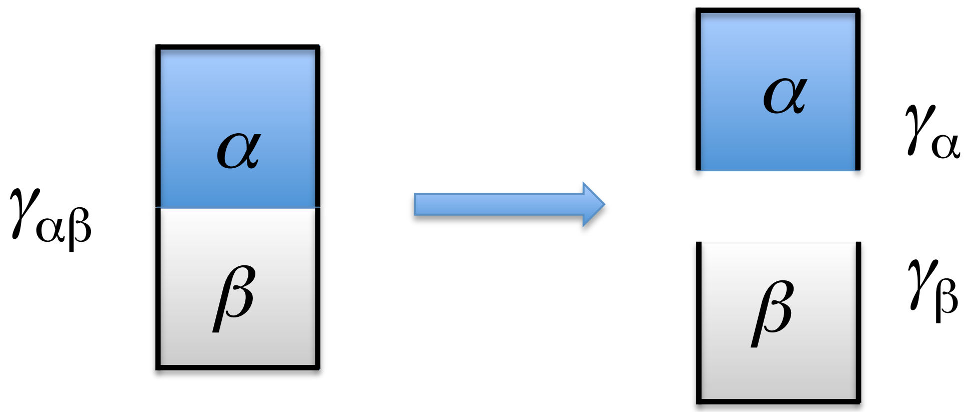
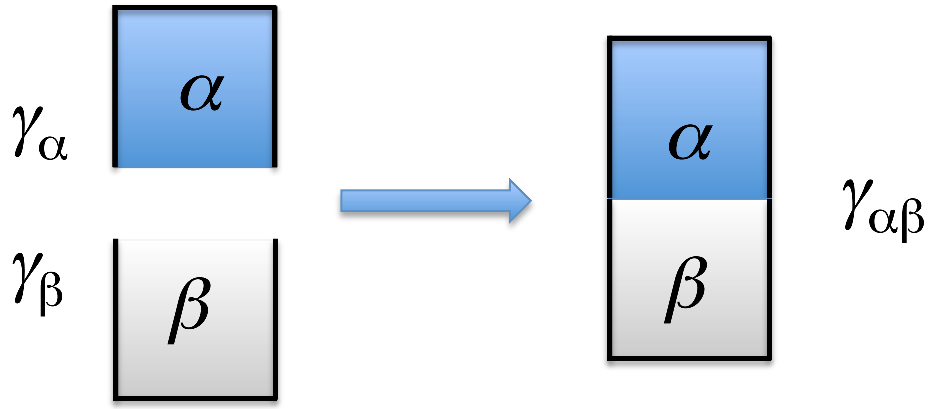
Origin of the Hydrophobic Force

Consider the energy required to pull apart the interface between two liquids
(α & β are either hydrocarbon or water)

'Work of Adhesion' $W_{\alpha\beta} = \gamma_\alpha + \gamma_\beta - \gamma_{\alpha\beta}$



The opposite process is the energy of interface formation = $-W_{\alpha\beta}$

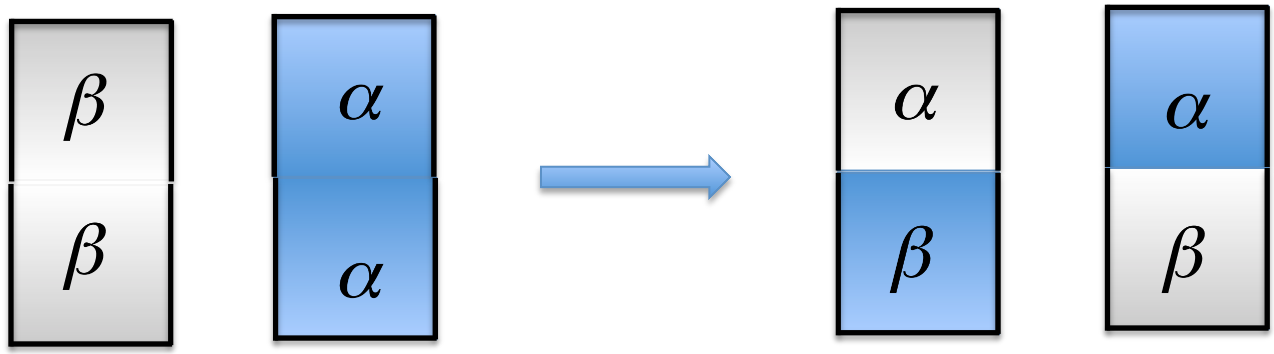


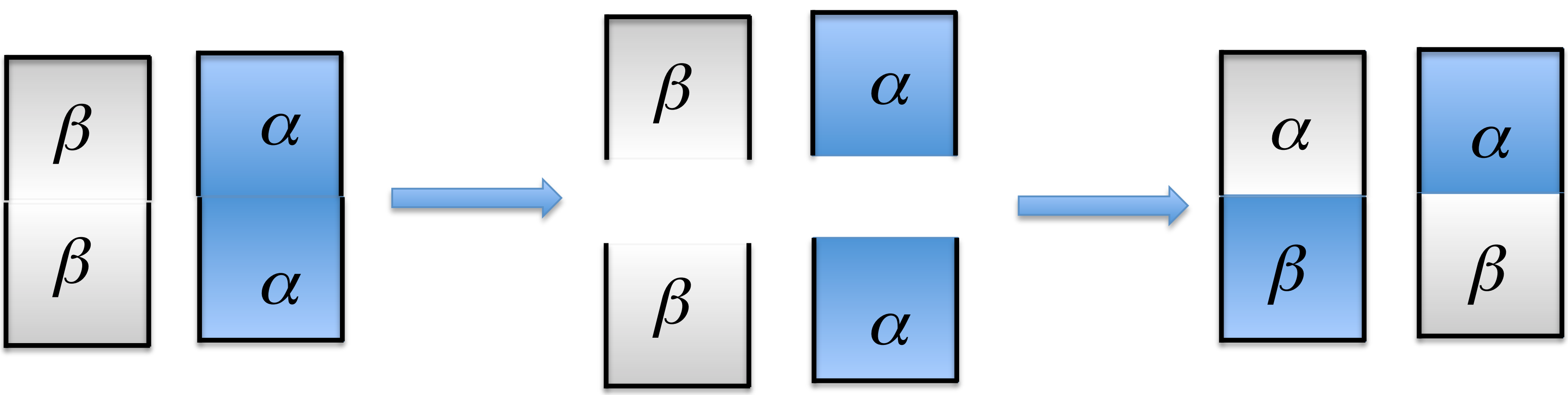
Free energy of formation of a liquid-liquid area of contact from surfaces previously exposed to air, erg/cm^2 at 25 ^{o}C

Liquid Interface	Hexane	Octane
Hydrocarbon/Water	-39.5	-42.0
Hydrocarbon/Hydrocarbon	-35.8	-42.4
Water/Water	-144	-144

Energy of Interface formation (relative to vacuum/liquid interface) is favorable in all cases

Is the formation of hydrocarbon/water interface favorable?

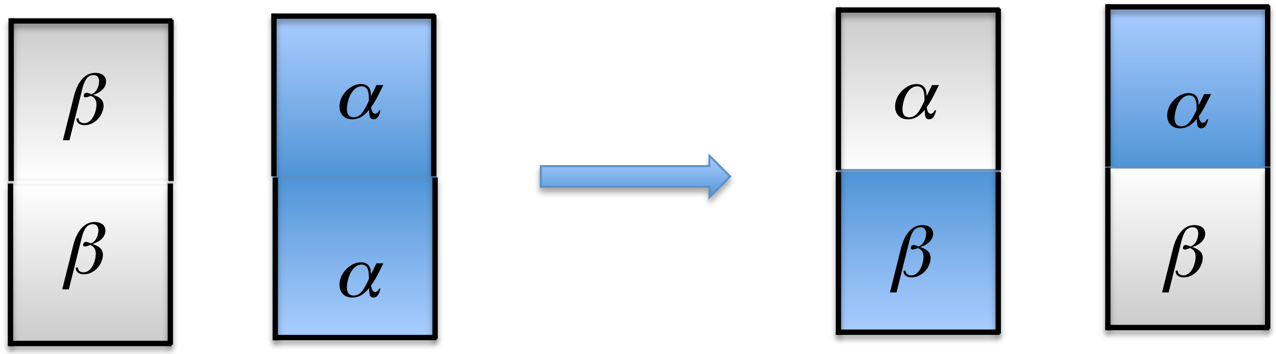




$W_{\alpha\alpha} + W_{\beta\beta}$

$-2W_{\alpha\beta}$

Transfer reaction



Energy of Water/Hydrocarbon interface formation from Water/Water & Hyd/Hyd Interfaces =

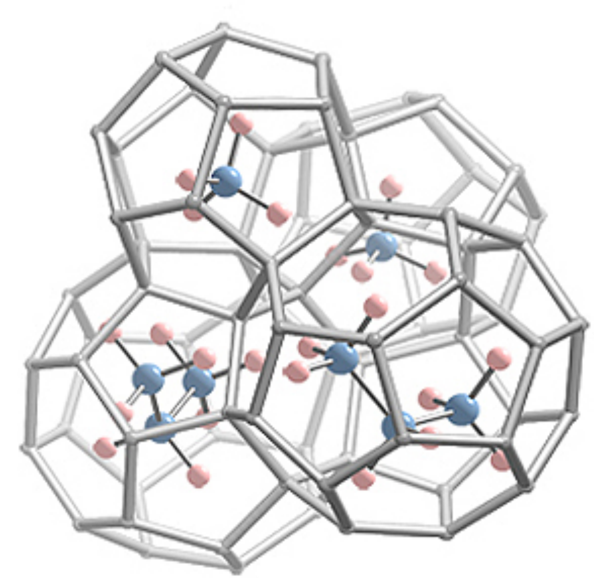
$$\frac{1}{2}\,(W_{\alpha\alpha} + W_{\beta\beta} - 2W_{\alpha\beta})$$

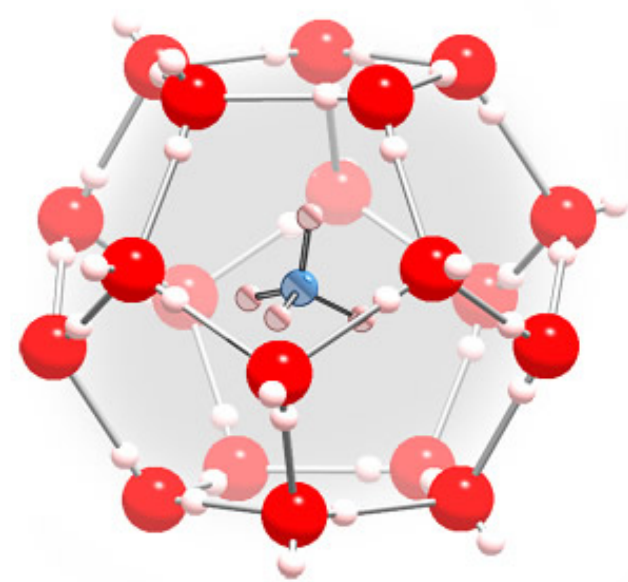
$$\frac{1}{2}\,(144 + 42.4 - 84)$$

51.2 erg/cm^2 of octane/water interface

Clathrate Structures

The unfavorable Gibbs energy of Hyd/Water interface formation is mainly *entropic*





21-25 cal/mole per Å^2 for saturated aliphatic hydrocarbons

<20 cal/mole per Å^2 for aromatic hydrocarbons.