دانشگاه صنعتی اصفهان

صنایع لبنی تکمیلی

دکتر علی نصیرپور

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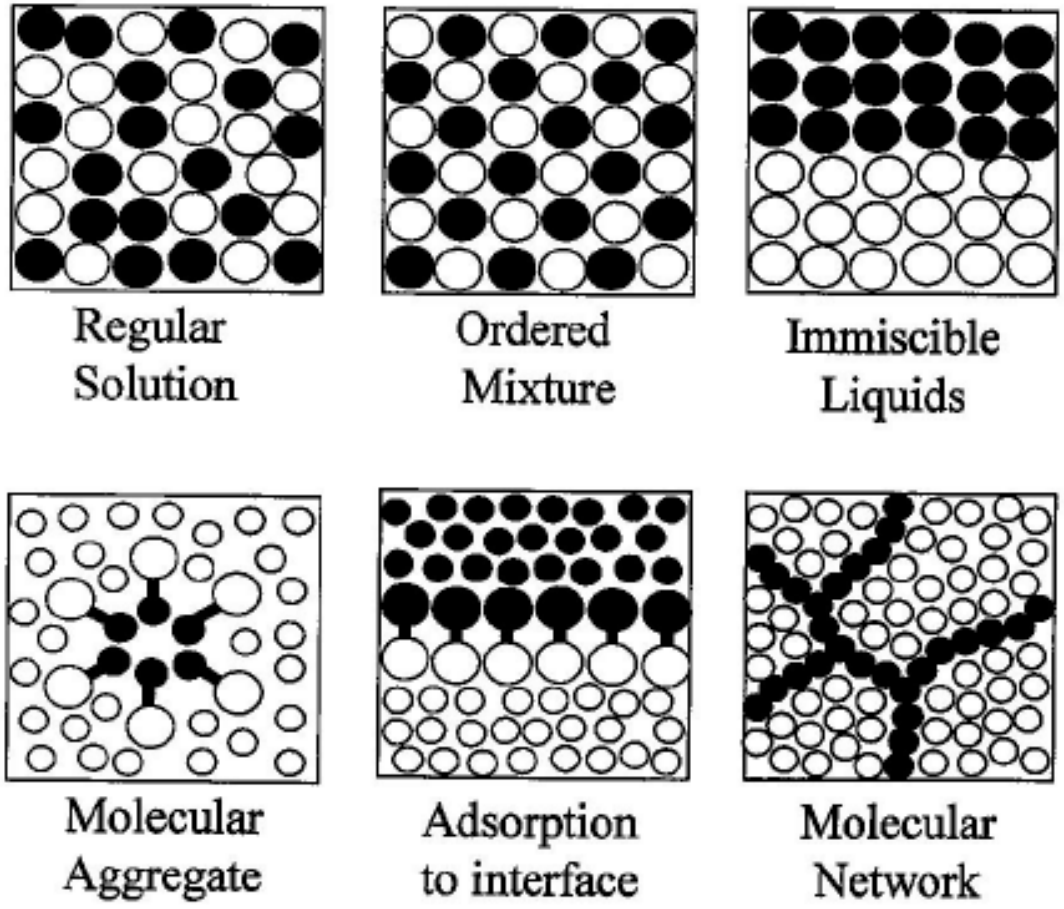

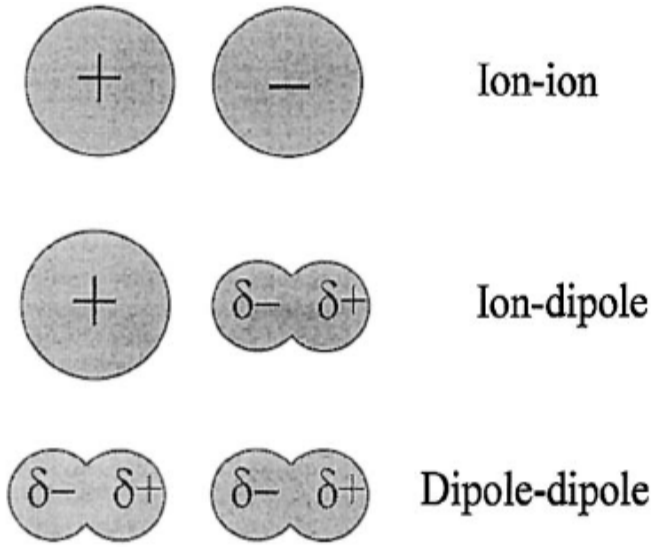

Schematic representation of the most important types of intermolecular electrostatic interactions that arise between molecules

The molecules in food emulsions may adopt a variety of different structural arrangements depending on the nature of their interactions with their neighbors

TABLE 2.1
Parameters Needed to Calculate the Interaction Pair Potential for Ion–Ion, Ion–Dipole, and Dipole–Dipole Electrostatic Interactions Using Equation 2.1 (see also Figure 2.3a)

Interaction type	Example	Q_1Q_2	n
Ion–ion	Na^+ Cl^-	(z_1e) (z_2e)	1
Ion–dipole	Na^+ H_2O	(z_1e) $\mu_2 \cos \phi$	2
Dipole–dipole	H_2O H_2O	$\mu_1\mu_2 f(\phi)$	3

Note: z is the valence, μ is the dipole moment, e is the electronic charge, and ϕ is the angle between the charges.

TABLE 2.2
Compilation of Molecular Properties of Some Common Liquids and Solutes Needed to Calculate Intermolecular Interactions

Static Relative Dielectric Constants (ε_R)			
Water	78.5	Chloroform	4.8
Ethylene glycol	40.7	Edible oils	2.5
Methanol	32.6	Carbon tetrachloride	2.2
Ethanol	24.3	Liquid paraffin	2.2
Acetone	20.7	Dodecane	2.0
Propanol	20.2	Hexane	1.9
Acetic acid	6.2	Air	1.0

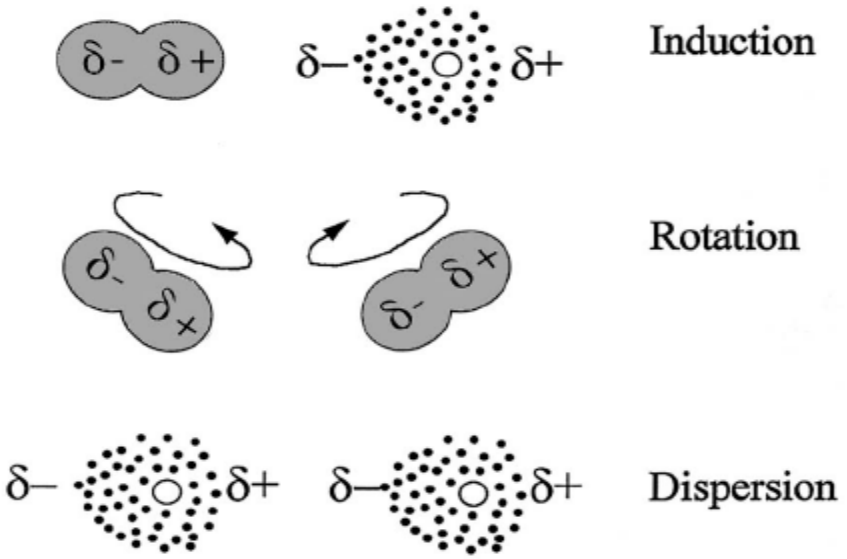

FIGURE 2.4 Schematic representation of van der Waals intermolecular interactions which involve either the electronic or orientational polarization of molecules.

Molecular Diameters, Polarizabilities, and Dipole Moments

Molecule type	σ (nm)	$\alpha/4\pi\varepsilon_0$ ($\times 10^{-30}$ m^3)	μ (D [a])
H_2O	0.28	1.48	1.85
CH_4	0.40	2.60	0
HCl	0.36	2.63	1.08
CH_3Cl	0.43	4.56	1.87
CCl_4	0.55	10.5	0
NH_3	0.36	2.26	1.47
Methanol	0.42	3.2	1.69
Ethanol	[b]	5.2	1.69
Acetone	[b]	6.4	2.85
Benzene	0.53	10.4	0

[a] $D = 3.336 \times 10^{-30}$ C m.

[b] Cannot be treated as spheres.

TABLE 2.3
Approximate Bond Strengths for Some of the Most Important Types of Molecular Interactions That Occur in Foods at Room Temperature

Type of interaction	In vacuum		In water	
	$w(s^*)$ (kJ mol^{-1})	$w(s^*)$ (RT)	$w(s^*)$ (kJ mol^{-1})	$w(s^*)$ (RT)
Covalent bonds				
C–O	340	140		
C–C	360	140		
C–H	430	170		
O–H	460	180		
C=C	600	240		
C≡N	870	350		
Electrostatic ion–ion				
Na^+ Cl^-	500	200	6.3	2.5
Mg^{2+} Cl^-	1100	460	14.1	5.7
Al^{3+} Cl^-	1800	730	22.5	9.1
Ion–dipole				
Na^+ H_2O	97	39	1.2	0.5
Mg^{2+} H_2O	255	103	3.2	1.3
Al^{3+} H_2O	445	180	5.6	2.3
Dipole–dipole				
H_2O H_2O	38	15	0.5	0.2
Ion polarization				
Na^+ CH_4	24	10		
van der Waals				
CH_4 CH_4	1.5	0.60		
C_6H_{14} C_6H_{14}	7.4	3.0		
$C_{12}H_{26}$ $C_{12}H_{26}$	14.3	5.7		
$C_{18}H_{38}$ $C_{18}H_{38}$	21.2	6.1		
CH_4 H_2O	2.6	0.7		
H_2O H_2O	17.3	6.9		

Note: All dipole interactions assuming that the molecules are aligned so they get maximum attraction. van der Waals forces calculated from Israelachvili (1992) assuming that $w(s^*)$ is approximately equal to the cohesive energy over 6.