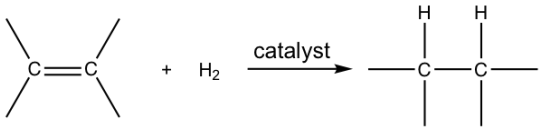
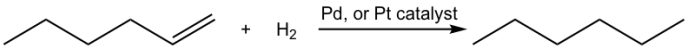
10.5: Reaction of Alkenes- Hydrogenation

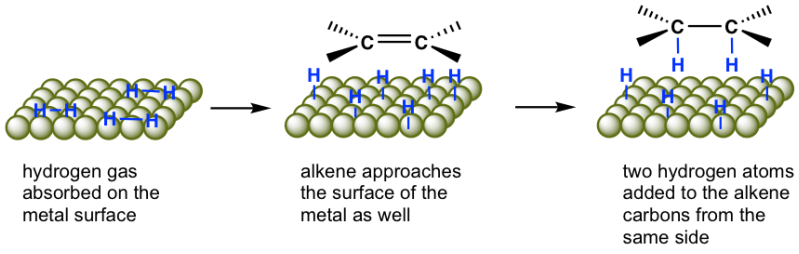
When alkenes react with hydrogen gas in the presence of a variety of metal catalysts, a hydrogen molecule will be added to the double bond in the way that each carbon atom bonded with one hydrogen atom, such addition reaction is called **hydrogenation**.



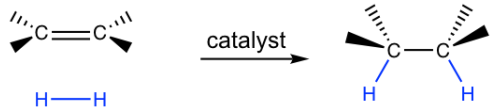
Catalysts are must-have for hydrogenation, so the reaction can also be called **catalytic hydrogenation**. The commonly applied metal catalysts involve palladium and platinum. Palladium, which is used as a powder absorbed on charcoal to maximize the surface area, is the most common catalyst that is referred to as palladium on charcoal (Pd/carbon). Platinum, which is used usually as oxide PtO2, is also employed frequently and referred to as Adams catalyst. These metal catalysts are **not** soluble in the reaction mixture and therefore are described as heterogeneous catalysts. The heterogeneous catalyst can be easily filtrated out of the reaction mixture after reaction, and then be recycled and reused.



The hydrogenation reaction does not take place without catalyst because of the enormous activation energy. The catalysts lower down the activation energy by weakening the H-H bond, and make the reaction feasible at room temperature. The details of the mechanism of catalytical hydrogenation are not completely clear. What was understood was that hydrogen gas is adsorbed on the surface of the metal, and the alkene also complexes with the metal by overlapping its π orbitals with vacant orbitals of the metal. The reaction occur on the surface of the metal catalyst, with both hydrogen atoms added from the same side of the alkene, to give alkane as the product that diffuses away from the metal surface. This mode of addition that the atoms added from the same side of the alkene is called the **syn addition**.

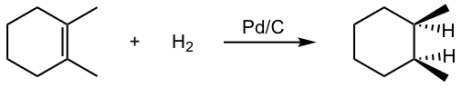


simplified diagram for catalytic hydrogenation of alkene



catalytic hydrogenation: syn addition

Example:



syn addition