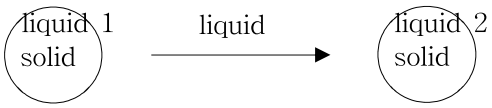
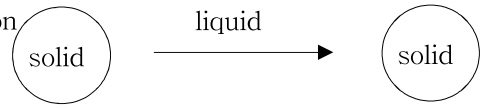
Chap 6 Solid-Liquid Interface

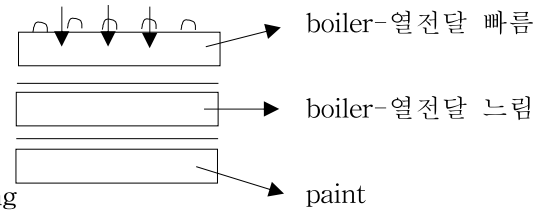
• wetting : displacement from a surface of one fluid by another

gas liquid



• application





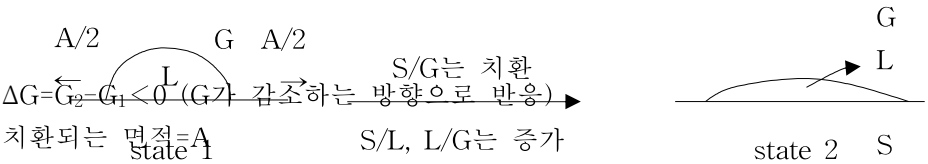
• wetting의 종류

① spreading wetting

② adhesional wetting

③ immersional wetting

1) spreading wetting



$\Delta G = G_2 - G_1 < 0$ (G가 감소하는 방향으로 반응)

치환되는 면적=A S/L, L/G는 증가

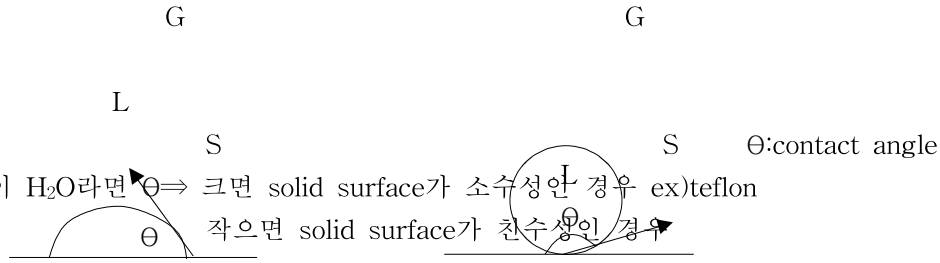
state 1 state 2

$-\Delta G = G_1 - G_2 = \gamma_{SG}A - (\gamma_{SL}A + \gamma_{LG}A)$ cf) γ:단위면적당 G.E.

spreading coeff $= -\frac{\Delta G}{A} = \gamma_{SG}A - (\gamma_{SL}A + \gamma_{LG}A)$ S= + : spontaneous spreading

- : contraction

at equilibrium



θ:contact angle

if L이 H_2O라면 θ⇒ 크면 solid surface가 소수성인 경우 ex)teflon

작으면 solid surface가 친수성인 경우

θ= 180°: complete non-wetting

0 : complete wetting

point A에서의 force balance

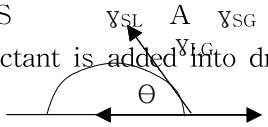
G $\gamma_{SG}=\gamma_{SL}+\gamma_{LG}\cos\theta$

L $\cos=\frac{\gamma_{SG}-\gamma_{SL}}{\gamma_{LG}}$: Young's Equation

S γ_{SL} A γ_{SG}

γ_{LG}

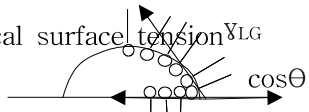
if, surfactant is added into drop



γ_{SG}=constant, $\gamma_{SL}\downarrow$ $\gamma_{SG}\downarrow$

⇒NaCl첨가

• critical surface tension γ_{LG}

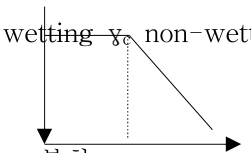


$\cos\theta$ 1.0 at fixed material

$\cos=\frac{\gamma_{SG}-\gamma_{SL}}{\gamma_{LG}}$ γ_{SG}

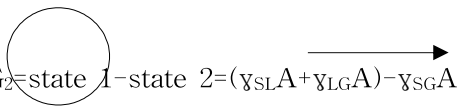
wetting γ_c non-wetting

2) adhesional wetting

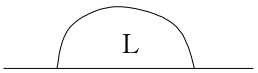


G L G

S S



$-\Delta G=G_1-G_2$=state 1−state 2=$(\gamma_{SL}A+\gamma_{LG}A)-\gamma_{SG}A$



$-\frac{\Delta G}{A}=(\gamma_{SL}+\gamma_{LG})-\gamma_{SG}$: Dupre Equation

3)immersional wetting

G immersion into liquid G

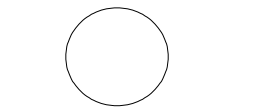
S

L L

$-\Delta G=G_1-G_2=\gamma_{SG}A-\gamma_{SL}A$

S

$=\frac{\Delta G}{A}=\gamma_{SG}-\gamma_{SL}$



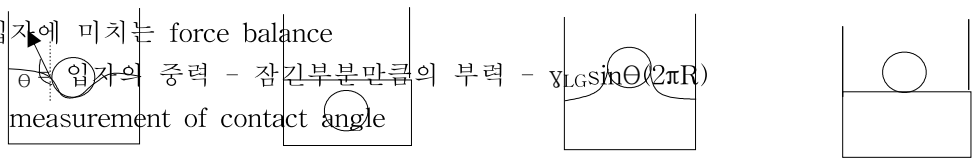
if $\gamma_{SG}>\gamma_{SL}$: wetting

$\gamma_{SG}<\gamma_{SL}$: non-wetting

cf) $\rho_{solid}>\rho_{H2O}$ $\rho_{solid}<\rho_{liquid}$

입자에 미치는 force balance

θ 입자의 중력 - 잠긴부분만큼의 부력 - $\gamma_{LG}\sin\theta(2\pi R)$



• measurement of contact angle

① contamination of liquid

pure H_2O 0.0001%의 surf.

② hetergenity of solid surface

PS : 50%

PMMA : 50

③ roughness of solid surface

cf) friction

ture contact area

=apparent contact area×10^{-4}

• 측정방법

① goniometer : 현미경

② tilting plate method

기울어줌

contact angle < 90°

θ

contact angle > 90°

③ fine powder인 경우

finely divided particle column

시간 t동안에 물이 올라간 거리

$$l^2 = \frac{(kr)t\,\gamma_{LA}\cos\theta}{2\eta}$$

Kr:constant

γ: liquid surface tension

η: liquid의 점도

• 분산개념 : 입자를 liquid로 wetting

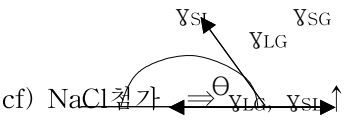
AgI/PE/접착 안정화 stabilize

• contact angle modify

: wetting agent(surface active agent)⇒wetting되기 힘든 것을 wetting시키기 위해 사용

$\gamma_{SG} = \gamma_{SL} + \gamma_{LG}\cos\theta$

$\cos\theta = \frac{\gamma_{SG} - \gamma_{SL}}{\gamma_{LG}}$ γ_{SG}⇒modify가 difficult



by wetting agent $\gamma_{LG}\downarrow$, $\gamma_{SL}\downarrow$⇒cosθ값 증가

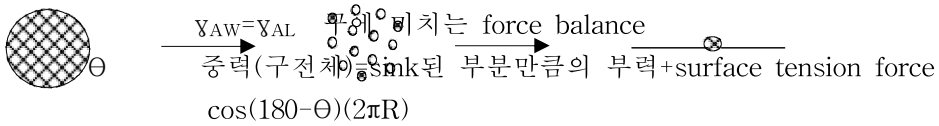
⇒θ작아지면 wetting

cf) NaCl첨가 ⇒

• ore flotation(부유선광)

분쇄 G

L



• cleaning : substrate에서 unwanted 물질(soil)을 제거하는 것

mechanical cleaning : 연마, agitation

chemical cleaning : organic solvent로 용해

detergency : surface active agent 이용⇒surface chemical property변화

liquid

soil detergency soil

solid solid

(total energy) 떨어지는데 필요한 일

$\Delta G \Rightarrow (\gamma_{OL}' + \gamma_{SL}' - \gamma_{OS})A$

$\frac{\Delta G}{A} \Rightarrow (\gamma_{OL}' + \gamma_{SL}' - \gamma_{OS})$: (-)면 자발적으로 떨어짐

• mechanism of detergency (good detergency)

① good wetting

② good removability of solid

③ good dispersing agent