

Reactions of Amines and Epoxides

Preparation of Amines

Amination of alcohols: Polyalkylation is a serious problem for indirect synthesis of amines



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



Regioselectivity and Stereochemistry

Bond Types, Strength, Length, Polarity and Dipole Moment

Two types of covalent bond

There are two types of covalent bond: bonding and non-bonding bond

- Bonding bonds are formed by the overlap of atomic orbitals (AOs) to form molecular orbitals (MOs) and are stronger than non-bonding bonds (lone pairs). Examples:



- Non-bonding bonds are formed by the overlap of atomic orbitals (AOs) to form molecular orbitals (MOs) and are weaker than bonding bonds. Examples:



The Relative Strength of σ and π Bonds



Bonding and Non-bonding Bonds



Bonding and Non-bonding Bonds



There are two types of covalent bond

Definition of covalent bond



Sigma (σ) and pi (π) bonds

Covalent bonds are classified as sigma (σ) and pi (π) bonds

- Sigma bonds are formed by the end-to-end overlap of atomic orbitals (AOs) to form molecular orbitals (MOs) and are stronger than pi bonds.
- Pi bonds are formed by the side-to-side overlap of atomic orbitals (AOs) to form molecular orbitals (MOs) and are weaker than sigma bonds.
- Any single bond is a sigma bond.
- Any multiple bond consists of one sigma and n pi bonds.



σ bonds are stronger than π 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 covalent bond). Examples: $\text{C}-\text{C}$ and $\text{C}-\text{H}$ bonds.
- If the difference in electronegativity is between 0.5 and 1.7, the electrons are shared unequally (polar covalent bond). Examples: $\text{C}-\text{O}$ and $\text{C}-\text{N}$ bonds.
- A difference of 1.7 or higher is ionic (the electrons are not shared; instead, an ionic bond is formed).

Dipole Moment

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

It is a vector quantity that points from the positive end to the negative end.



The magnitude of the dipole moment is the product of the charge and the distance between the charges.

- The dipole moment is a vector pointing from the less electronegative atom 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 dipoles are not zero. A good example is carbon dioxide.



Carbon dioxide is a linear molecule and the dipoles cancel out.

Bond Length and Bond Strength

The longer the bond, the weaker it is.

Bond	$\text{H}-\text{H}$	$\text{H}-\text{Cl}$	$\text{H}-\text{Br}$	$\text{H}-\text{I}$
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 are shorter.

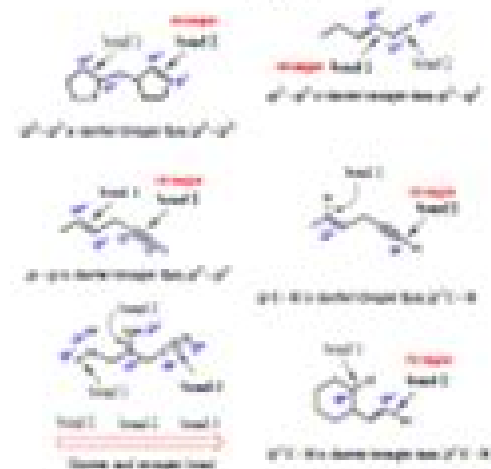


The longer the bond, the weaker it is.

Average values of C-C and C-H bonds depending on hybridization			
C-C Bond	sp^3-sp^3	sp^2-sp^2	$\text{sp}-\text{sp}$
Hybridization	sp^3-sp^3	sp^2-sp^2	$\text{sp}-\text{sp}$
Length	154 pm	134 pm	120 pm
Strength	347 kJ/mol	460 kJ/mol	590 kJ/mol
Hybridization	sp^3-sp^3	sp^2-sp^2	$\text{sp}-\text{sp}$
C-H Bond	sp^3-sp^3	sp^2-sp^2	$\text{sp}-\text{sp}$
Length	109 pm	108 pm	106 pm
Strength	413 kJ/mol	460 kJ/mol	505 kJ/mol

Higher s character = stronger and shorter bond

Examples



Study Guide For Organic Chemistry 2

Michael Brown



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