Difference Between Syn and Anti Addition

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Key Difference - Syn vs Anti Addition

In organic chemistry, the addition reactions are characterized by two groups that bond to a double bond. During this characteristic addition reaction of alkenes, the p bond of the double bond is broken and new σ bonds are formed. It is because p bond of C=C bond is much weaker and unstable than C-C σ bond. Moreover, p bond of alkenes makes them electron rich, as p bond's electron density is concentrated above and below the plane of the molecule. Therefore, p bond is more vulnerable to σ electrophiles than the bond. The stereochemistry is important in determining the mechanism of addition reactions. The stereochemistry of addition reactions depends on two aspects. First one is the joining side of electrophile and nucleophile to the double-bonded carbons (whether it is from the same side of the double bond or from the opposite side). The second aspect is the geometrical orientation of electrophile and nucleophile to each other and the rest of the organic molecule. Based on these aspects, there are two possible stereochemistries for the addition, syn and anti. The **key difference** between syn addition and anti addition is that **in syn addition, both electrophile and nucleophile add from the same side of the plane of double-bonded carbon atoms, whereas in anti-addition, nucleophile and electrophile add from opposite sides of this plane**. Further details related to syn and anti additions are discussed below.

What is Syn Addition?

Syn addition is a possible stereochemistry of addition where both electrophile and nucleophile bond to the same side of the plane of the double-bonded carbon atoms of an alkene. The syn addition often occurs when alkenes have an aryl substituent.

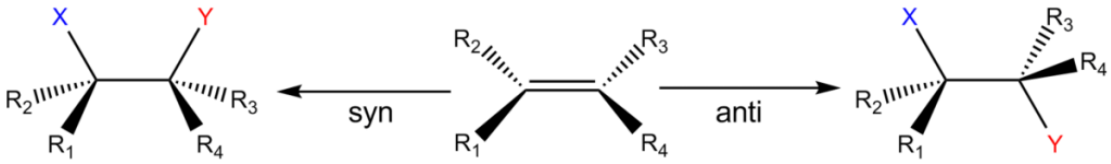

Figure 01: Syn and Anti Addition

Moreover, it occurs in hydroboration. During hydrohalogenation and hydration, both syn and anti addition can occur. During hydroboration, the first step is the formation of an intermediate alkylborane by the addition of H and BH_2 to the p bond of an alkene. Then in the second step, H-BH_2 and p bond are broken to form new σ bonds. The transition state of this reaction is four-centered as four atoms are involved to form the intermediate.

What is Anti Addition?

Anti addition is a possible stereochemistry of addition where electrophile and nucleophile bond to the opposite sides of the plane of the double-bonded carbon atoms

of an alkene. Anti addition occurs in halogenation and halohydrin formation. Halogenation is the addition of X_2 (where X= Br or Cl). Halogenation of alkenes has two steps.

In the first step, the addition of the electrophile (X^+) to the pbond is taken place. During this step, a three-membered ring with positively charged halogen atom called bridged halonium ion is formed. The first step is the rate-determining step. Then in the second step, nucleophilic attack of X^- takes place. During this step, X^-attacks the ring of halonium ion opens it and then forms the C-X new σ bond.

What is the Difference Between Syn and Anti Addition?

Syn Addition vs Anti Addition	
Syn Addition is a possible stereochemistry of addition where both electrophile and nucleophile bond to the same side of the plane of the double-bonded carbon atoms of an alkene.	Anti-Addition is a possible stereochemistry of addition where electrophile and nucleophile bond to the opposite sides of the plane of the double-bonded carbon atoms of an alkene
Addition Reactions	
hydroboration, hydrohalogenation and hydration	halogenation, halohydrin formation, hydrohalogenation and hydration

Summary - Syn vs Anti Addition

Alkenes are characterized by the addition reactions, which are categorized into two types based on the stereochemistry;syn addition and anti addition. During the addition, p bond of C=C breaks to form new σ bond. In syn addition, both nucleophile and electrophile bonds to the same side of the plane of p bond of C=C bond of alkene, whereas in anti addition, nucleophile and electrophile add to opposite side of the plane of p bond. This is the difference between syn and anti additions.

Reference:

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