The energy Contribution (Fe) is equal to Zero for an ideal rubbery material (The rubber elasticity has its origins in the entropy effects.

For ideal rubbery materials, the expression of entropy is:

$S = K \ln Pr$ where:

K is Boltzmann's Constant, and Pr is the ~~prob~~ Probability of finding a particular chain Configuration.

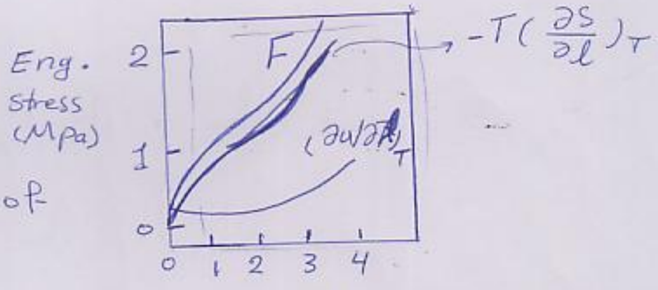


Fig. 1: change in internal energy and entropy (U, S) accompanying the extension of rubber. F is the Sum of two Contributions

When an elastomer is stretched, the distance between Cross-linked points increases and the number of possible chain Configurations decreases.

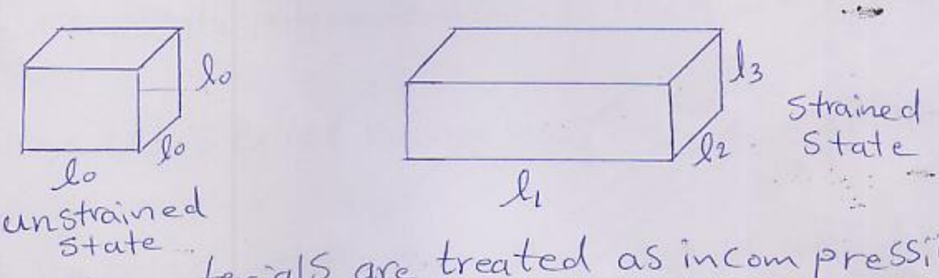
Example: a piece of rubber in the Form of a Cube. The side of the cube is l_0, The volume of rubber before deformation or undeformed volume is equal to

l_o^3). If we deform the rubber cube in direction 1, the rubber elongated in l_1 direction and shortened in l_2 and l_3 directions. after deformation, the volume of the cube is $l_1 l_2 l_3$. To describe the large deformations involved in stretching rubbery materials, strain can be defined in terms of parameter called draw ratio (λ) = Final length / original length.

The draw ratio in direction 1 : $\lambda_1 = l_1 / l_o$

$(\lambda = 1 + \varepsilon)$ <u>or</u> $l_1 = \lambda_1 / l_o$

Fig.(2): Deformation at Const. volume



Elastomeric materials are treated as incompressible materials where the volume is constant.

(If we taking the strains in the transverse directions are equal ($l_2 = l_3$).

$l_1 l_2 l_3 = l_0^3 = (\lambda_1 l_0) l_2^2$

~~For rubber or elastomers~~

Flexible polymeric chains are joined by bonds at cross-link points and forming a network. In stretching rubber or elastomer, these chains will be stretched. The number of configurations available to a stretched polymer is less than the number of configurations available to unstretched polymer, so the entropy is reduced on stretching.

~~If we assume the polymeric chain is freely jointed and has no volume (it is called volumeless). one end of the chain is at the origin while the other end is at a distance r, from the origin (r) is called the end to end distance of the chain. The chain is assumed to be freely jointed and volumeless. The network is treated~~

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e need to use statistics to treat the properties of a single polymeric chain and network of chains.

Gaussian chain (or model) assumes the end-to-end separation of a macromolecule follows Gaussian statistics and the freely jointed chain as a special case.

We assume the polymeric chain is freely jointed and has no volume (volumeless). One end of the chain is at the origin while the other end is at a distance $\underline{\underline{r}}$ from the origin, r is called the end-to-end distance of the chain. The network is treated as a Gaussian network, Gaussian distribution function is used to evaluate the probability of finding the other end of the chain in some volume element,