Answer on #57259, Physics / Molecular Physics | Thermodynamics

What is Gibb's free energy? The wikipedia states that it is the maximum work done without expansion by a closed system. How can work be done without expansion?

Answer

The Gibbs free energy G is a thermodynamic potential which depends on temperature T and pressure p. This means that differential of G is expressed via differentials of T and p, i.e. $G = G(T, p)$ and

$$dG = \frac{\partial G}{\partial T} dT + \frac{\partial G}{\partial p} dp, \quad (1)$$

where $\frac{\partial G}{\partial T}$ and $\frac{\partial G}{\partial p}$ are partial derivatives. It is convenient to use G when temperature and pressure are independent parameters of the system state. The Gibbs free energy is defined as

$$G = U + pV - TS, \quad (2)$$

where U - internal energy, V – volume and S – entropy of the system. Using relation $TdS = dU + pdV$ we find

$$dG = -SdT + Vdp, \quad (3)$$

which means that $\frac{\partial G}{\partial T} = -S$ and $\frac{\partial G}{\partial p} = V$.

Now, the Wikipedia statement should be clarified. First of all, the thermodynamic (not mechanic) work is meant in the article. The later is defined as the **energy** transferred by the system to its surrounding. Such a transfer can be caused by any of the following reasons: expansion, heat transfer, chemical reactions, etc.. Thus, even isochoric process (no expansion!) can, in principle, produce some amount of the thermodynamic work. In other words, the Gibbs free energy is rather capacity to release energy need to do mechanical work. This energy equals to maximal energy transfer in the isochoric process.