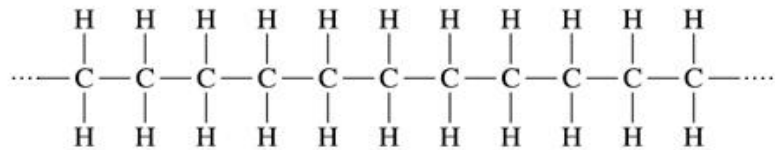
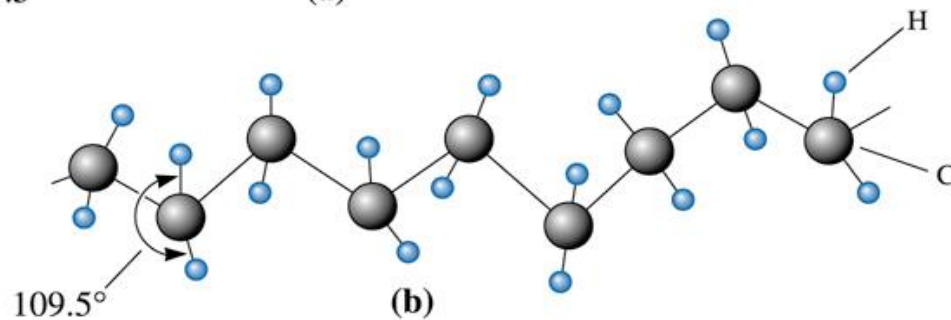
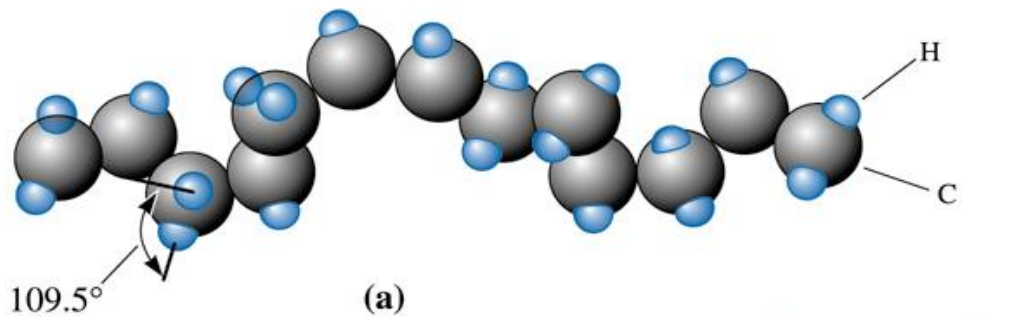




Estruturas Poliméricas

- Cadeias e redes
- Peso molecular, isomerismo
 - Cristais e fase amorfa

Polímeros (estructura básica)

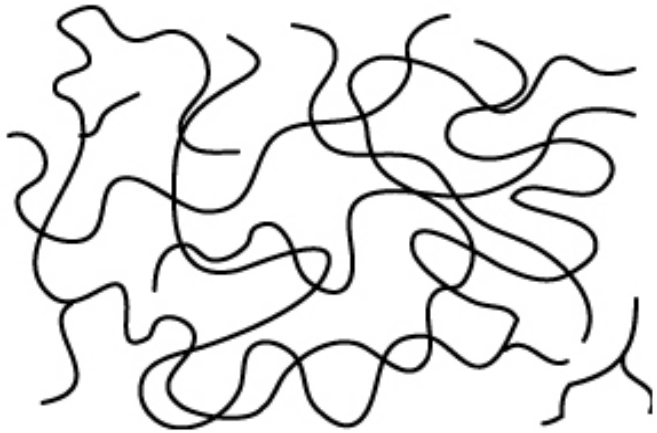


(c)

Polietileno



Classes

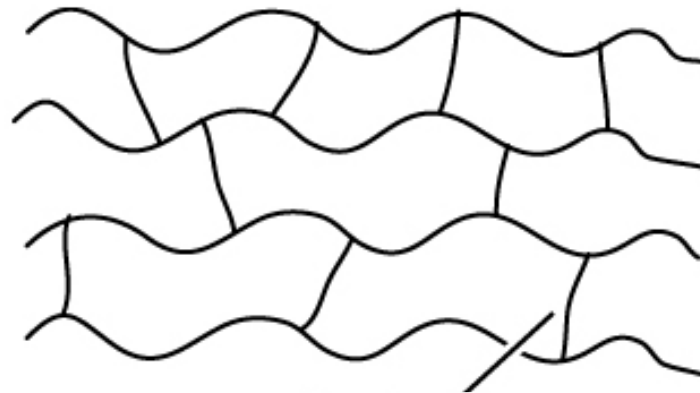


Termoplástico



Cross-link

Elastômero

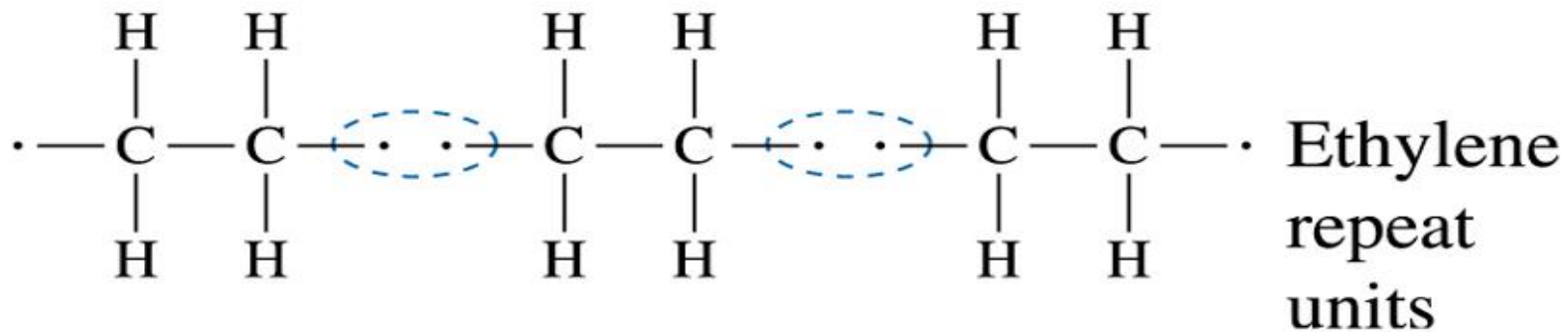
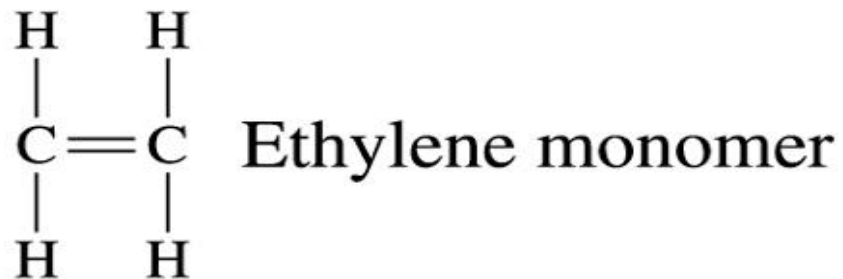


Termofixo

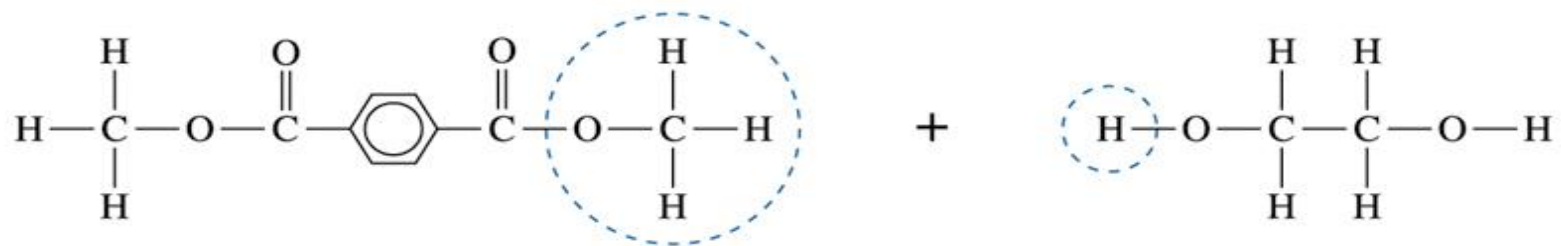
Rede tridimensional



Polimerização (adição)

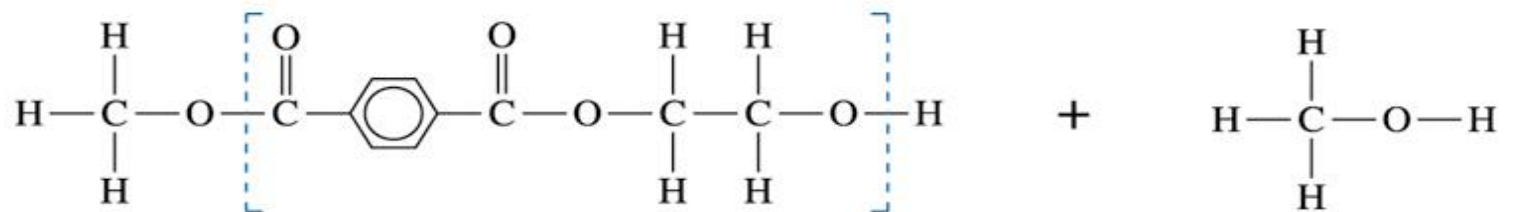


Polimerização (condensação)



Dimethyl terephthalate

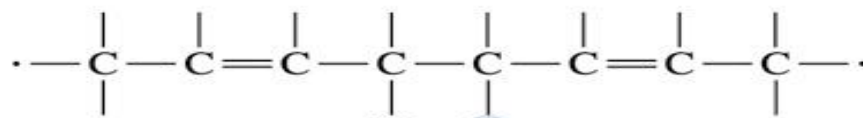
Ethylene glycol



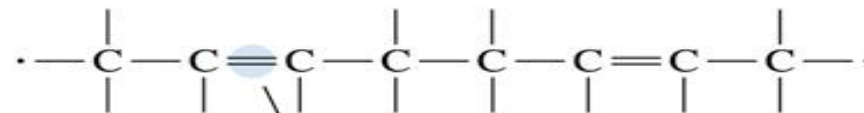
Repeat unit for polyethylene terephthalate
(PET polymer)

Methyl alcohol
(byproduct)

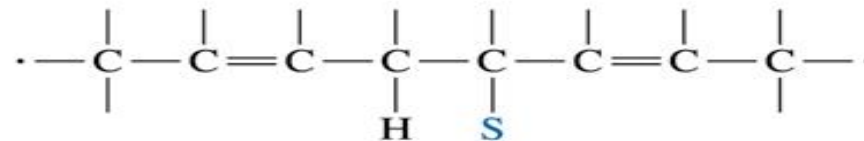
Formação de Elastômeros (Ligações cruzadas)



Sulfur →

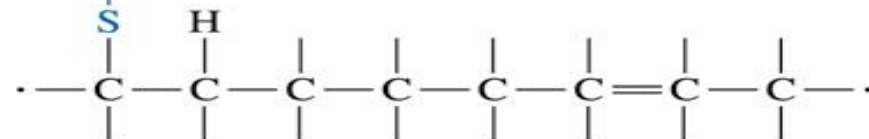


Break unsaturated bond

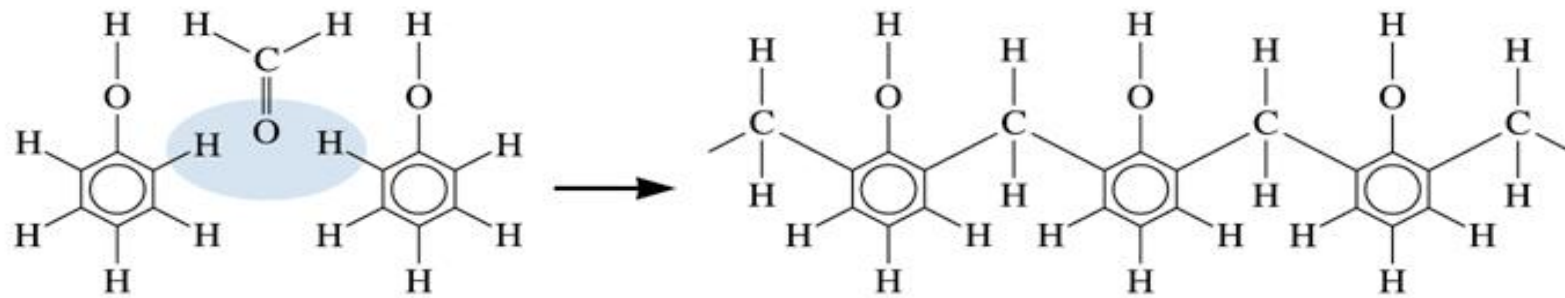


Exemplo:

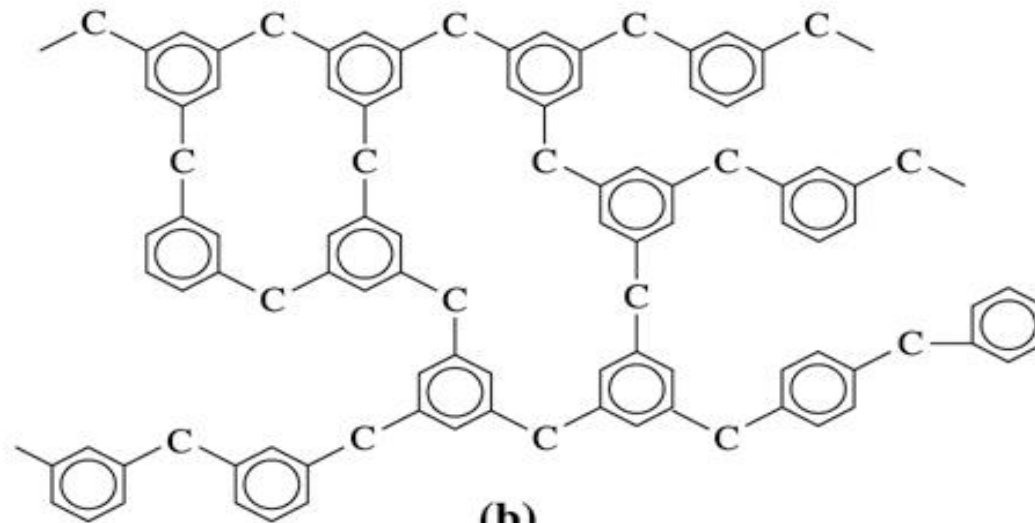
Vulcanização da borracha



Polimerização de Termofixo

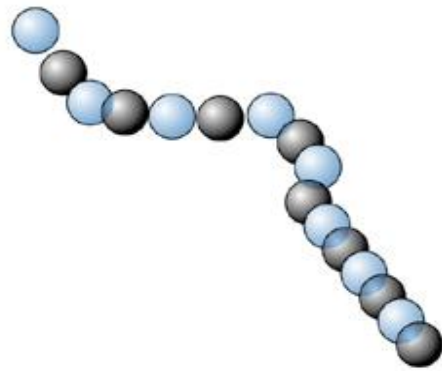


(a)

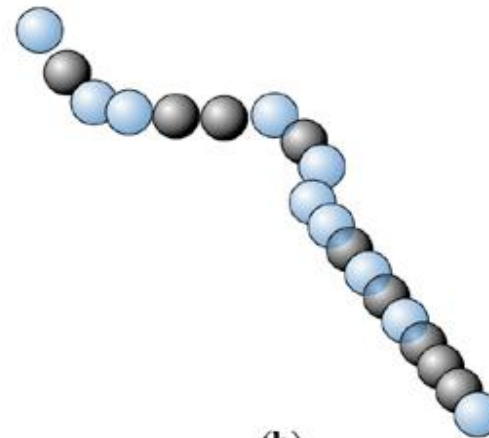


(b)

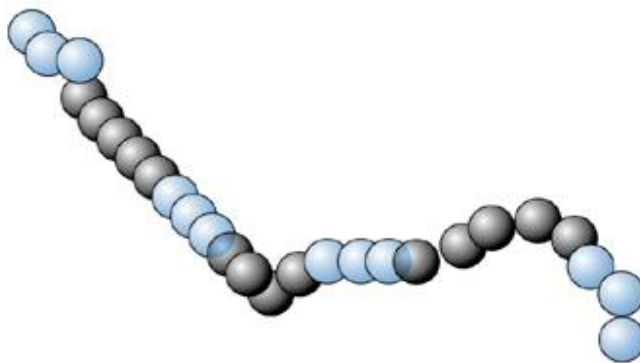
Copolímeros



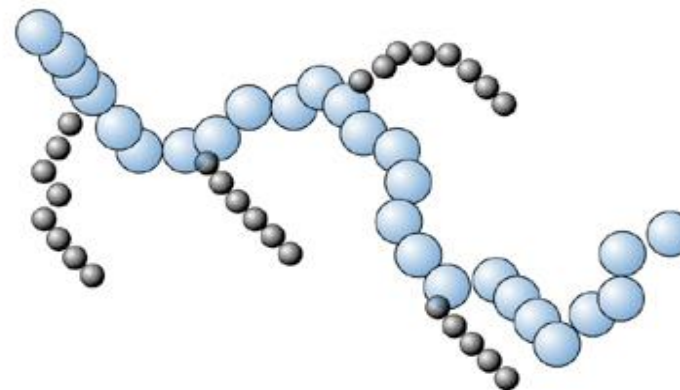
(a)



(b)



(c)

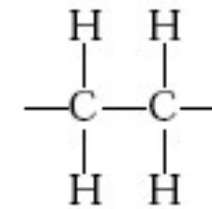


(d)

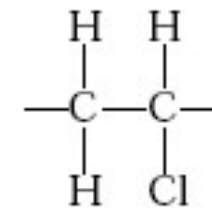
Polímeros comuns



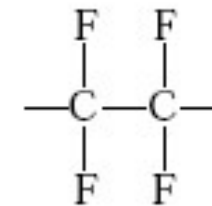
Polyethylene (PE)



Polyvinyl chloride (PVC)



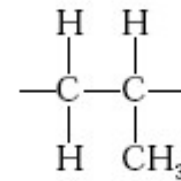
Polytetrafluoroethylene (PTFE)



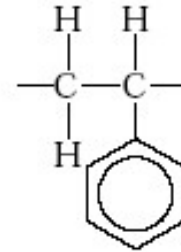
Polímeros comuns



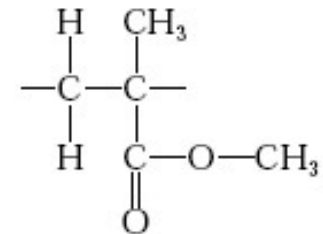
Polypropylene (PP)



Polystyrene (PS)



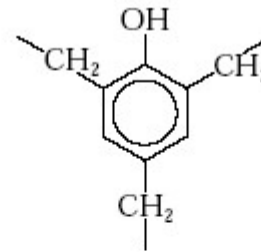
Polymethyl methacrylate (PMMA)



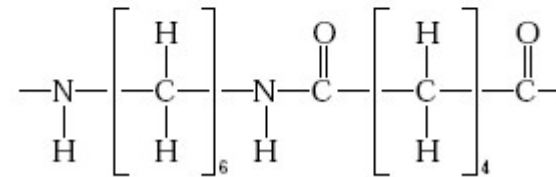
Polímeros comuns



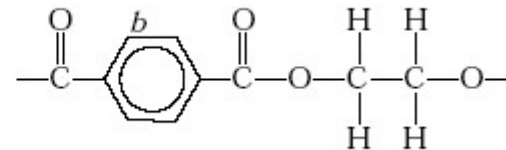
Phenol-formaldehyde (Bakelite)



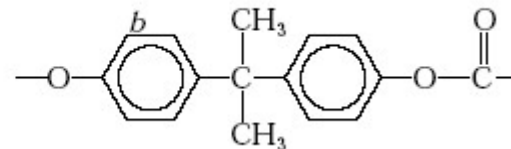
Polyhexamethylene adipamide (nylon 6,6)



Polyethylene terephthalate (PET, a polyester)



Polycarbonate





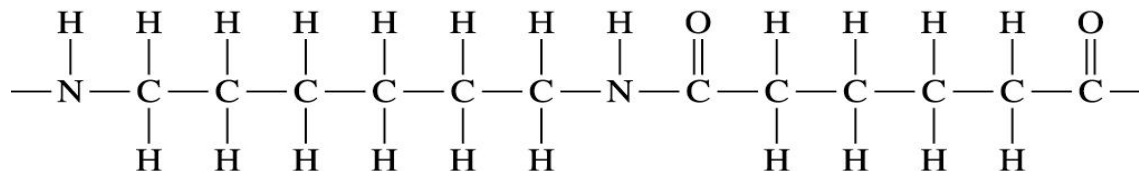
Grau de Polimerização

- Razão entre o peso molecular médio numérico do polímero e o peso molecular do monômero

$$DP = \frac{\overline{M}_n}{m}$$

- Exemplo:

- Calculate the degree of polymerization if 6,6-nylon has a molecular weight of 120,000 g/mol.





Peso Molecular

- Peso molecular médio numérico

$$\bar{M}_n = \sum x_i M_i$$

- Peso molecular médio ponderal

$$\bar{M}_w = \sum w_i M_i$$

Peso Molecular (exemplo)

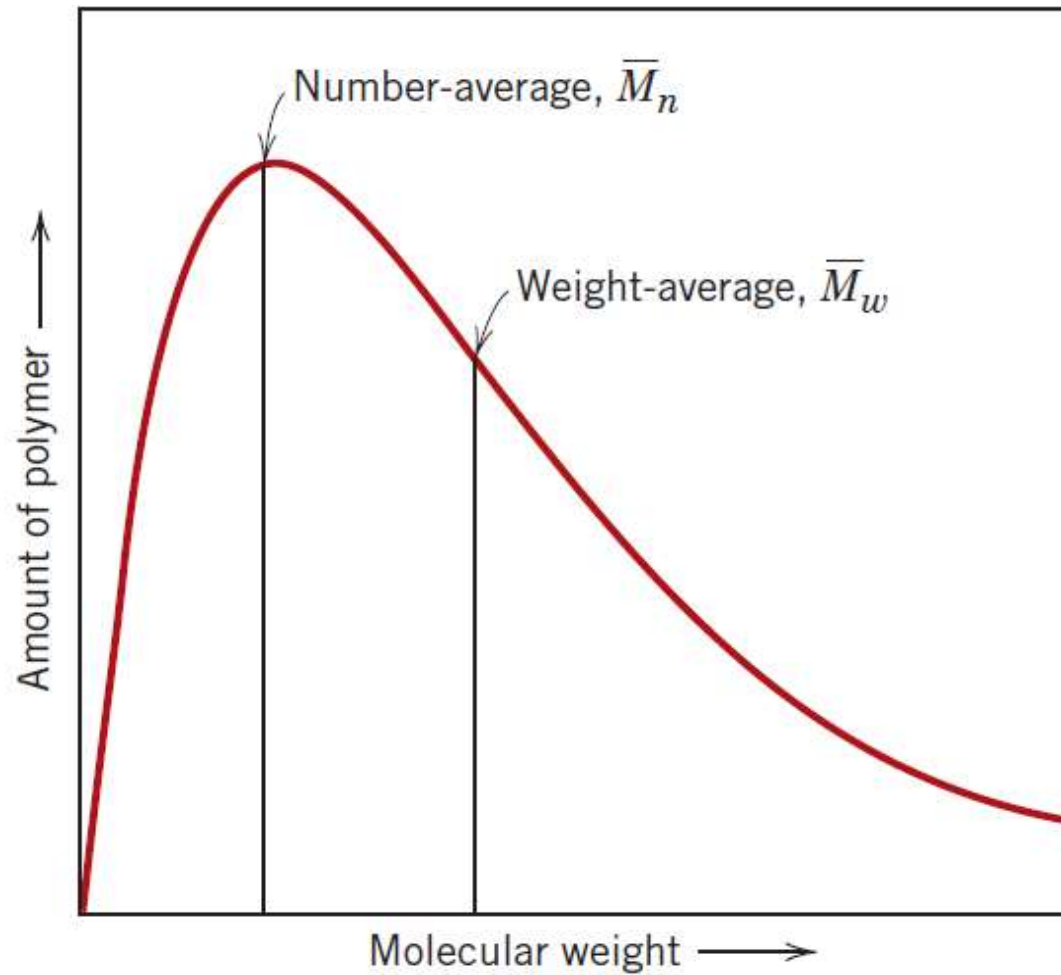
Number of Chains	Mean M per Chain	x_i	$x_i M_i$	Weight	f_i	$f_i M_i$
4000	2500	0.191	477.5	10×10^6	0.0519	129.75
8000	7500	0.381	2857.5	60×10^6	0.3118	2338.50
7000	12,500	0.333	4162.5	87.5×10^6	0.4545	5681.25
2000	17,500	0.095	1662.5	35×10^6	0.1818	3181.50
$\Sigma = 21,000$		$\Sigma = 1.00$	$\Sigma = 9160$	$\Sigma = 192.5 \times 10^6$	$\Sigma = 1$	$\Sigma = 11,331$

$$\bar{M}_n = \sum x_i M_i = 9160 \text{ g/mol}$$

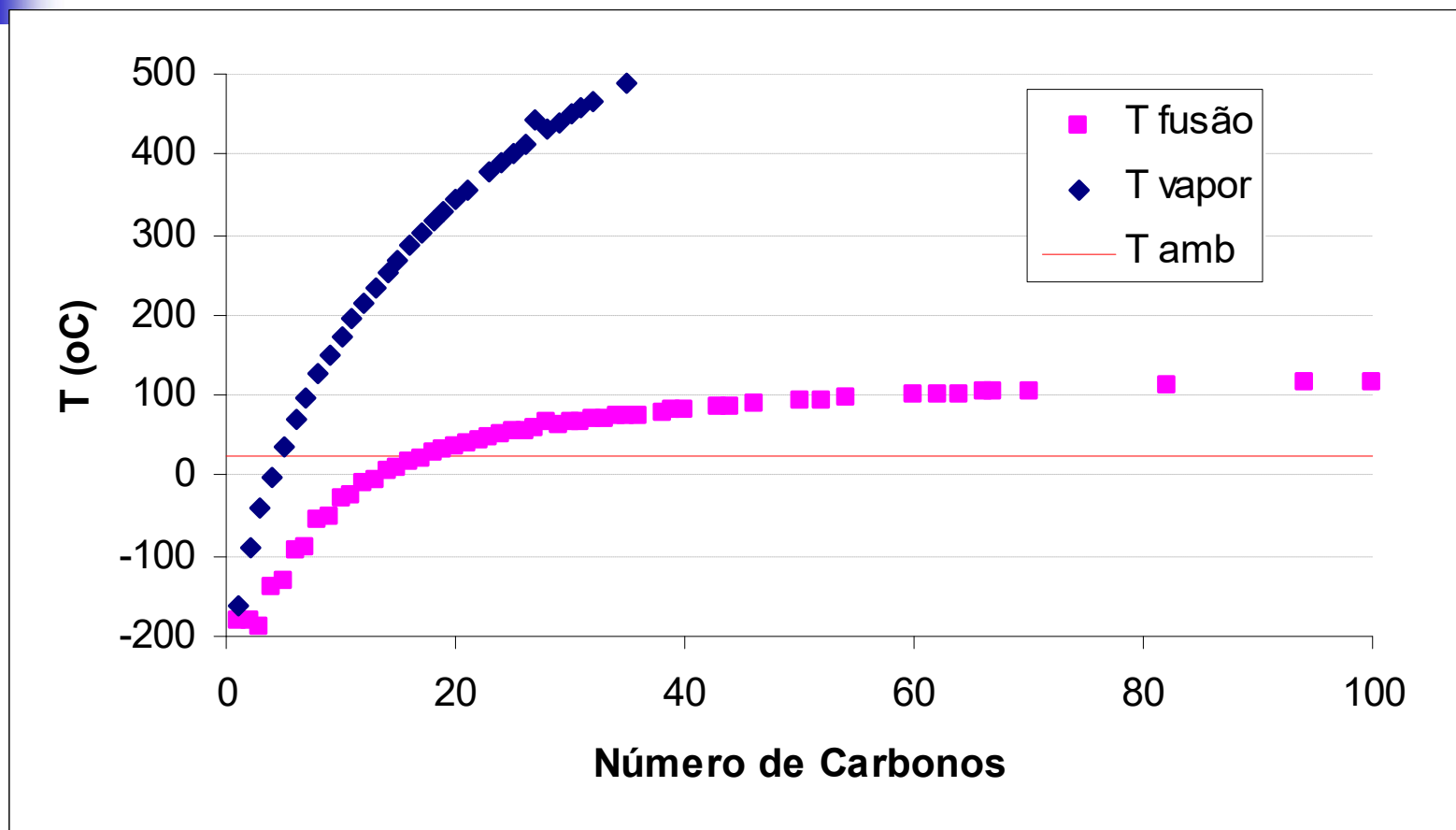
$$\bar{M}_w = \sum f_i M_i = 11,331 \text{ g/mol}$$

The weight average molecular weight is larger than the number average molecular weight.

Peso Molecular

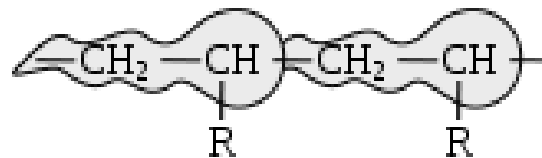
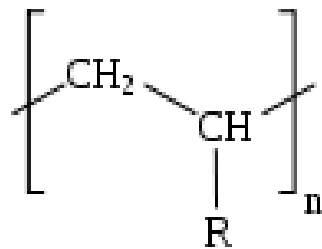


Temperaturas de fusão e vaporização em alcanos

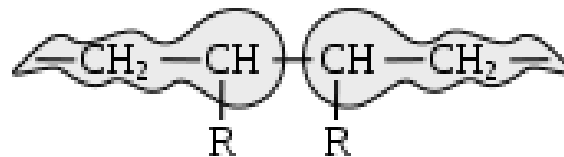


Configuração da moléculas

- Encadeamento
 - Cabeça-Cauda
 - Cabeça-Cabeça e/ou Cauda-Cauda



head-tail



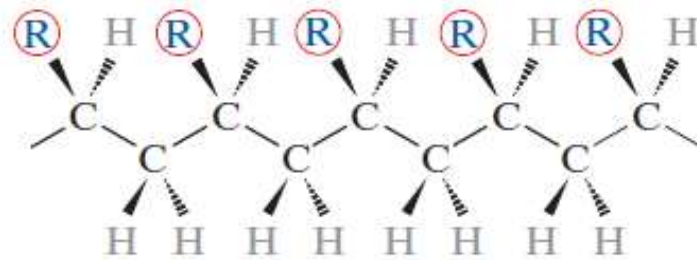
head-head



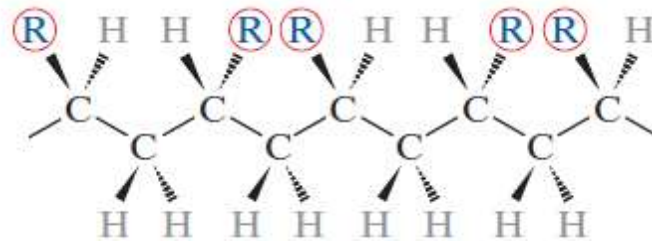
tail-tail

Configuração das moléculas

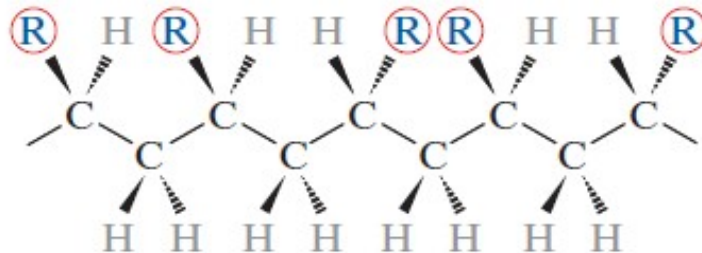
Etereoisomerismo



isotático



sindiotático

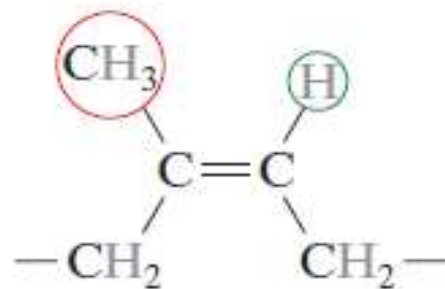


atático

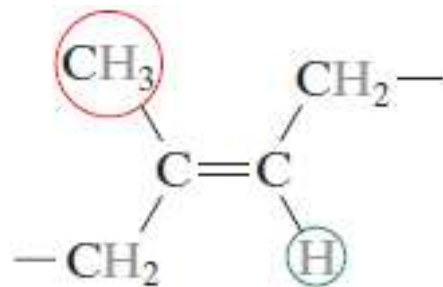


Configuração das Moléculas

Isomerismo Geométrico

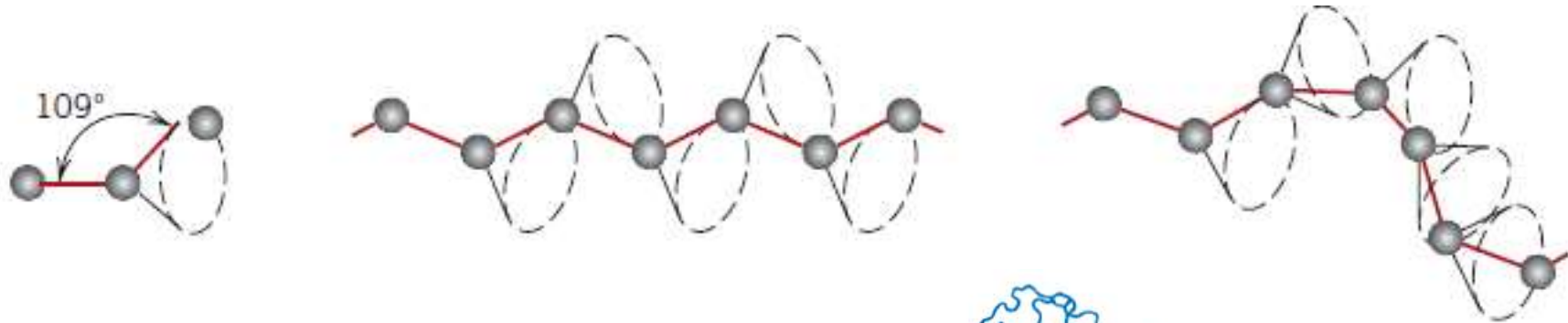


cis

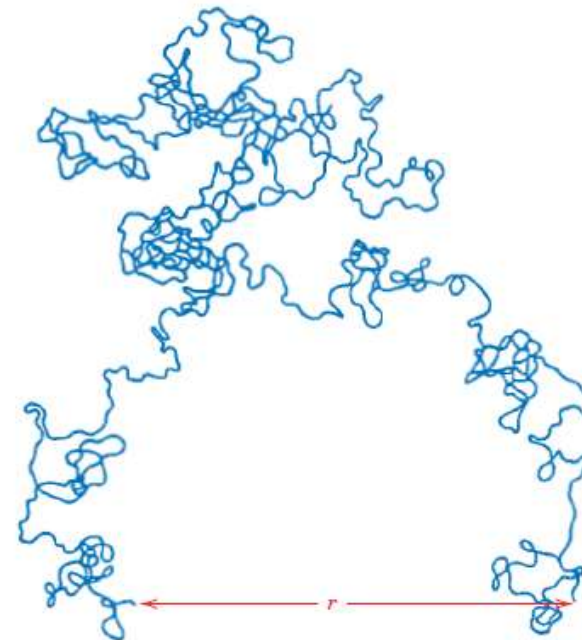


trans

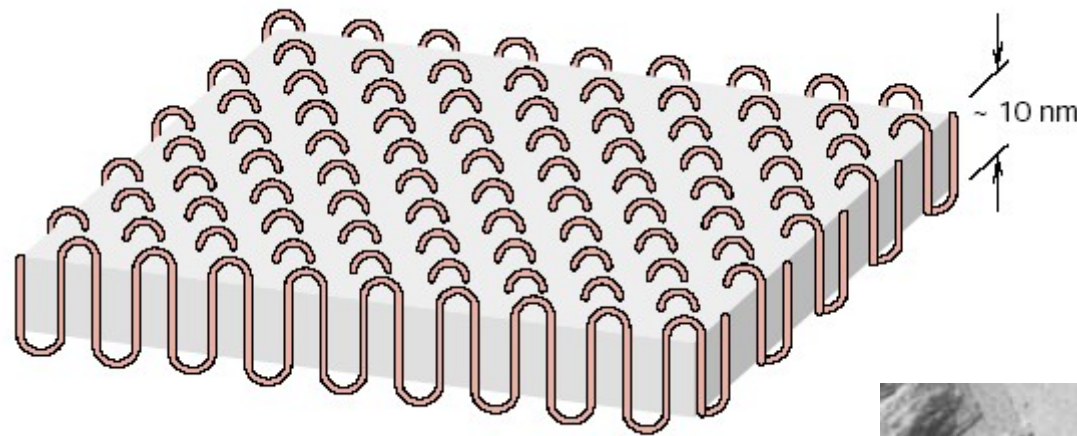
Arranjo das moléculas



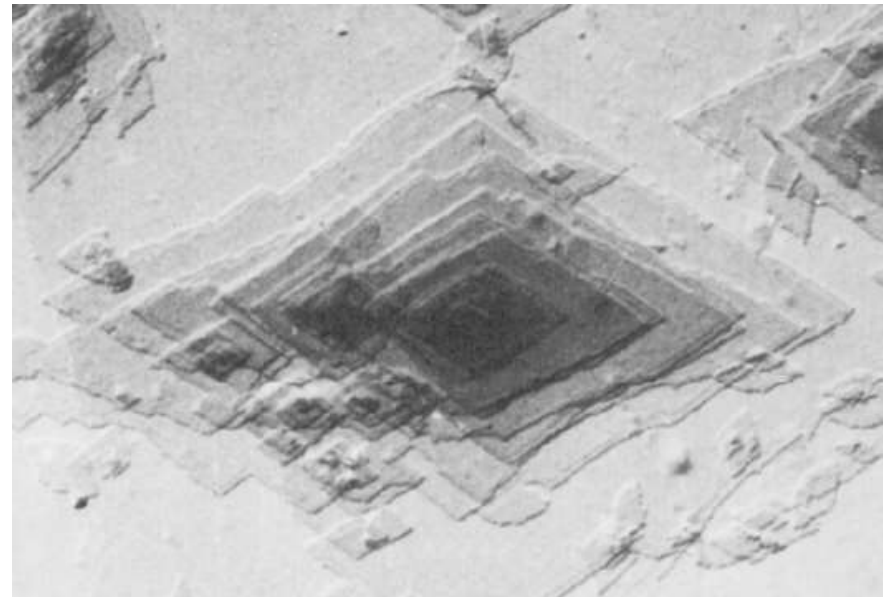
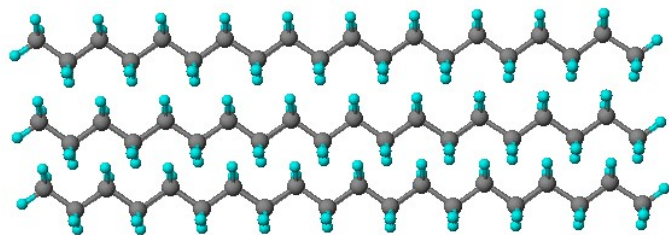
Obs.: Ligações duplas na cadeia limitam os movimentos e a capacidade de dobramento das moléculas.



Cristais Poliméricos



Exemplo:
PE em configuração
Zig-Zag planar

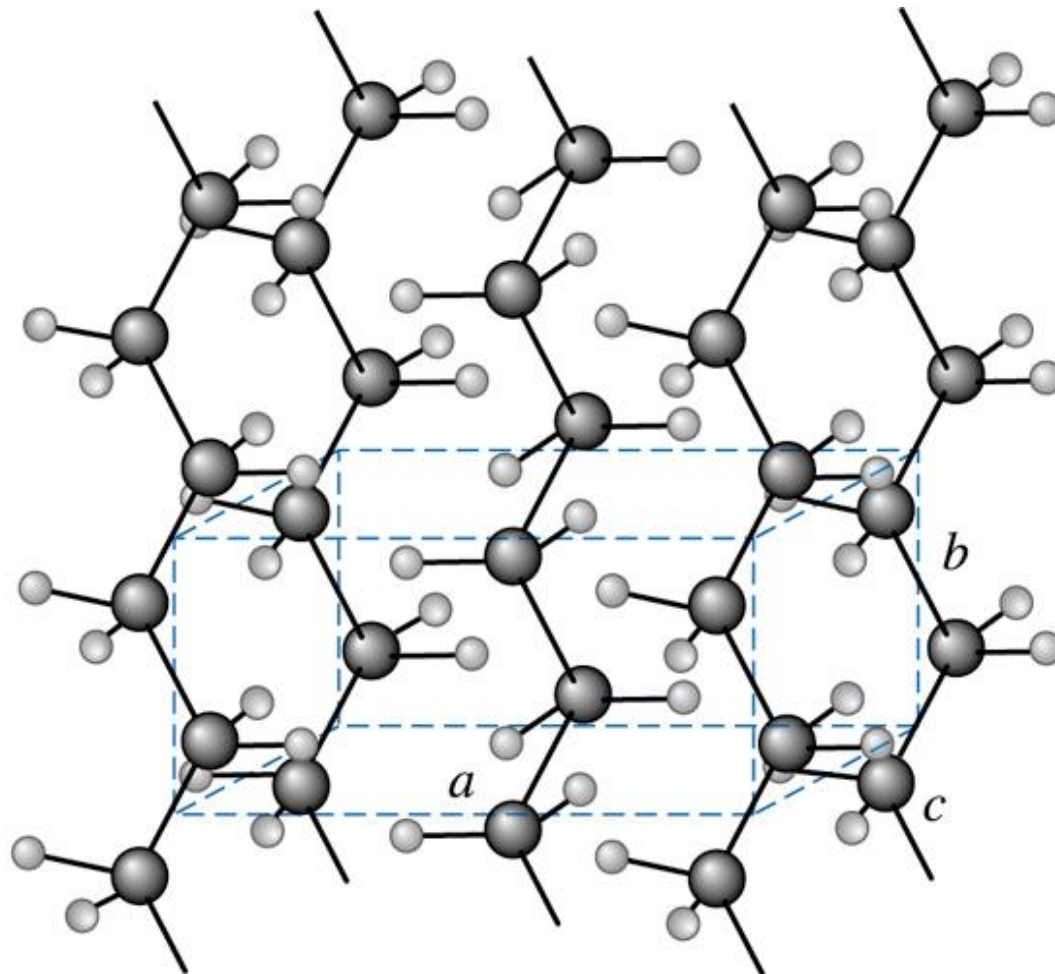


Cristal de PE

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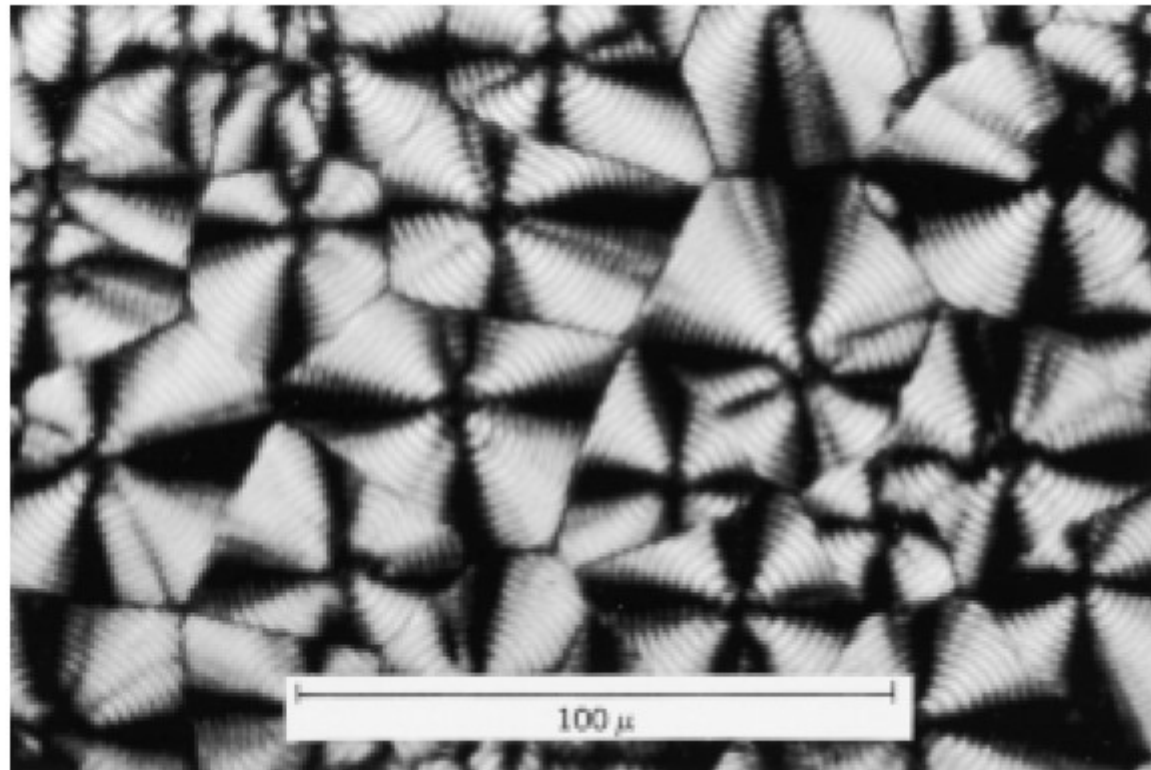
$$a = 7.41 \text{ \AA}$$
$$b = 4.94 \text{ \AA}$$
$$c = 2.55 \text{ \AA}$$

● Hydrogen
● Carbon

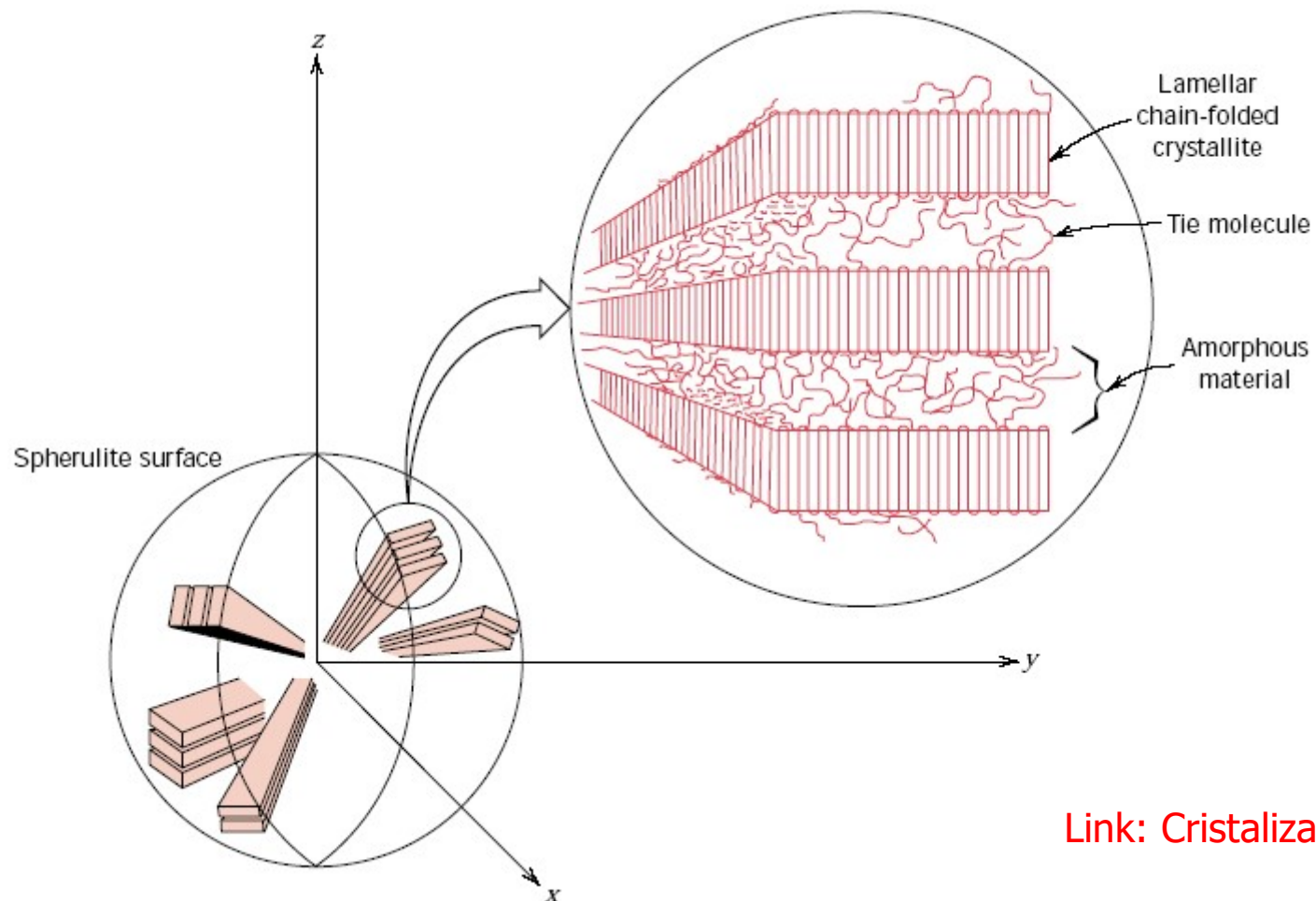




Esferulitos

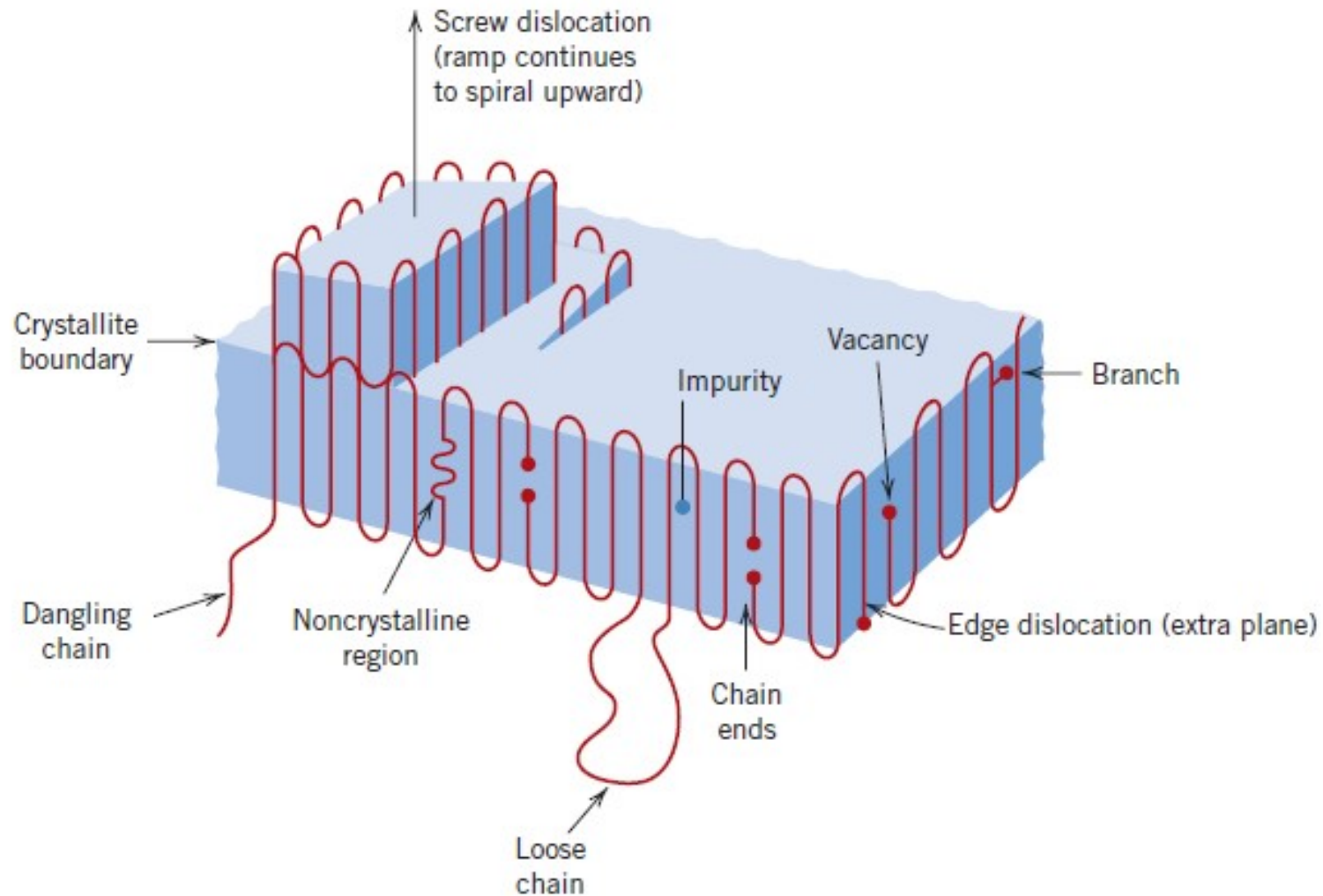


Estrutura do Esferulito

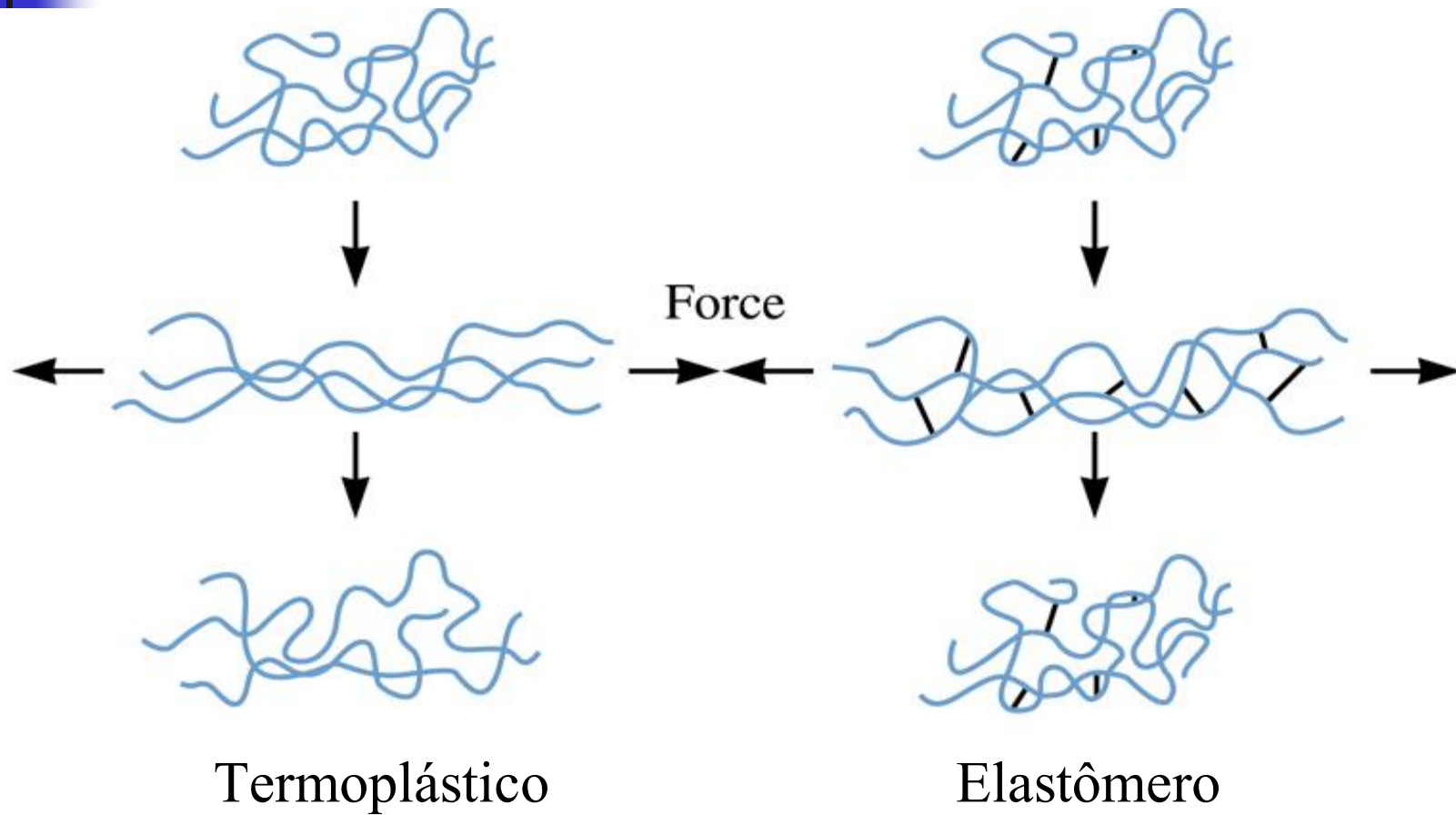


[Link: Cristalização de PE](#)

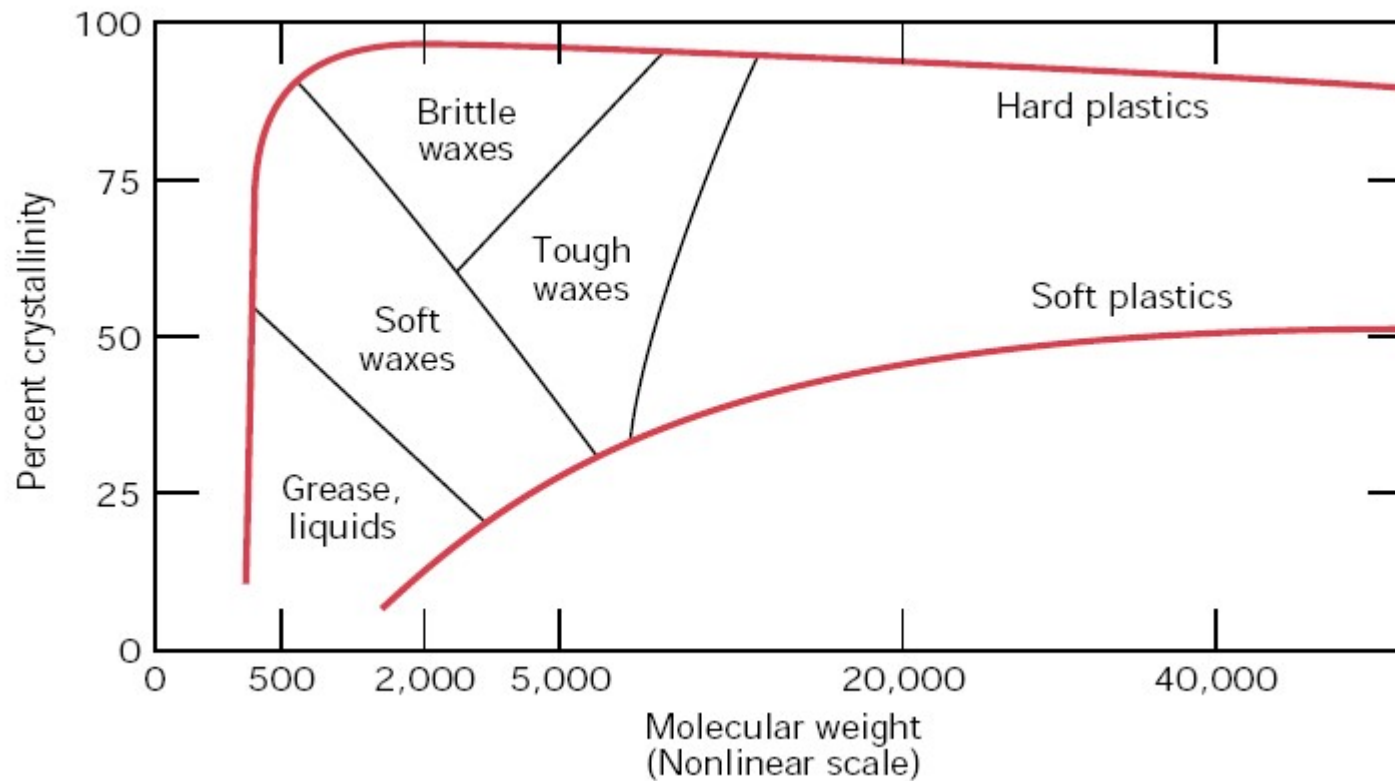
Defeitos cristalinos



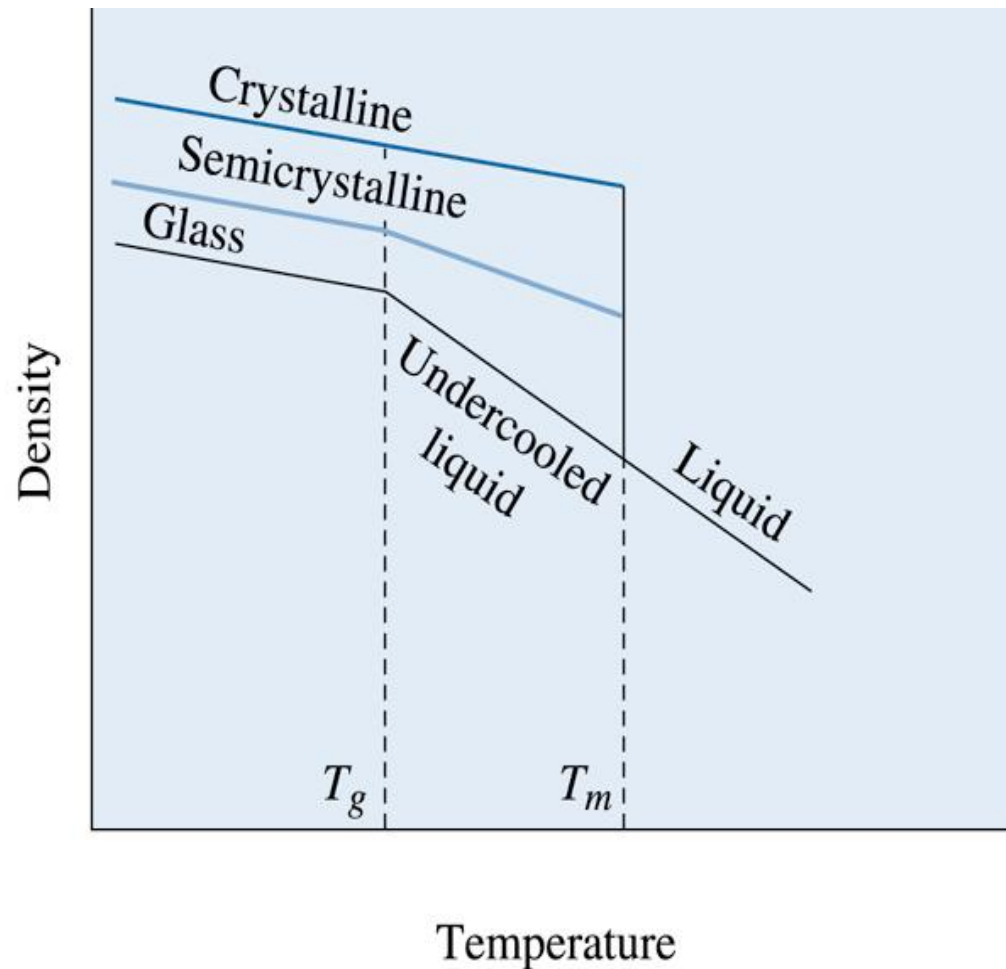
Comportamento mecânico



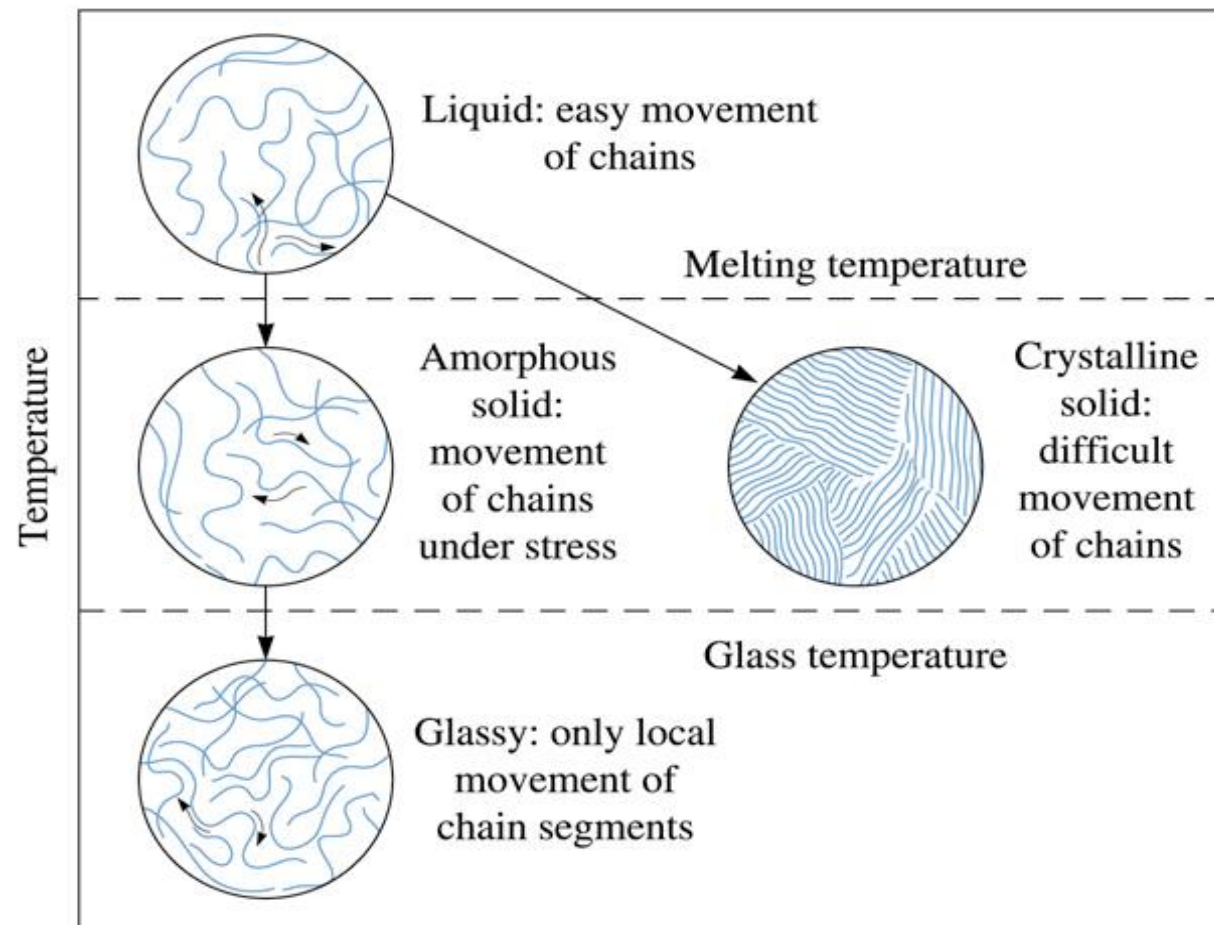
Efeito da cristalinidade e PM



Transição Vítre

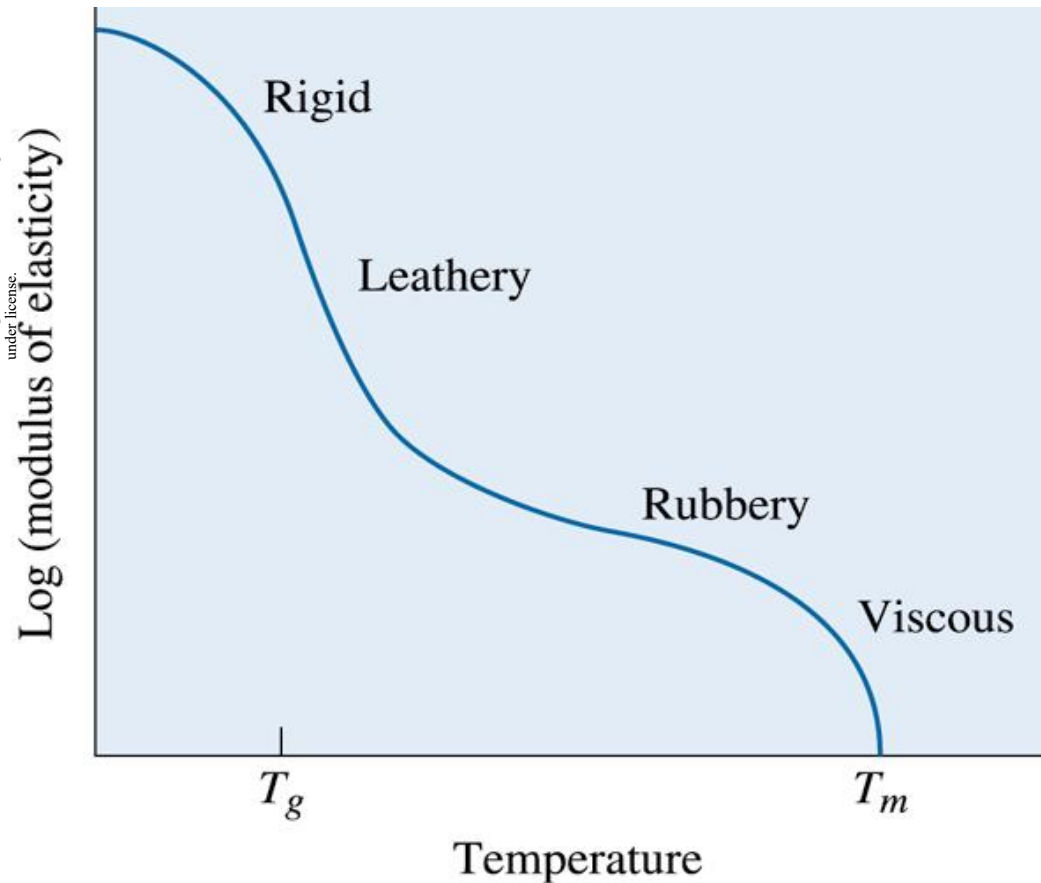


Transição vítrea



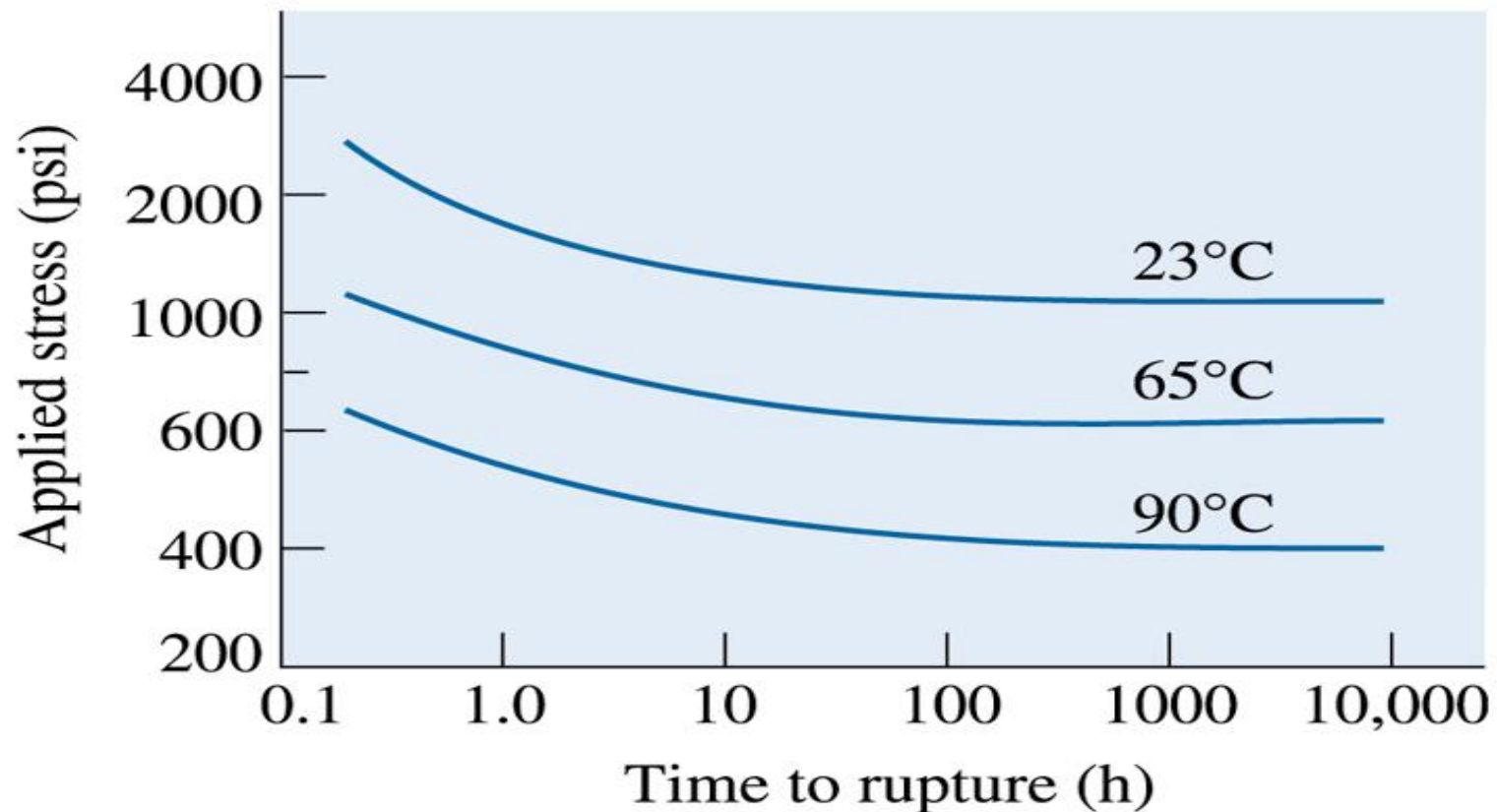
Efeito da temperatura no comportamento mecânico

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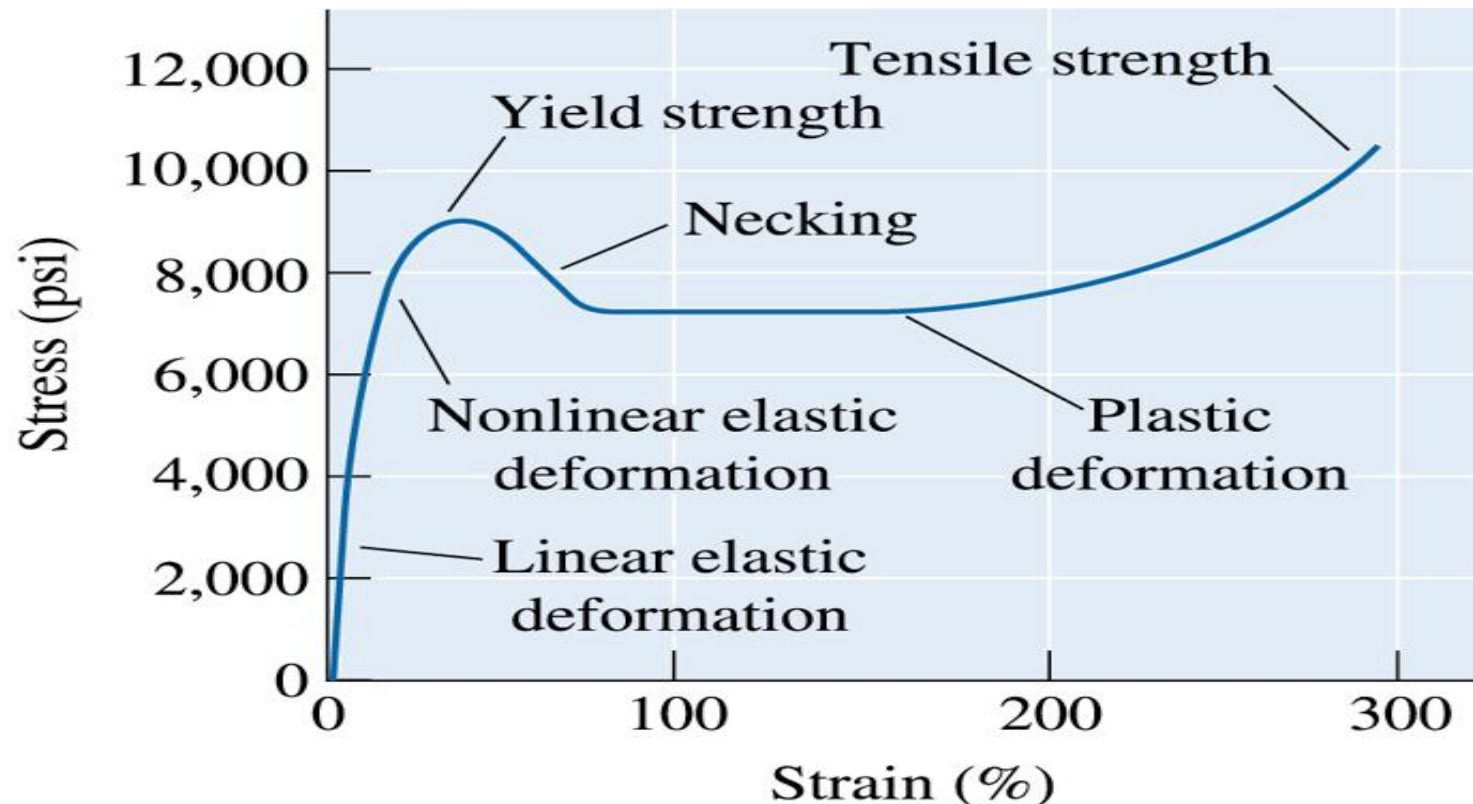
Relaxação de tensão

- Termoplástico acima de T_g

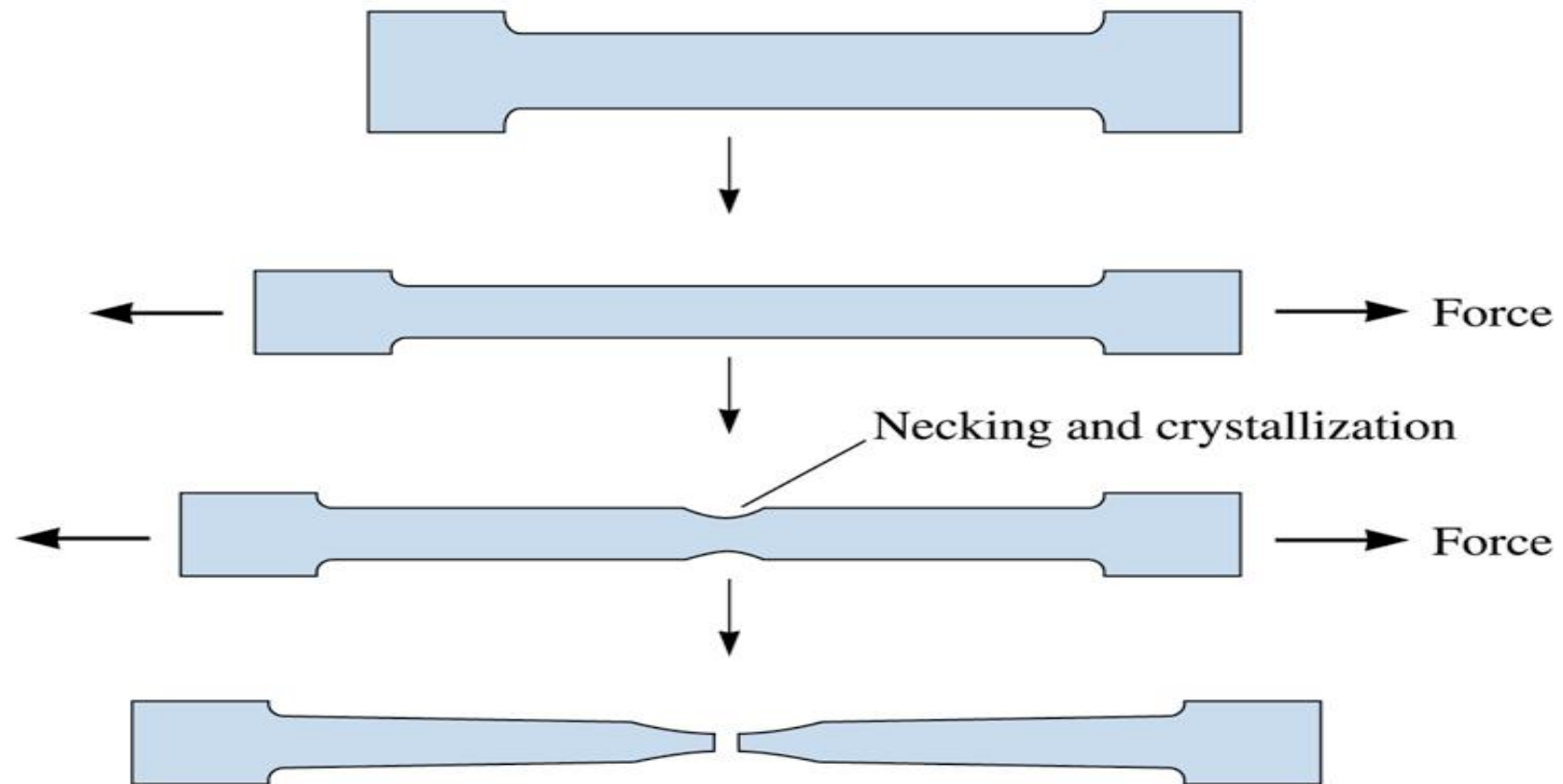


Comportamento Mecânico

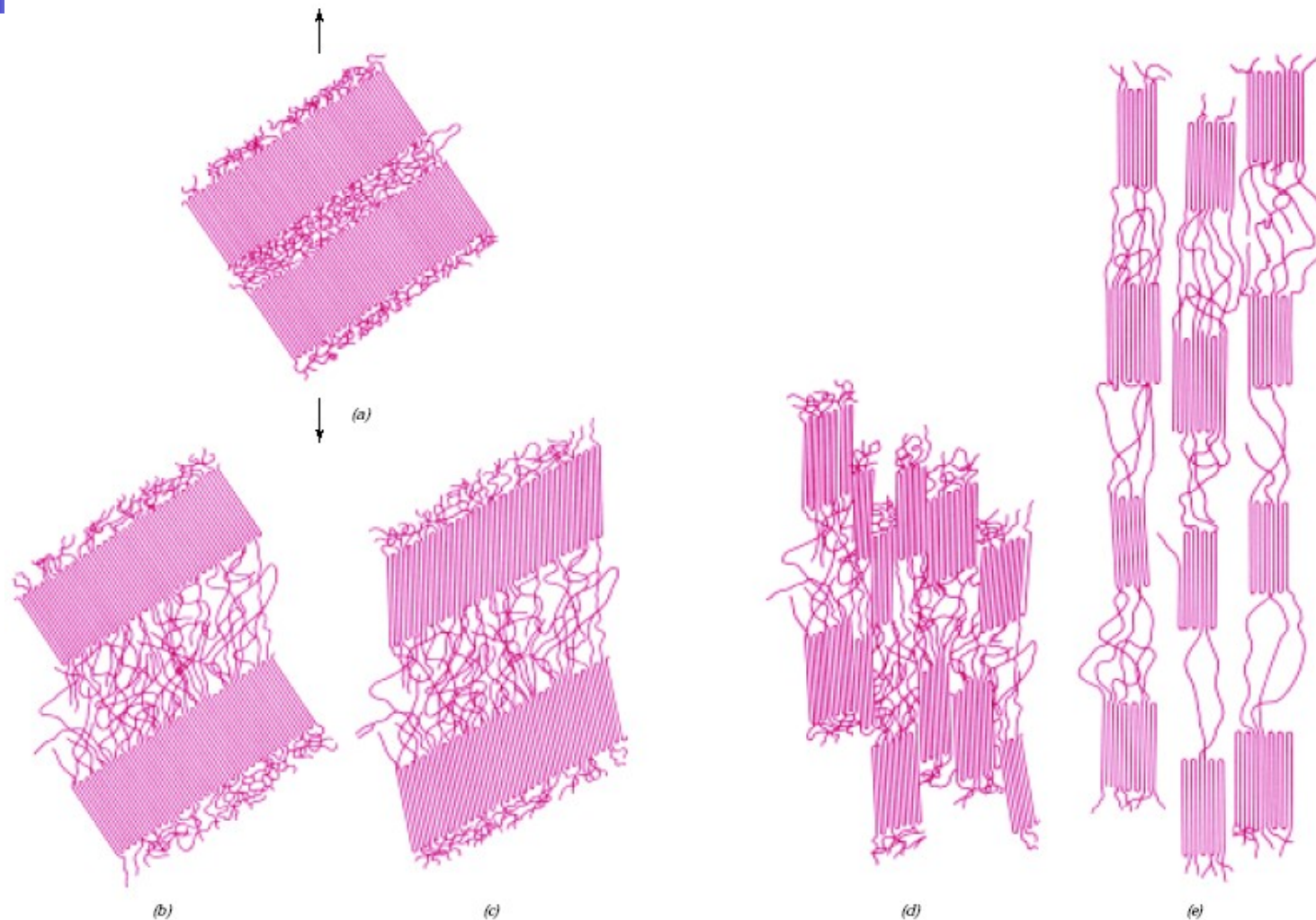
- Termoplástico acima de T_g



Cristalização induzida por deformação

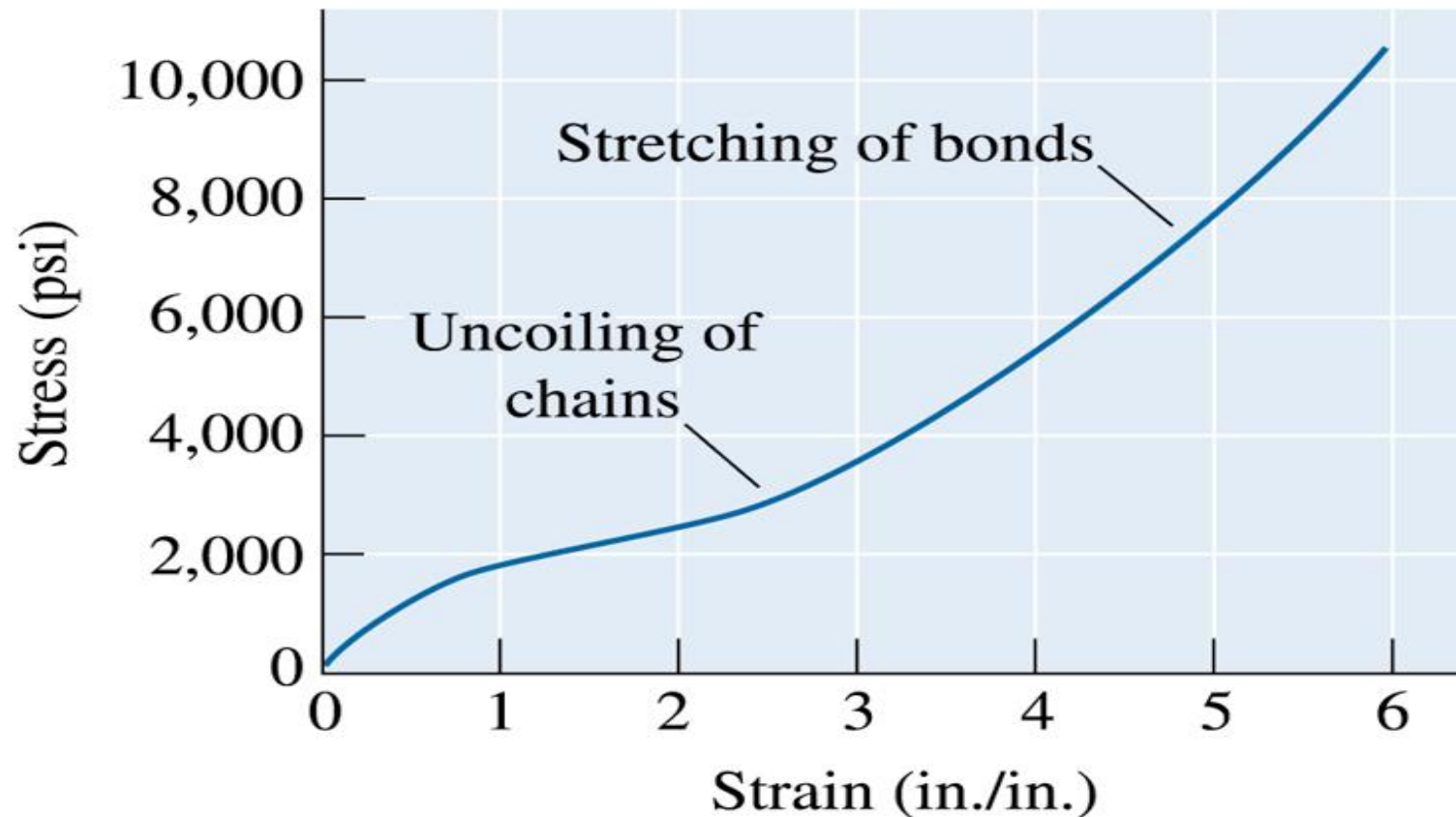


Deformação de Termoplástico (semicristalino)

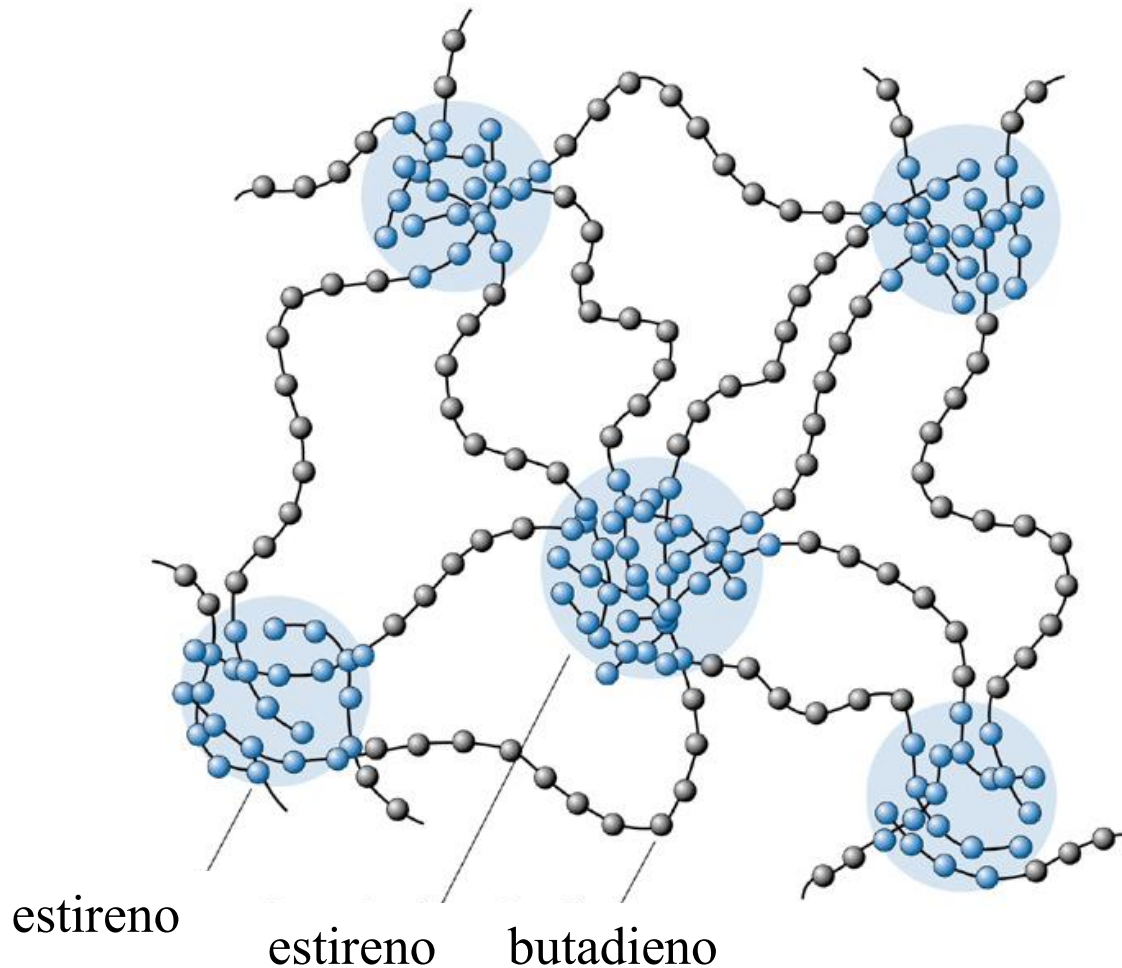


Comportamento Mecânico

■ Elastômero acima de T_g



Elastômero Termoplástico



Copolímero

Poli(estireno-butadieno-
estireno)

SBS