1.

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$V = n\Omega = \frac{4}{3}\pi r^3$

$r = \left(\frac{3nv}{4\pi}\right)^{\frac{1}{3}} \longrightarrow 4\pi r^2 = 4\pi \times \left(\frac{3}{4\pi}\right)^{\frac{2}{3}} \times (nv)^{\frac{1}{3}}$

$A = \cancel{36}\ \underline{(36)^{\frac{1}{3}} \cdot \pi^{\frac{1}{3}} \cdot \pi^{\frac{2}{3}} \cdot v^{\frac{2}{3}}}$

$\Delta G = -V \cdot \Delta G_v + A \cdot \gamma$

$= -nV\Delta G_v + (36\pi)^{\frac{1}{3}} \cdot n^{\frac{2}{3}} \cdot v^{\frac{2}{3}} \cdot \gamma$

2.

(a) $\swarrow$ $-nv\Delta G_v + (36\pi)^{\frac{1}{3}} \cdot n^{\frac{2}{3}} \cdot v^{\frac{2}{3}} \cdot \gamma$

(b) $\left.\frac{\partial \Delta G}{\partial n}\right|_{n=n^*} = -v\Delta G_v + \frac{2}{3} \cdot (36\pi)^{\frac{1}{3}} \cdot n^{-\frac{1}{3}} \cdot v^{\frac{2}{3}}\gamma$

$\left(n^{-\frac{1}{3}}\right)^{-3} = \cancel{\ldots}\ \cancel{\frac{+3v\Delta G_v}{2(36\pi)^{\frac{1}{3}} v^{\frac{2}{3}}\gamma}} = \left(\frac{3v\Delta G_v}{2(36\pi)^{\frac{1}{3}} v^{\frac{2}{3}} \gamma}\right)^{-3}$

$n^* = \frac{32\pi}{3v} \cdot \left(\frac{\gamma}{\Delta G_v}\right)^3$

$\Delta G^* = -\frac{32\pi}{3v}\left(\frac{\gamma}{-\Delta G_v}\right)^3 \cdot v \cdot \Delta G_v$

$+ (36\pi)^{\frac{1}{3}} \cdot \left(\frac{32\pi}{3v} \cdot \left(\frac{\gamma}{-\Delta G_v}\right)^3\right)^{\frac{2}{3}} \cdot v^{\frac{2}{3}} \cdot \gamma$

$= \frac{\gamma^3}{(\Delta G_v)^2}\left(-\frac{32\pi}{3} + 16\pi\right) = \frac{16\pi}{3}\frac{\gamma^3}{(\Delta G_v)^2}$

(c) $\Delta G_{n,d} = -n(\Delta G_{gra} - \Delta G_{dia}) + (36\pi)^{\frac{1}{3}} \cdot n^{\frac{2}{3}} \cdot v_{dia}^{\frac{2}{3}} \gamma_{dia}$

$\Delta G_{n,gra} = -n(\Delta G_{gas} - \Delta G_{gra}) + (36\pi)^{\frac{1}{3}} \cdot n^{\frac{2}{3}} \cdot v_{gra}^{\frac{2}{3}} \gamma_{gra}$

$\Delta G_{n,dia} = \Delta G_{n,gra}$

$n(G^\circ_{dia} - G^\circ_{gra}) = n^{\frac{2}{3}} \times (36\pi)^{\frac{1}{3}} \times \left(v_{gra}^{\frac{2}{3}} \gamma_{gra} - v_{dia}^{\frac{2}{3}} \gamma_{dia}\right)$

$n = 36\pi \times \left(\frac{v_{gra}^{\frac{2}{3}} \gamma_{gra} - v_{dia}^{\frac{2}{3}} \gamma_{dia}}{G^\circ_{dia} - G^\circ_{gra}}\right)^3$

if $\gamma_{dia} = 2.6\ J/m^2$

$n = 36\pi \times \left(\frac{(3\times10^{-30})^{\frac{2}{3}} \times 3.1 - (1\times10^{-30})^{\frac{2}{3}} \times 2.6}{0.021 \times 1.602 \times 10^{-19}}\right)^3 = 464$

if $\gamma_{dia} = 3.64$, $n = 143$,

if) $\gamma_{dia} = 3.7\ J/m^2$

$n = 21$

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(d) $\Delta G_{n,gra} > \Delta G_{n,dia}$

$$-n(\Delta G_{gas} - \Delta G_{gra}) + (36\pi)^{\frac{1}{3}} n^{\frac{2}{3}} V_{gra}^{\frac{2}{3}} \gamma_{gra} > -n(\Delta G_{gas} - \Delta G_{dia}) + (36\pi)^{\frac{1}{3}} n^{\frac{2}{3}} V_{dia}^{\frac{2}{3}}$$

$$n(G^{\circ}_{dia} - G^{\circ}_{gra}) < n^{\frac{2}{3}} (36\pi)^{\frac{1}{3}} (V_{gra}^{\frac{2}{3}} \gamma_{gra} - V_{dia}^{\frac{2}{3}} \gamma_{dia})$$

$$n < 36\pi \times \left(\frac{V_{gra}\gamma_{gra} - V_{dia}\gamma_{dia}}{G^{\circ}_{dia} - G^{\circ}_{gra}} \right)^3$$

e) $n^* = 100$

$$n^* = \frac{32\pi \gamma_{gra}^3}{3V_{gra}\Delta G_{v\,gra}^3}, \quad \Delta G_{v\,gra} = \gamma_{gra}\left(\frac{32\pi}{3n^*\gamma_{gra}}\right)^{\frac{1}{3}}$$

$$= 3.1 \times \left(\frac{32\pi}{3\times100\times8.4\times10^{-30}}\right)^{\frac{1}{3}}$$

$$= 1.077\times10^{10}\ J/m^3$$

(f) $\Delta G^* = \frac{16}{3}\pi \frac{\gamma^3}{\Delta G_v^2}$

$$\frac{I_{gra}}{I_{dia}} = \frac{A\exp(-\Delta G^*_{gra}/kT)}{A\exp(-\Delta G^*_{dia}/kT)}$$

$$= \exp\left(\frac{\Delta G^*_{dia} - \Delta G^*_{gra}}{kT}\right) = \exp\left(\frac{16\pi}{3kT} \times \left(\frac{\gamma_{dia}^3}{\Delta G_{v,dia}^2} - \frac{\gamma_{gra}^3}{\Delta G_{v,gra}^2}\right)\right)$$

$$G^{\circ}_{dia} - G^{\circ}_{gra} = V_{gra}\Delta G_{v,gra} - V_{dia}\Delta G_{v,dia}$$

$$\Delta G_{v,dia} = \frac{V_{gra}\Delta G_{v,gra} - (G^{\circ}_{dia} - G^{\circ}_{gra})}{V_{dia}} = 1.42\times10^{10}\ J/m^3$$

if $\gamma_{dia} = 3.6\ J/m^2$, & $T = 300K$

$$(I/I)(gra/dia) = \exp\left(\frac{''}{T} \right) = 1.53\times10^{-21}$$

~~if $\gamma_{dia} = 3.65\ J/m^2$~~ → 2.37 [illegible]

if) $\gamma_{dia} : 3.65\ J/m^2 \rightarrow 2.4\times10^{-3}$

if) $\gamma_{dia} = 3.9\ J/m^2 \rightarrow 1.18\times10^{4}$

(g) nano scale 에서 A/V 비율 가 증가하기 때문에 surface energy 기여가 dominant 해진다. diamond 경우도 surface energy 에 대해서 energy 가 커질수록, density가 감소하고 이를 control 할 수 있다.

(h) hydrocarbon decomposition 에서 (그) concentration 이 증가하면 크기가 커지면 ~~[illegible]~~ driving force 식이 작용하지 않는다. 표면 (곡률이 작은 곳, capillary effect가 작용하는 nano scale 에서 가능