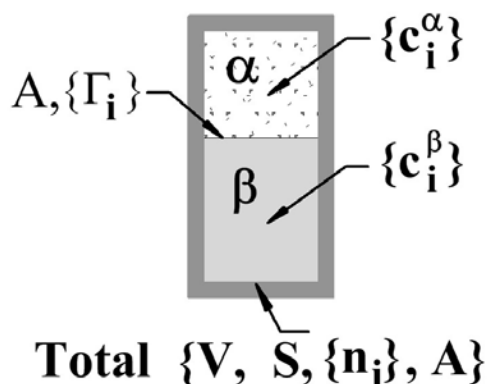


Consider the system:



Where α is a liquid or gas phase of composition $\{c_i^\alpha\}$ in mole numbers/volume and β is a liquid phase of composition $\{c_i^\beta\}$. The total volume is V and the total entropy is S , the total mole number of component i is $\{n_i\}$ and the interfacial area is A .

The internal energy of the system is $U=U(S, V, \{n_i\}, A)$ and by the chain rule of calculus

$$dU = \frac{\partial U}{\partial S} dS + \frac{\partial U}{\partial V} dV + \sum_{i=1}^{\text{\#components}} \frac{\partial U}{\partial n_i} dn_i + \frac{\partial U}{\partial A} dA$$

It is a result of the combination of the first and second laws of thermodynamics that

$$dU = TdS - pdV + \sum_{i=1}^{\text{\#components}} \mu_i dn_i + \gamma dA$$

So that in particular $\gamma = \frac{\partial U}{\partial A}$, which justifies naming γ as the surface energy. (Note that you may then call p the volume energy, if you wish.) However, just as we use p as the scalar component of the pressure tensor:

$$\vec{P} = p\vec{\delta} + \text{visco} - \text{elastic terms}$$

where $\vec{\delta}$ is the 3-d identity tensor $\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$. Then consider

$$\tilde{\gamma} = \gamma \vec{\delta} + \text{surface visco} - \text{elastic terms}$$

where $\vec{\delta}$ is the 2-d identity tensor. Here, γ can be considered a tension. $\gamma [=]$ N/m **or** $\gamma [=]$ J/m²!