

Hybridization

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Hybridization

Connections to Lewis

- Lewis dot structures are great predictors of structure. However.....
 - They don't tell us much about how covalent bonds form
- This is where hybridization becomes an important concept
- We are going to use geometry to predict hybridization
- We will first explore how hybridization happens, then look at how to determine the hybridization of an atom, given its Lewis dot structure.

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Hybridization

Hybridization Process

- Consider a CH₄ molecule
 - Draw the orbital filling diagram for C
 - Draw the Lewis dot structure for CH₄
- How is it that carbon is able to form 4 covalent bonds?

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Hybridization

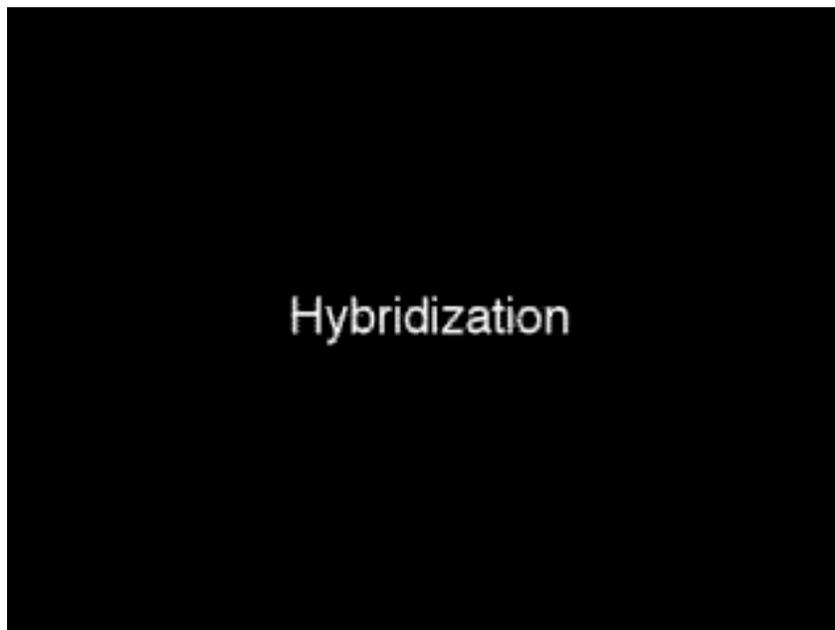
Hybridization Fundamentals

- Hybridization is the process of atomic orbitals “mix together” to form hybrid orbitals, which then bond covalently with other atoms
- When hybridization takes place, as many hybrid orbitals are produced as the number of atomic orbitals hybridized
- Hybrid orbitals have two lobes
 - The larger one is involved in bonding
 - The smaller one is not considered when looking at domain structure

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Hybridization

Connections to Lewis



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Hybridization

Hybridization Involving d orbitals

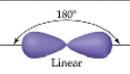
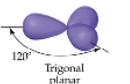
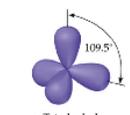
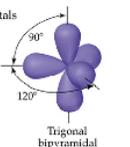
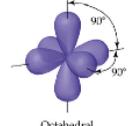
- sp^3d hybridization
 - Involves hybridizing 1 s, 3 p and 1 d orbitals
 - Creates 5 hybrid bonding orbitals
 - Trigonal bipyramidal domain structure
- sp^3d^2 hybridization
 - Involves hybridizing 1 s, 3 p and 2 d orbitals
 - Creates 6 hybrid bonding orbitals
 - Octahedral domain structure

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Hybridization

Connection to Structure

TABLE 9.4 Geometric Arrangements Characteristic of Hybrid Orbital Sets

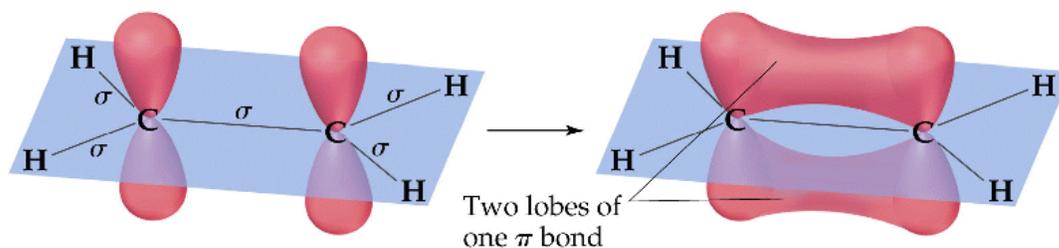
Atomic Orbital Set	Hybrid Orbital Set	Geometry	Examples
s, p	Two sp	Linear 	$\text{BeF}_2, \text{HgCl}_2$
s, p, p	Three sp^2	Trigonal planar 	BF_3, SO_3
s, p, p, p	Four sp^3	Tetrahedral 	$\text{CH}_4, \text{NH}_3, \text{H}_2\text{O}, \text{NH}_4^+$
s, p, p, p, d	Five sp^3d	Trigonal bipyramidal 	$\text{PF}_5, \text{SF}_6, \text{BrF}_3$
s, p, p, p, d, d	Six sp^3d^2	Octahedral 	$\text{SF}_6, \text{ClF}_3, \text{XeF}_4, \text{PF}_6^-$

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Hybridization

Hybridization and Multiple Bonds

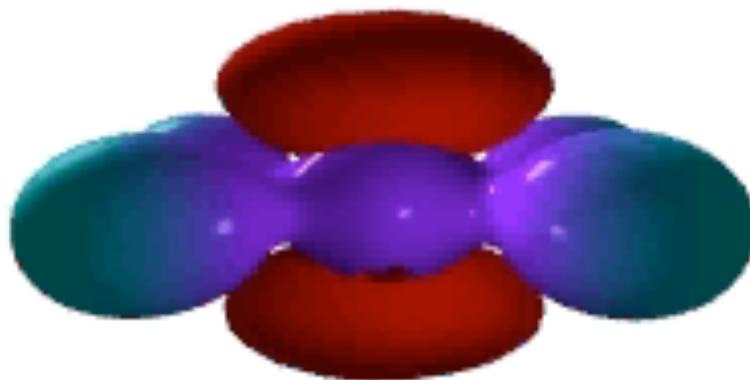
- A quick review of multiple bonds
 - All single bonds are sigma (δ) bonds
 - In the bond axis
 - Double and Triple bonds are a combination of sigma and pi (π) bonds
 - Pi bonds are created by unhybridized p orbital overlap
 - Double bond = 1δ and 1π
 - Triple bond = 1δ and 2π
 - π bonds tend to be weaker than sigma bond due to incomplete overlap
 - C_2H_4



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Hybridization

Hybridization and Multiple Bonds

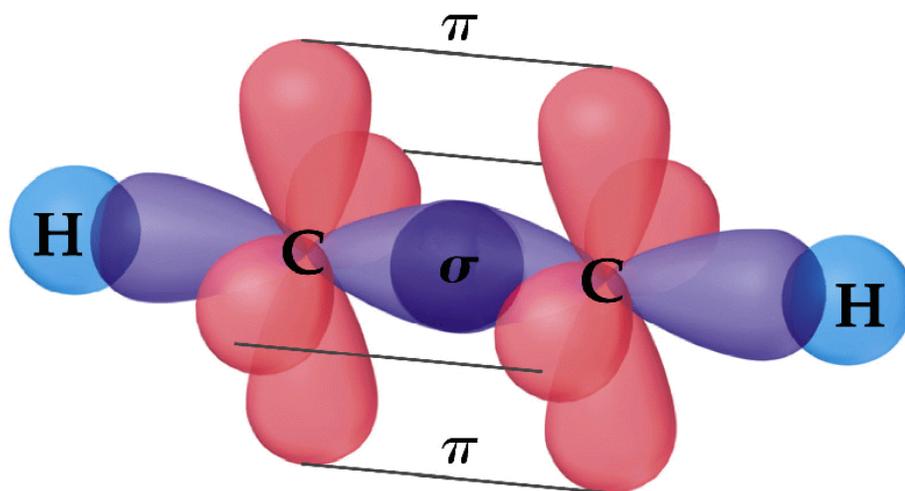


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Hybridization

Another Example

- Consider C_2H_2



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Hybridization

One for Practice

- Lets take a look at formaldehyde (CH_2O)
 - Draw the Lewis structure
 - Indicate the geometry
 - What is the approximate bond angle?
 - How will the measured H - C - O bond angle compare to the predicted value?
 - What is the hybridization of the carbon?
 - How many sigma and pi bonds are represented?

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Hybridization

Homework

- 9.7 / 9.8 / 9.47 / 9.49 / 9.51 / 9.53 / 9.55 / 9.57 / 9.59 /
9.61 / 9.66

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