

ENERGY  $\left\{ \begin{array}{l} \text{PV} \\ \text{STORAGE} \\ \text{NEW DEVICES (ELECTRONIC)} \end{array} \right.$

BIOMED  $\rightarrow$  DRUG DELIVERY  
TISSUE ENGR. (CONDUCTIVE NMS)  
THERANOSTICS (NPs - NR)  
INITIAL NP  
IMMUNIZATION - VAX

AGRI FOOD  $\rightarrow$  NPs VS PESTICIDES / FERT PRODUCTION ENHANC.  
PACKAGING (NANOLAMINATES) NANOFILTRATION

ENVIRONMENT  $\rightarrow$  REMEDIATION (MAGNETIC NPs); NP + CNT  $\rightarrow$  water  
PHOTO CATALYSIS

AEROSPACE  $\rightarrow$  MECH PROPS / SOLID FUELS

# ESTIMATING SURFACE ENERGY

$$\gamma \approx 1 \text{ J/m}^2$$

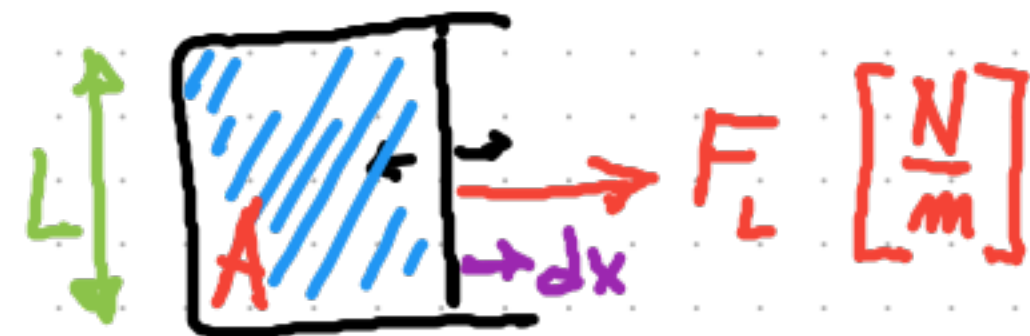
order of magnitude

## • Surface tension

$$G = G_0 + \gamma A$$

$$dG = \gamma dA + A d\gamma$$

$$\gamma dA + A d\gamma = F_L dA$$



$F_L$ : force per unit length  
 $dA = L dx$

$$dG = F_L \cdot dA$$

$$F_L = \gamma + A \frac{d\gamma}{dA}$$

$$F_L dx = \frac{F_L}{L} L dx = f_L dA$$

WORK

in sm  $\hookrightarrow \gamma \text{ const}$   $\frac{d\gamma}{dA} = 0$  (negligible)  $\Rightarrow \boxed{F_L = \gamma}$

solids  $\frac{d\gamma}{dA} \approx 0$   $\boxed{F_L \approx \gamma}$

## ESTIMATING SURFACE ENERGY IN SOLIDS

Bond energy  $\epsilon$        $\frac{\epsilon}{2}$  energy for every broken bond

$\Rightarrow$  For a (111) surface of an FCC

$\Rightarrow$  surf energy per atom  $\rightarrow 3 \frac{\epsilon}{2}$

$$\Rightarrow \mu_s = \frac{U_s}{A} = \frac{3 L_s}{12 N_A} = \frac{0.25 L_s}{N_A}$$

internal excess energy

SURFACE ENERGY (see correct definition in the slides)

$$\frac{\epsilon}{2}: \quad L_s = N_A \cdot \frac{\epsilon}{2} \cdot 12$$

Latent heat of sublim.

Avogadro

number of broken bonds