347 kJ/mol	461 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	439 kJ/mol	505 kJ/mol

Higher s character = stronger and shorter bond

Examples



Organic Chemistry Brown Study Guide

**Brent L. Iverson, Sheila A.
Iverson, Christopher S. Foote**



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