

Reactions of Amines and Epoxides

Preparation of Amines

Amines are colorless, basic, and have a strong, fishy odor. They are prepared by the reduction of nitriles.



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



Epoxide Reactions and Mechanisms

Bond Types, Strength, Length, Polarity and Dipole Moment

Types of Bonding Interactions

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 gain enthalpy).



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



The Relative Strength of Ions



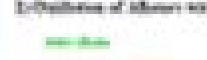
Bond and Bonding Interactions



Bonding Interactions



There are two types of bonding interactions



Sigma and pi bonds

Covalent bonds are classified into sigma and pi bonds.

- **Sigma bonds** are formed by head-on overlap of orbitals.
- **pi bonds** are formed by side-on overlap of orbitals.
- **Single bonds** are sigma bonds.
- **Double bonds** consist of one sigma and one pi bond.



pi bonds are stronger than sigma 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).
- If the difference in electronegativity is between 0.5 and 1.7, the electrons are shared unequally (polar covalent bond).
- If the difference in electronegativity is greater than 1.7, the electrons are not shared (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 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 dipoles are present. A good example is carbon dioxide.



Consider the vector sum of the dipole moments for the entire molecule.

Bond Length and Bond Strength

The length of the bond is important.



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

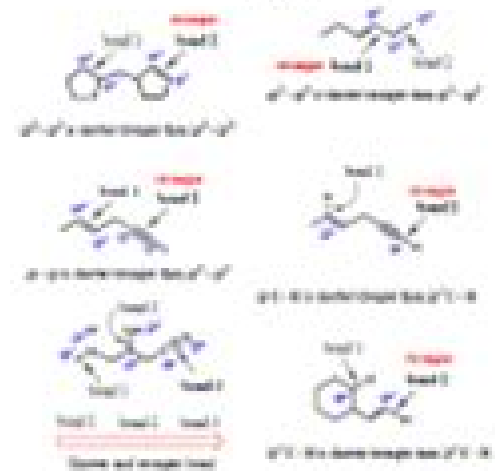


The length of the bond is important.

Average values of C-C and C-H bonds depending on hybridization			
C-C Bond	sp^3-sp^3	sp^2-sp^2	$sp-sp$
Hybridization	sp^3-sp^3	sp^2-sp^2	$sp-sp$
Length	154 pm	134 pm	121 pm
Strength	376 kJ/mol	472 kJ/mol	591 kJ/mol
Hybridization	sp^3-sp^2	sp^2-sp	$sp-sp$
C-H Bond	109 pm	108 pm	106 pm
Length	154 pm	134 pm	121 pm
Strength	376 kJ/mol	472 kJ/mol	591 kJ/mol

Higher s character means stronger bond

Examples



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