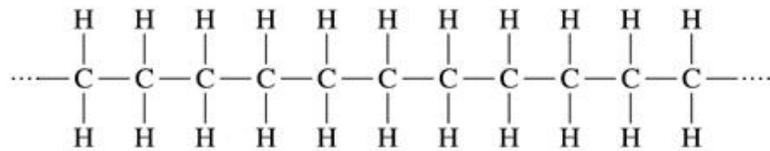
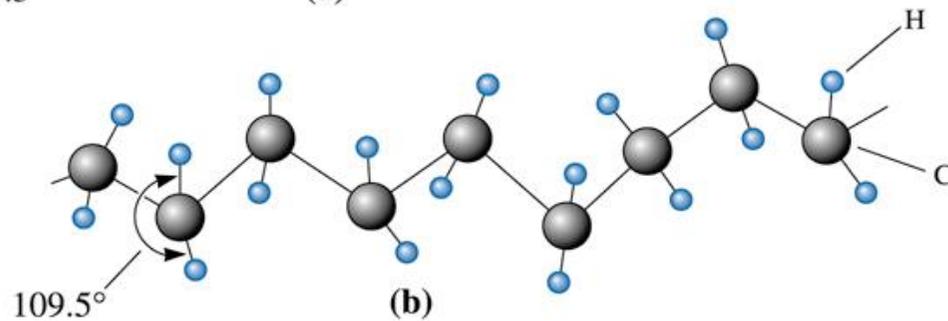
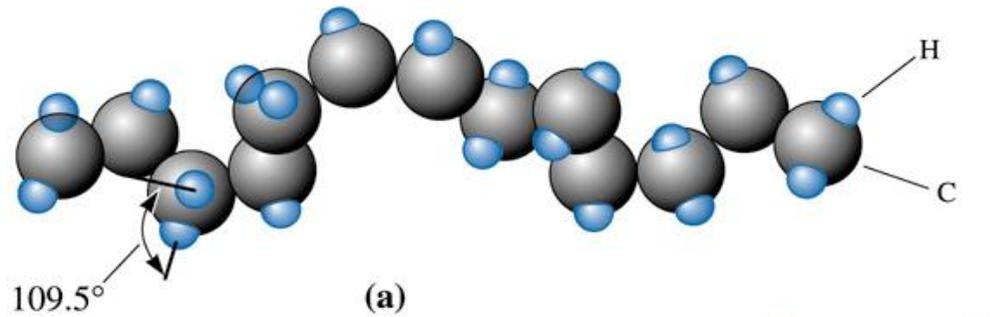


Estruturas Poliméricas

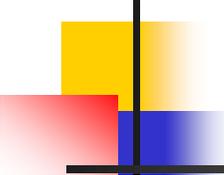
- Cadeias e redes
- Peso molecular, isomerismo
 - Cristais e fase amorfa

Polímeros (estructura básica)

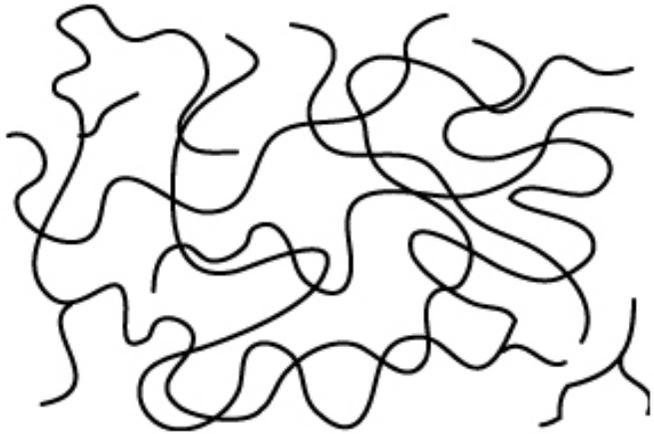


(c)

Polietileno



Classes

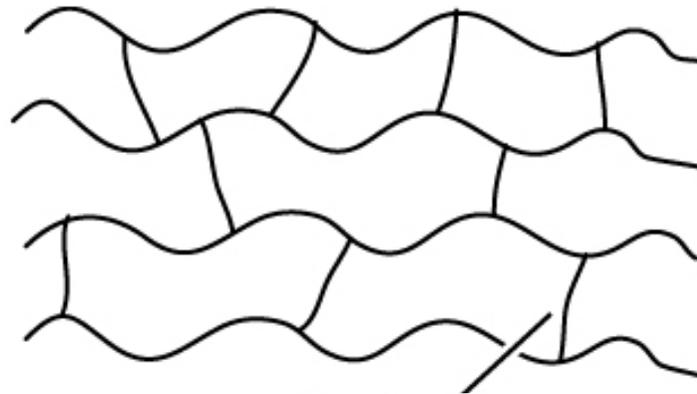


Termoplástico



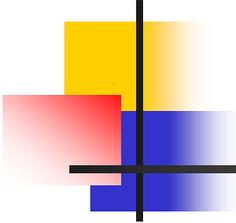
Cross-link

Elastômero

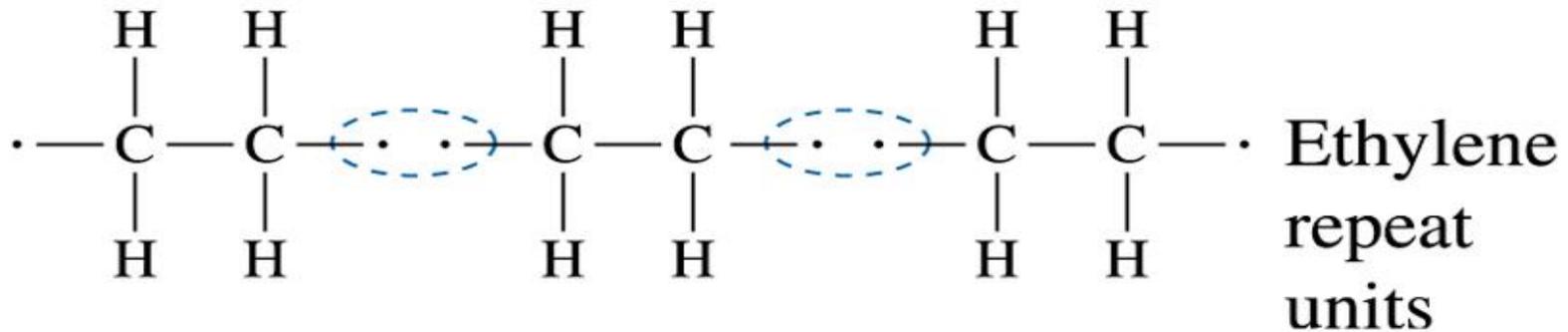
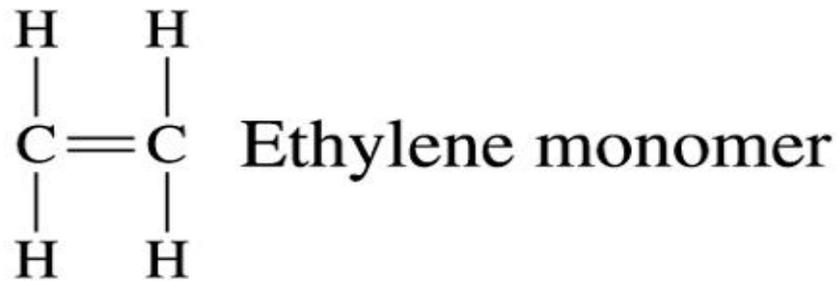


Termofixo

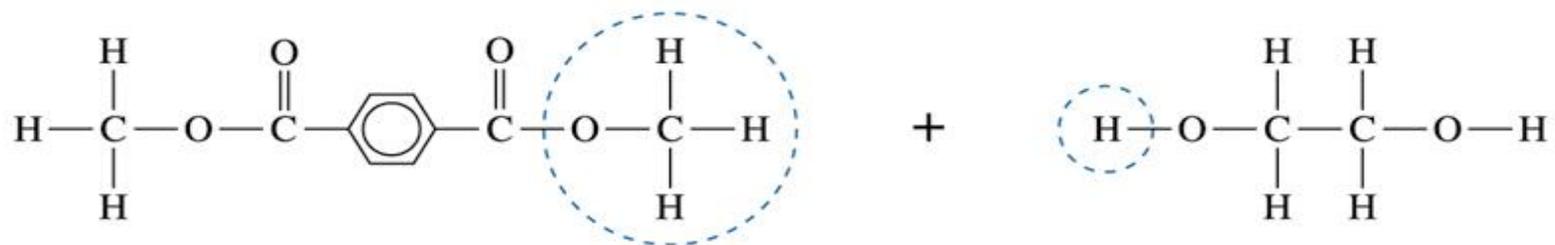
Rede tridimensional



Polimerização (adição)

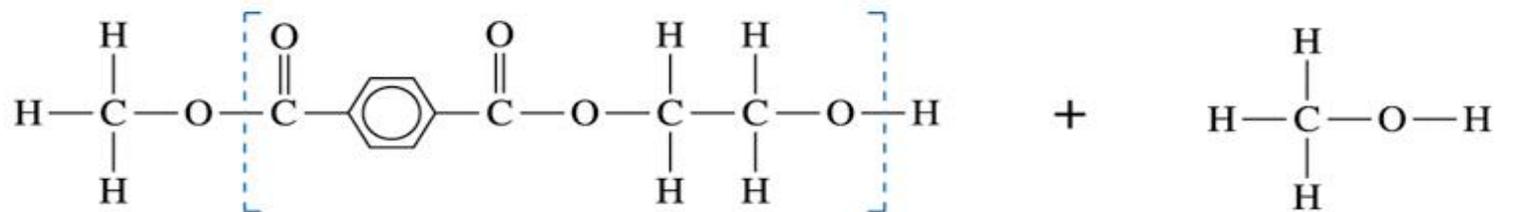


Polimerização (condensação)



Dimethyl terephthalate

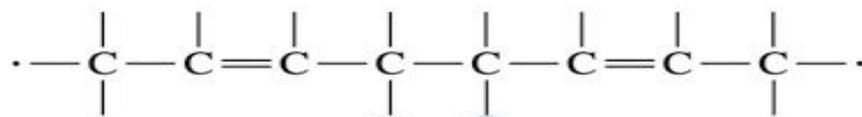
Ethylene glycol



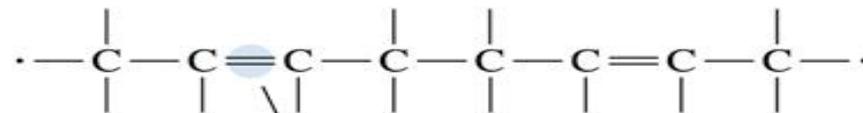
Repeat unit for polyethylene terephthalate
(PET polymer)

Methyl alcohol
(byproduct)

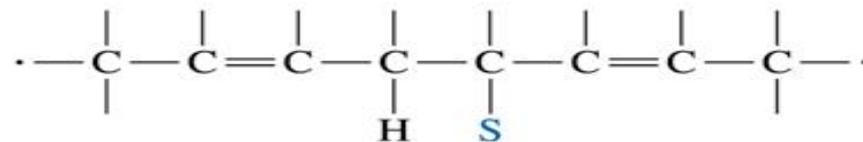
Formação de Elastômeros (Ligações cruzadas)



Sulfur →



Break unsaturated bond



H

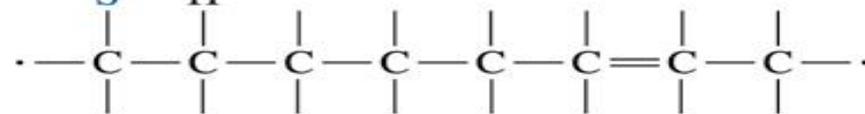
S

S

S

S

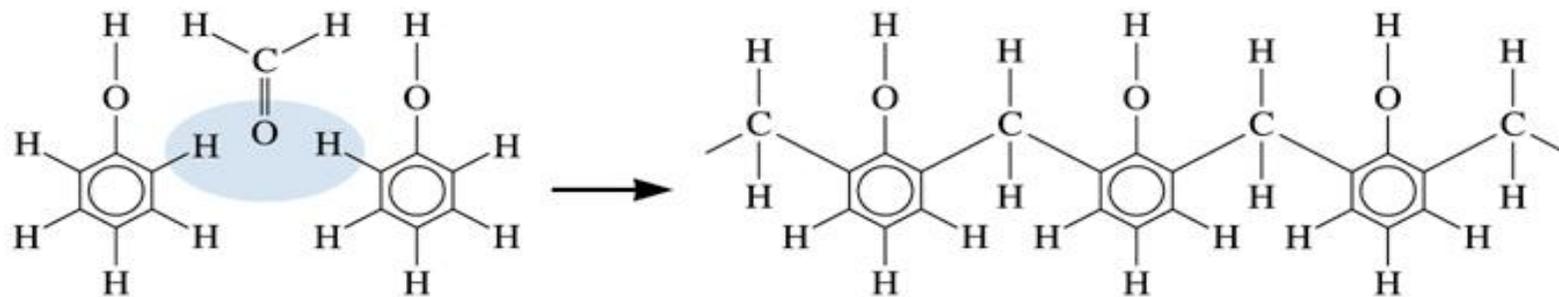
H



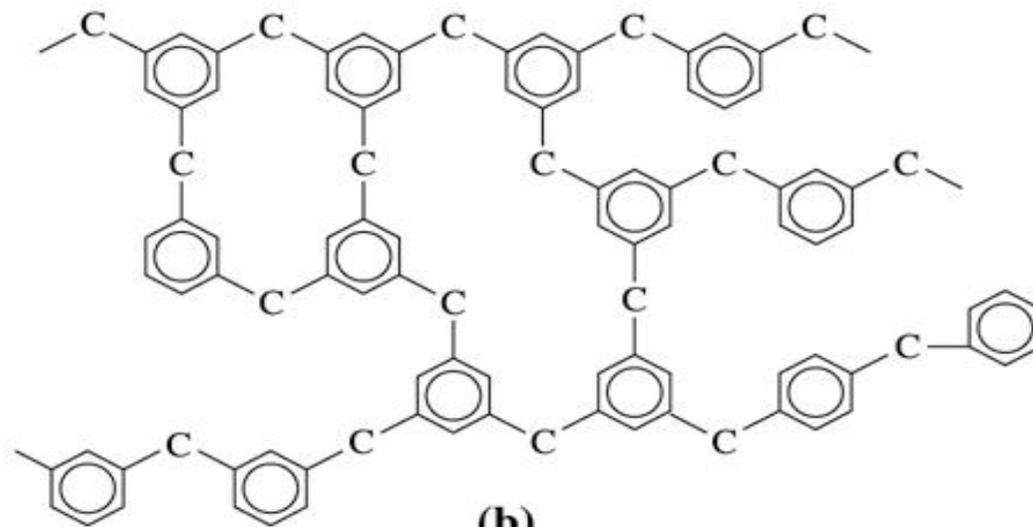
Exemplo:

Vulcanização da borracha

Polimerização de Termofixo



(a)

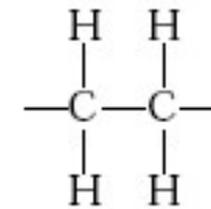


(b)

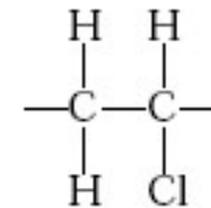
Polímeros comuns



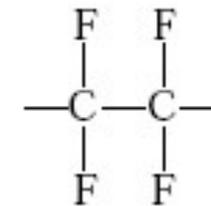
Polyethylene (PE)



Polyvinyl chloride (PVC)



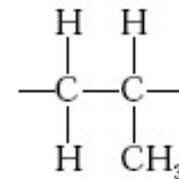
Polytetrafluoroethylene (PTFE)



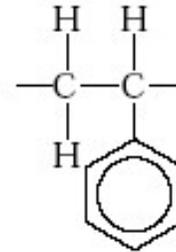
Polímeros comuns



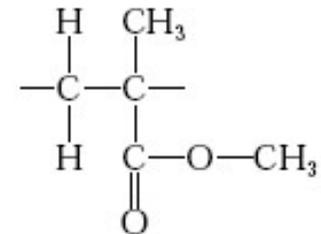
Polypropylene (PP)



Polystyrene (PS)



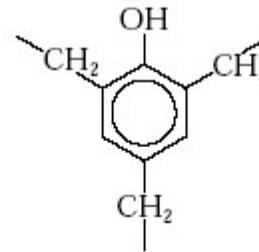
Polymethyl methacrylate (PMMA)



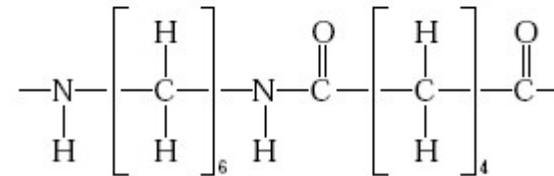
Polímeros comuns



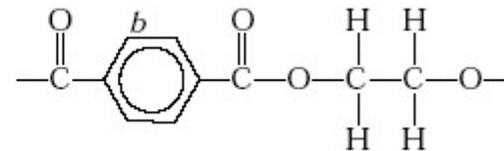
Phenol-formaldehyde (Bakelite)



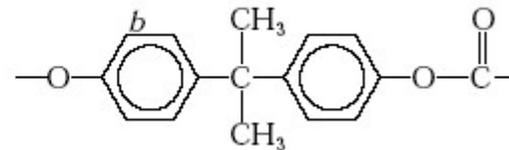
Polyhexamethylene adipamide (nylon 6,6)



Polyethylene terephthalate (PET, a polyester)



Polycarbonate



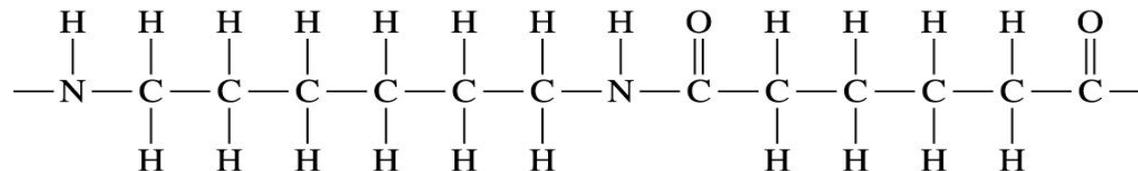
Grau de Polimerização

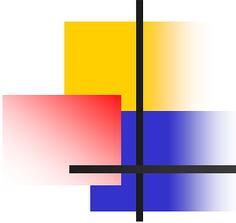
- Razão entre o peso molecular médio numérico do polímero e o peso molecular do monômero

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

- 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)

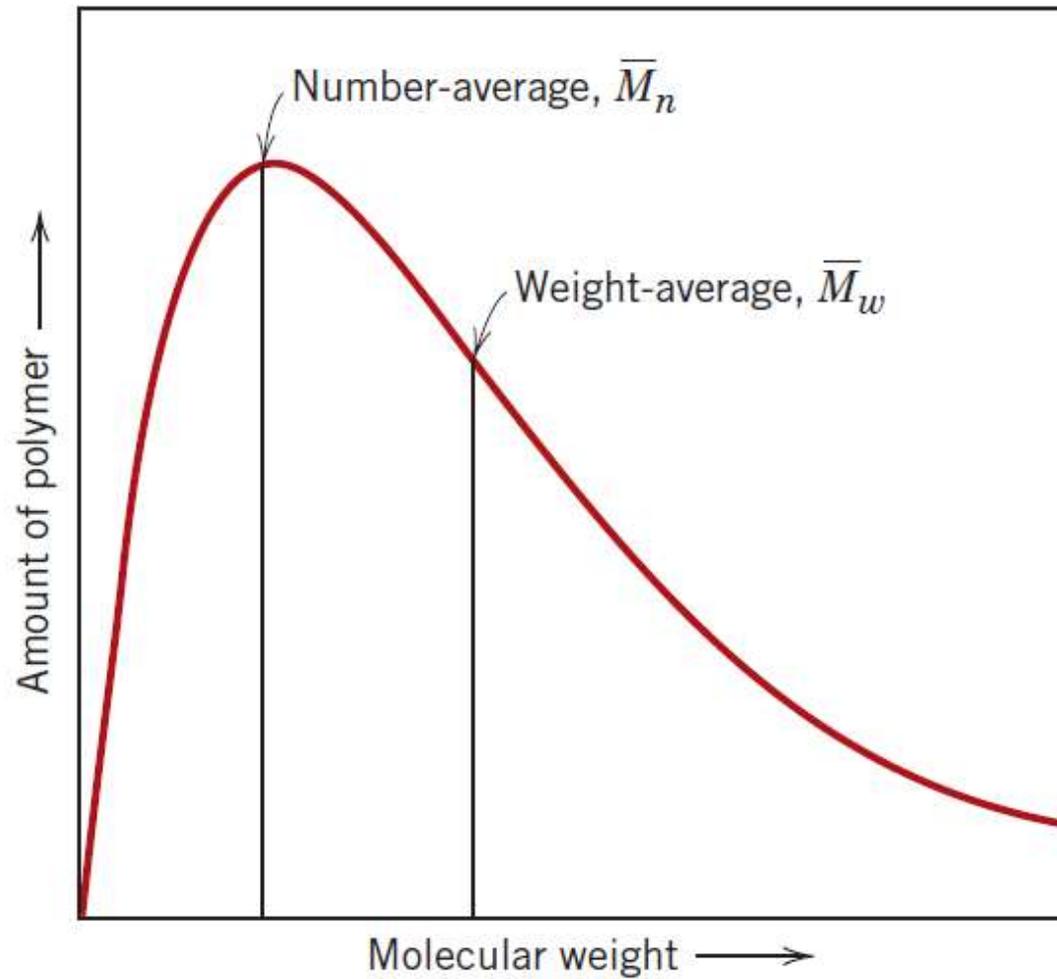
Number of Chains	Mean M per Chain	x_i	$x_i M_i$	Weight	f_i	$f_i M_i$
4000	2500	0.191	477.5	10×10^6	0.0519	129.75
8000	7500	0.381	2857.5	60×10^6	0.3118	2338.50
7000	12,500	0.333	4162.5	87.5×10^6	0.4545	5681.25
2000	17,500	0.095	1662.5	35×10^6	0.1818	3181.50
$\Sigma = 21,000$		$\Sigma = 1.00$	$\Sigma =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

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

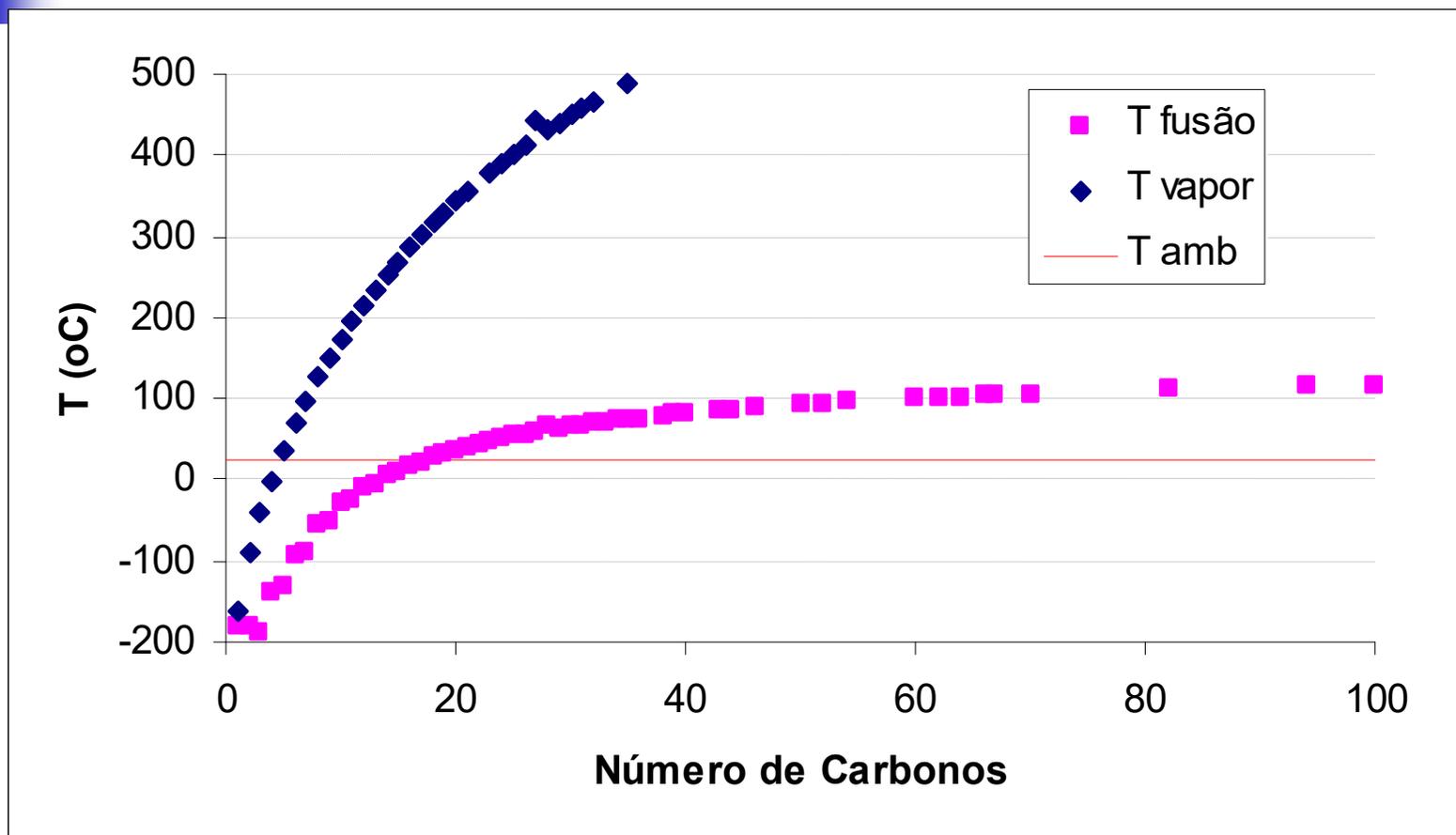
$$\bar{M}_w = \sum f_i M_i = 11,331 \text{ g/mol}$$

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

Peso Molecular

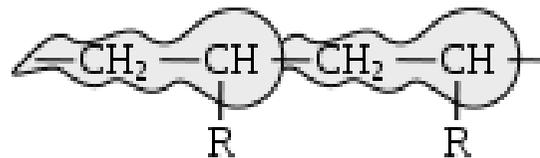
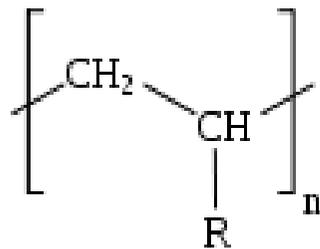


Temperaturas de fusão e vaporização em alcanos

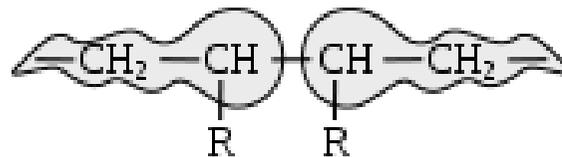


Configuração da moléculas

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



head-tail



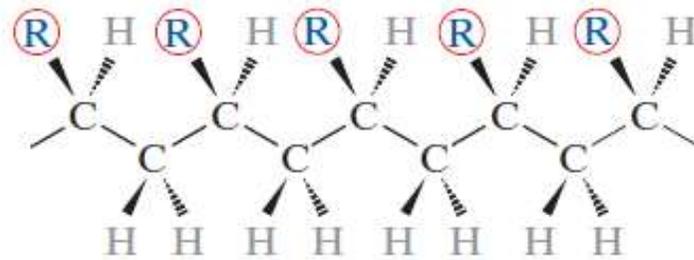
head-head



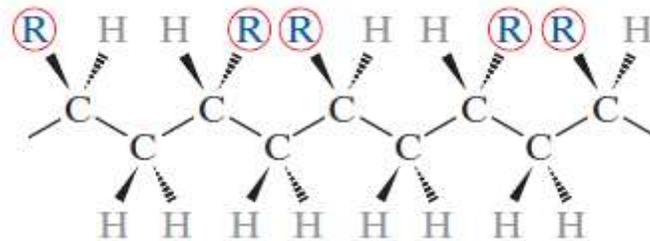
tail-tail

Configuração das moléculas

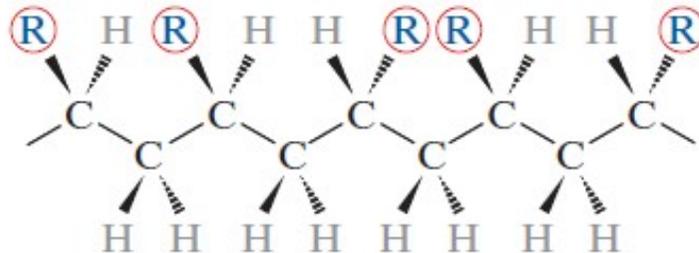
Etereoisomerismo



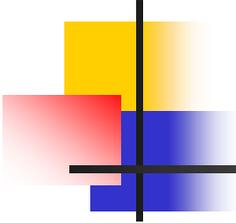
isotático



sindiotático

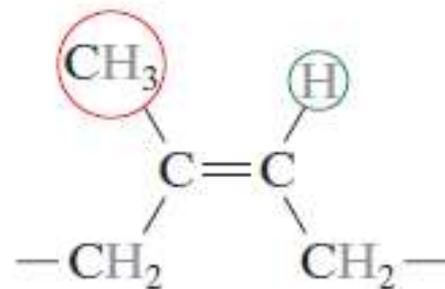


atático

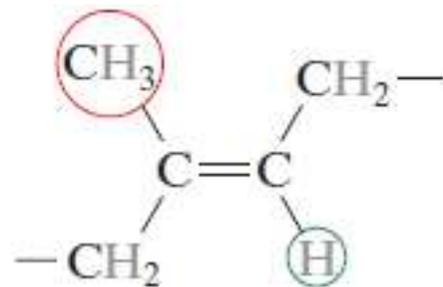


Configuração das Moléculas

Isomerismo Geométrico

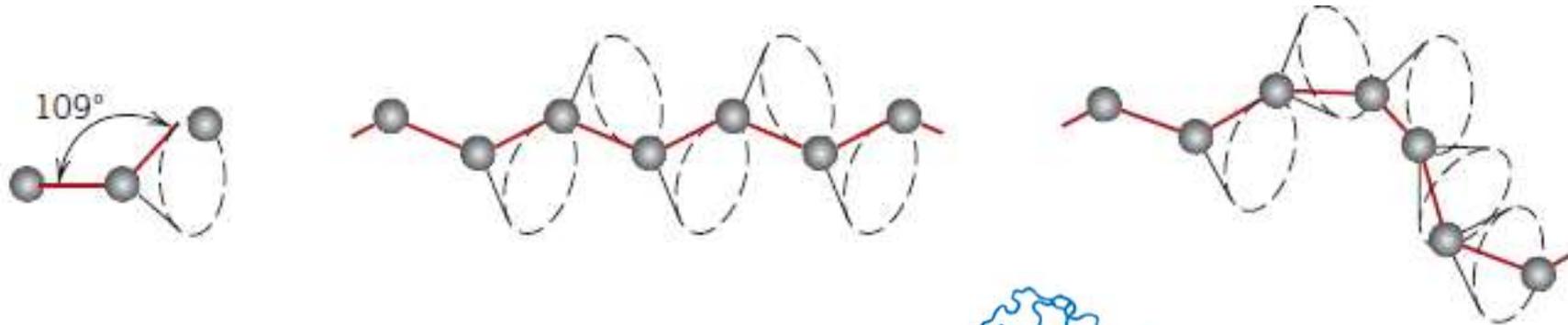


cis

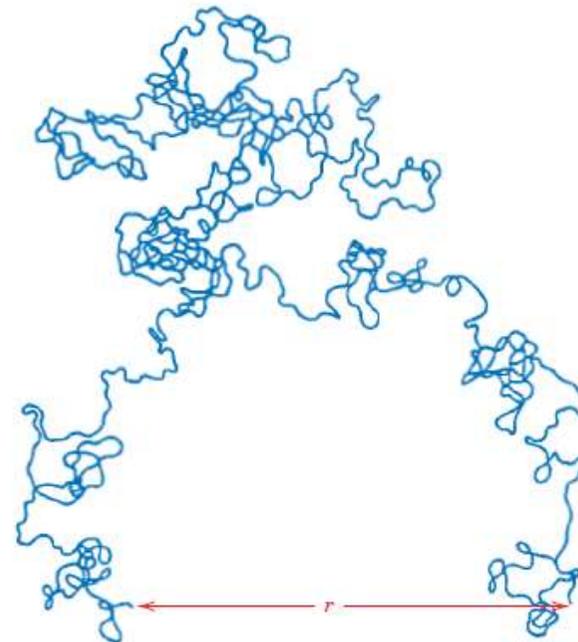


trans

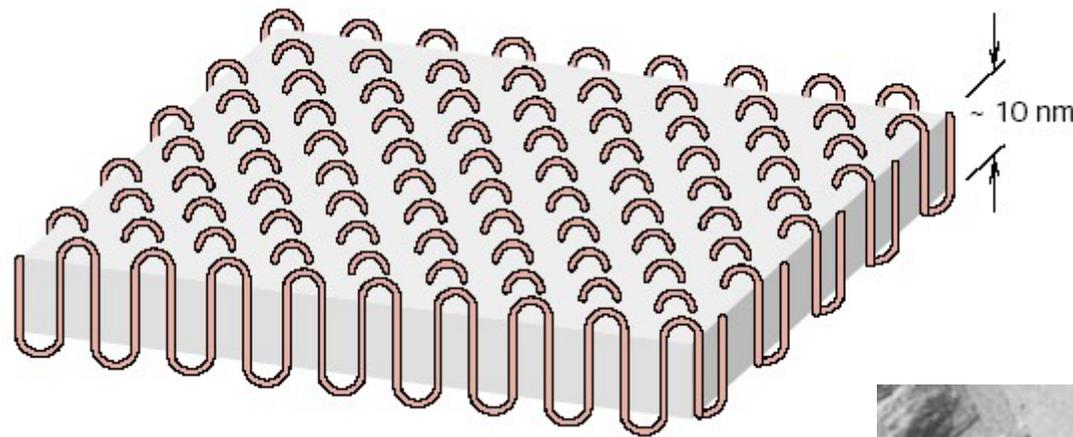
Arranjo das moléculas



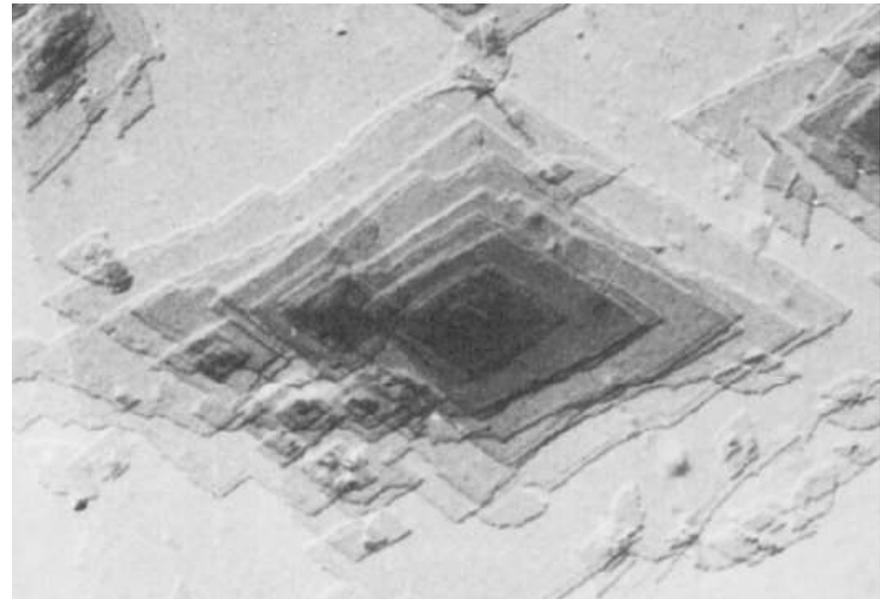
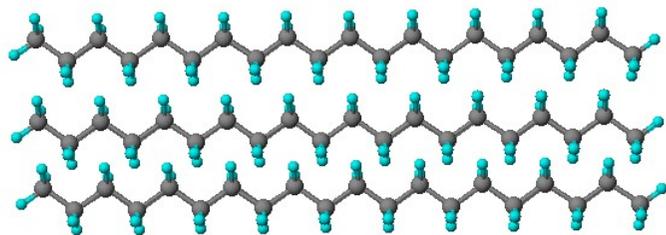
Obs.: Ligações duplas na cadeia limitam os movimentos e a capacidade de dobramento das moléculas.



Cristais Poliméricos



Exemplo:
PE em configuração
Zig-Zag planar

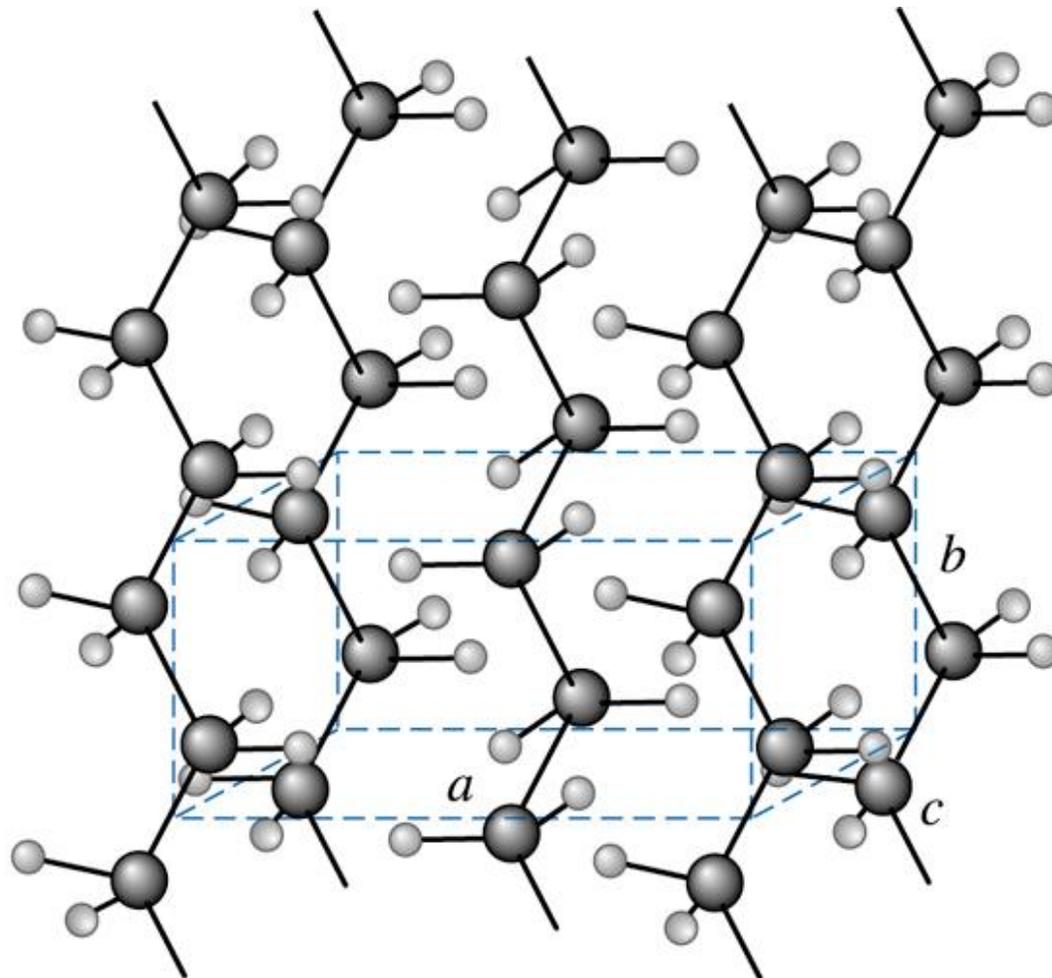


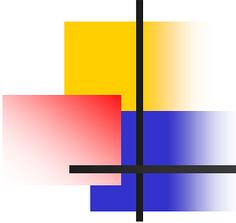
Cristal de PE

(c) 2003 Brooks/Cole Publishing / Thomson Learning

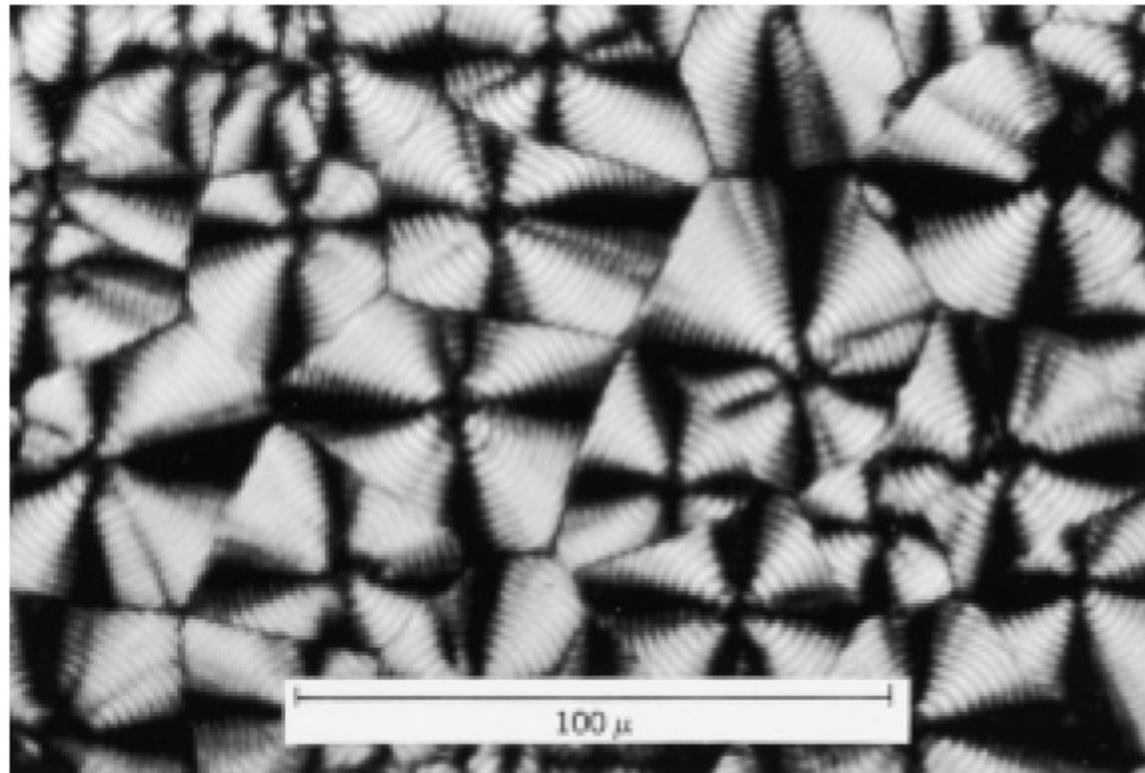
$$a = 7.41 \text{ \AA}$$
$$b = 4.94 \text{ \AA}$$
$$c = 2.55 \text{ \AA}$$

● Hydrogen
● Carbon

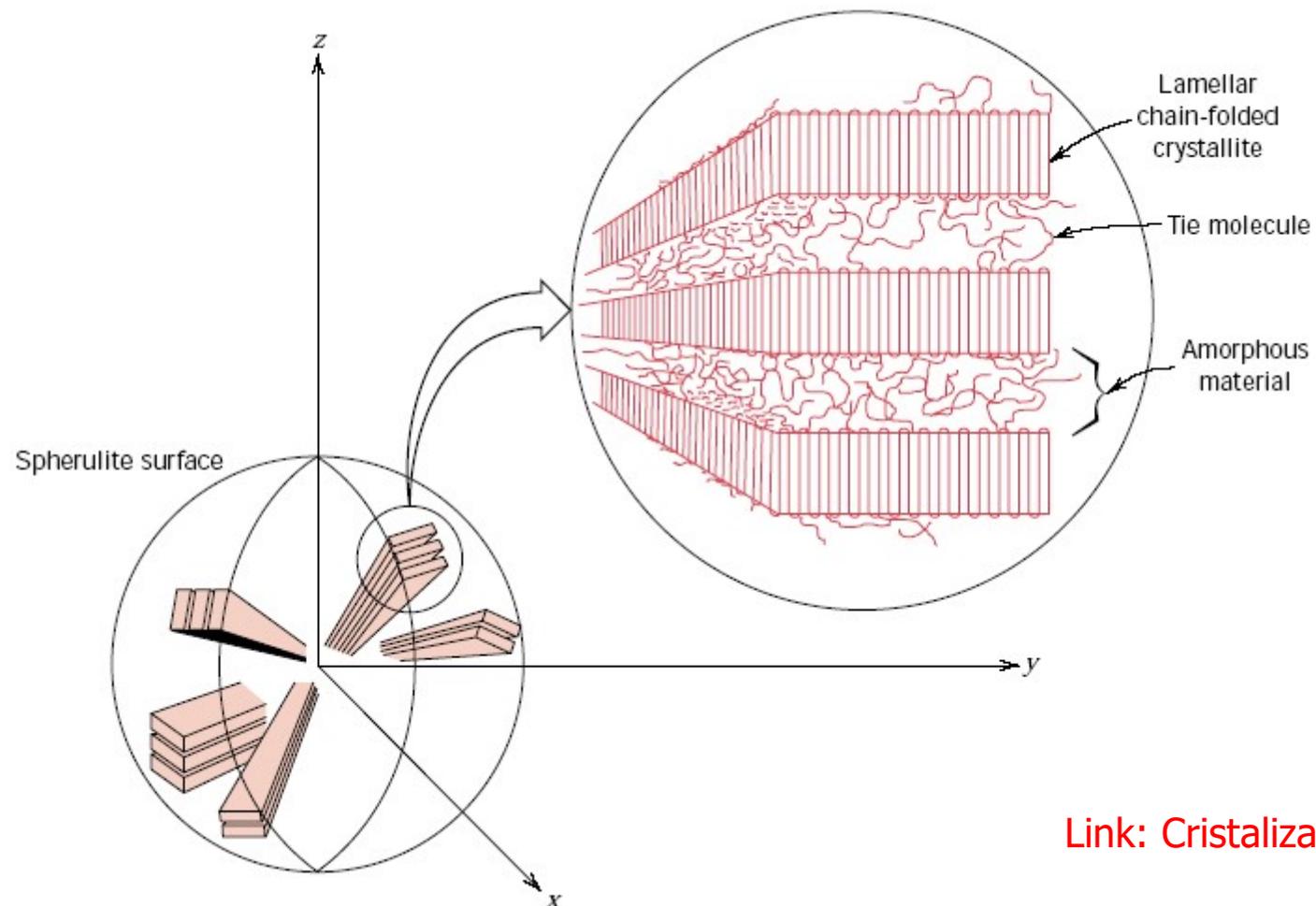




Esferulitos

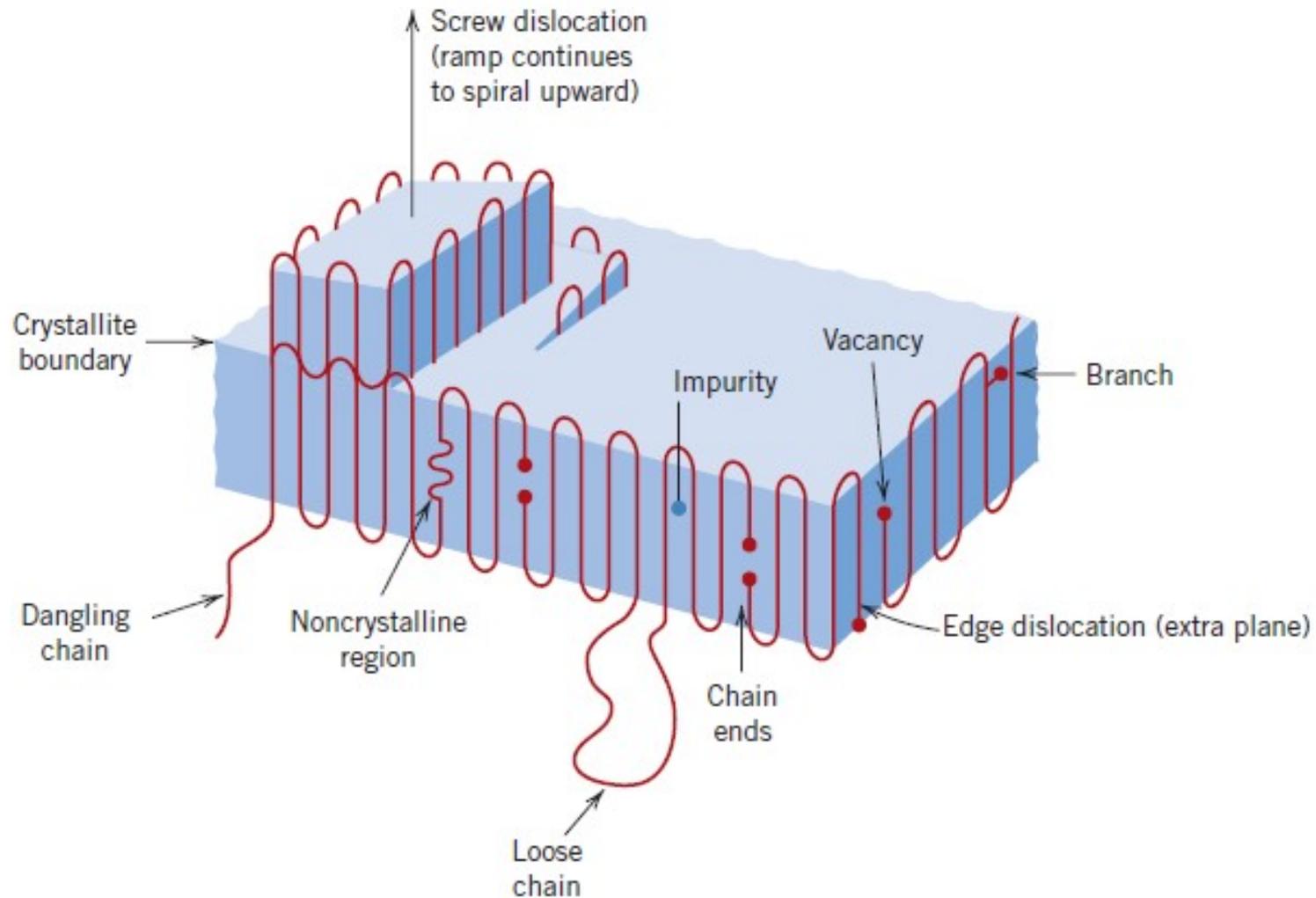


Estrutura do Esferulito

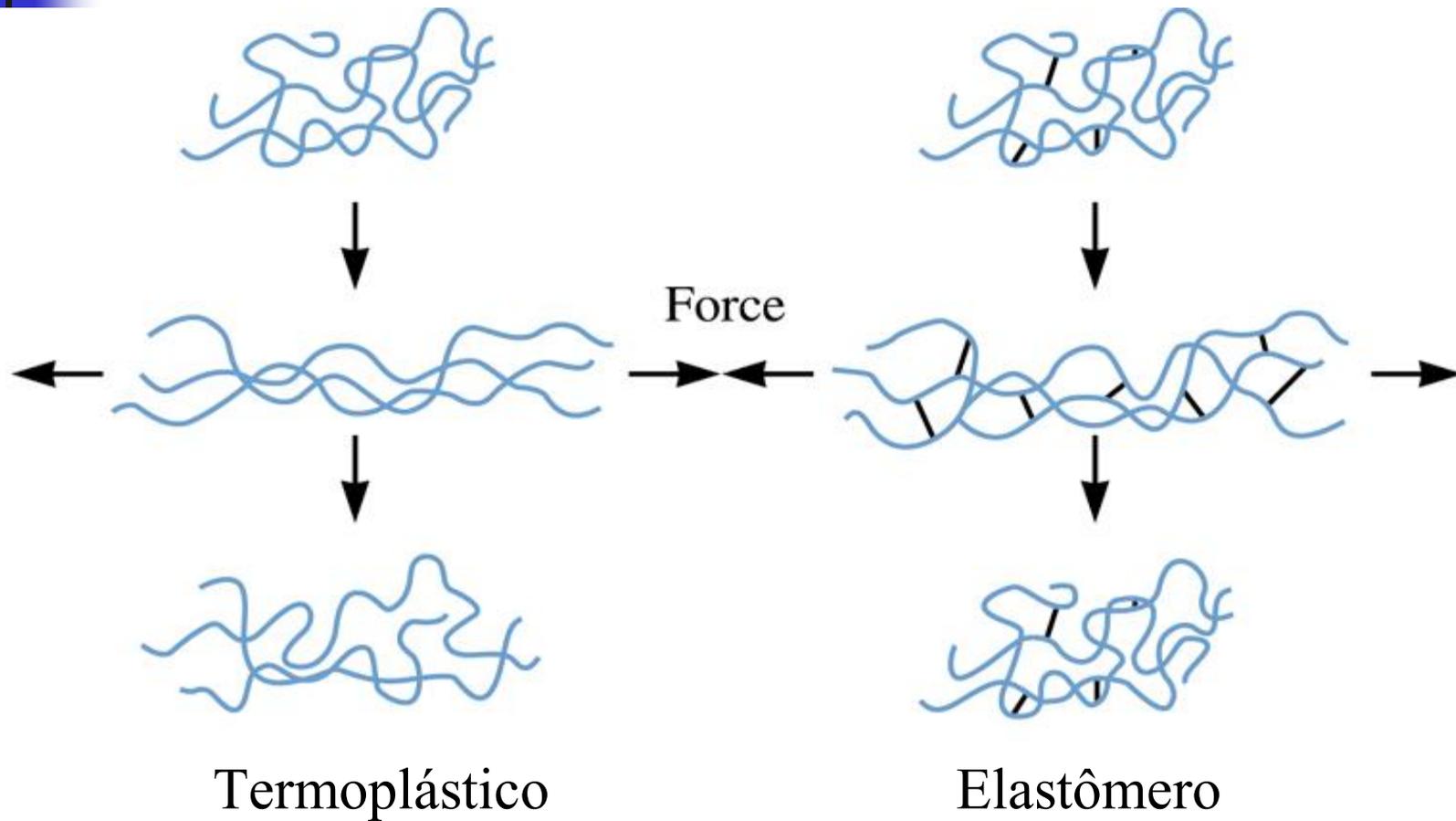


[Link: Cristalização de PE](#)

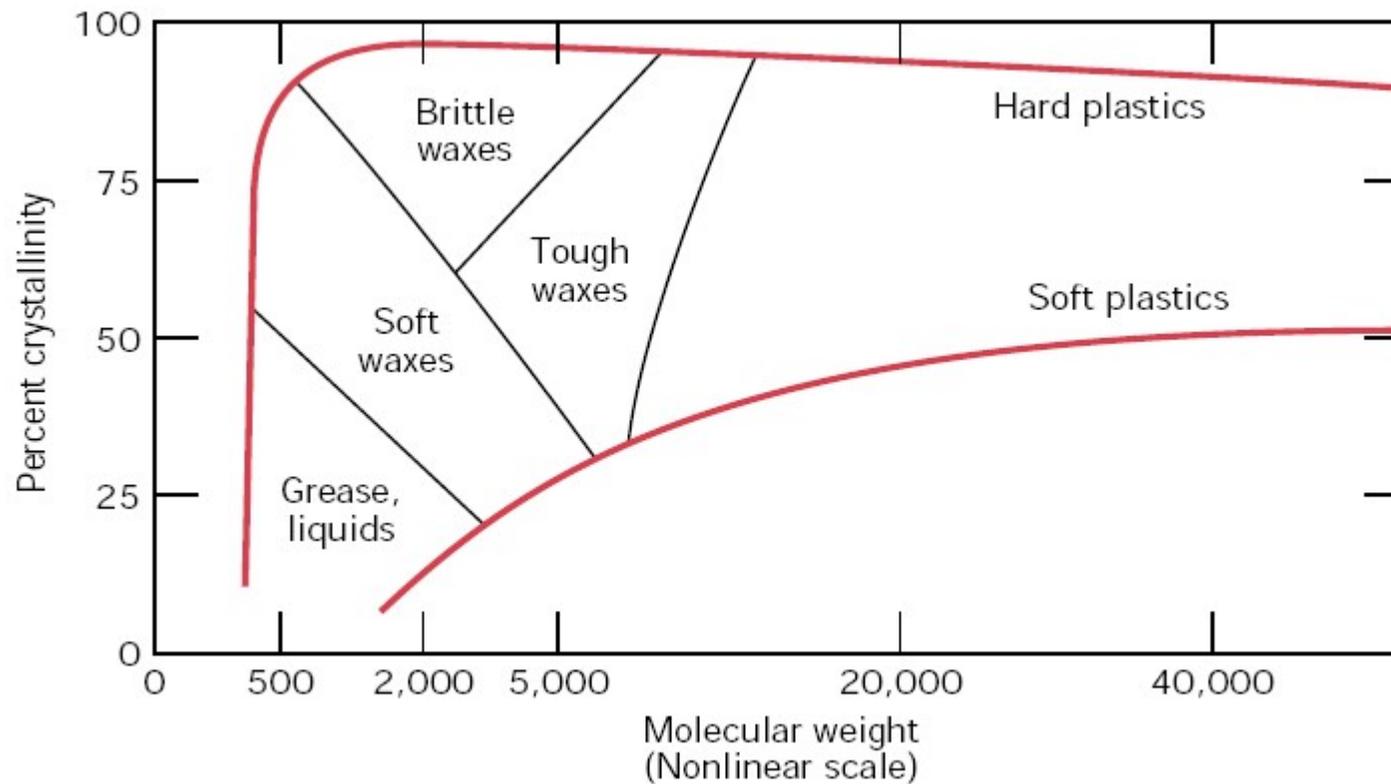
Defeitos cristalinos



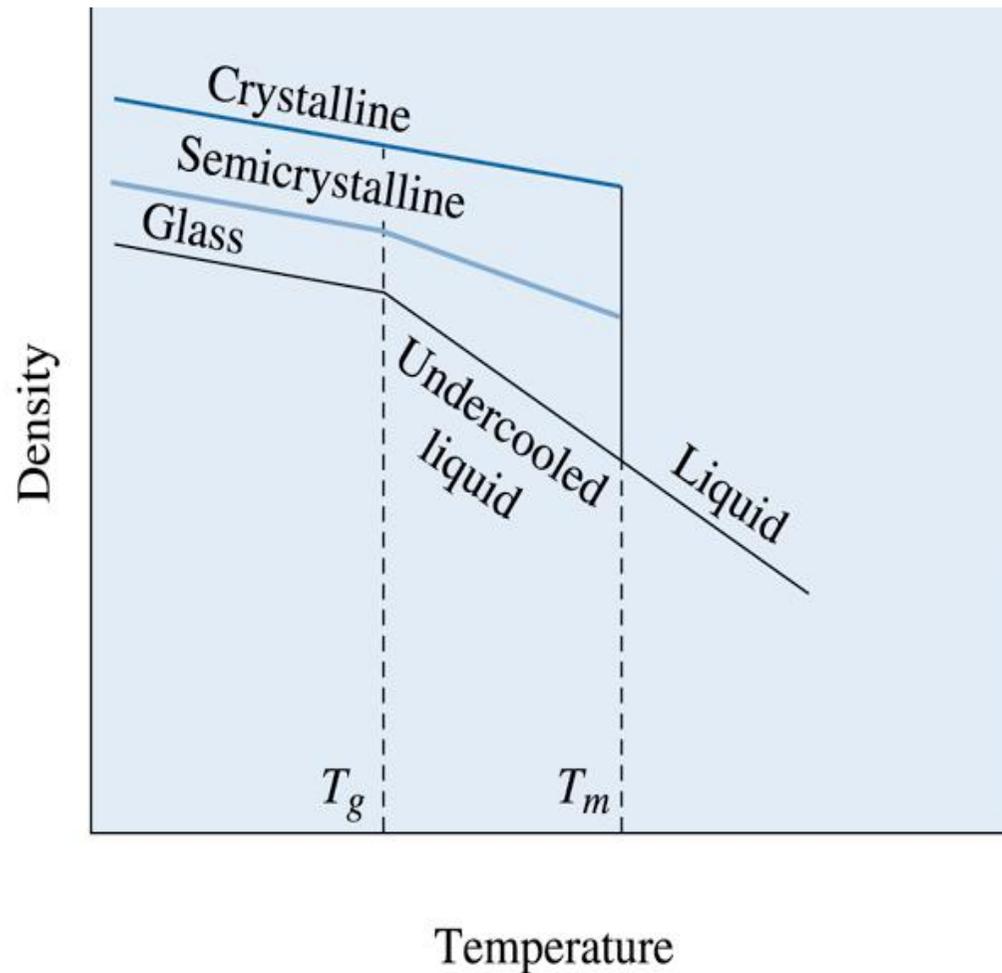
Comportamento mecânico



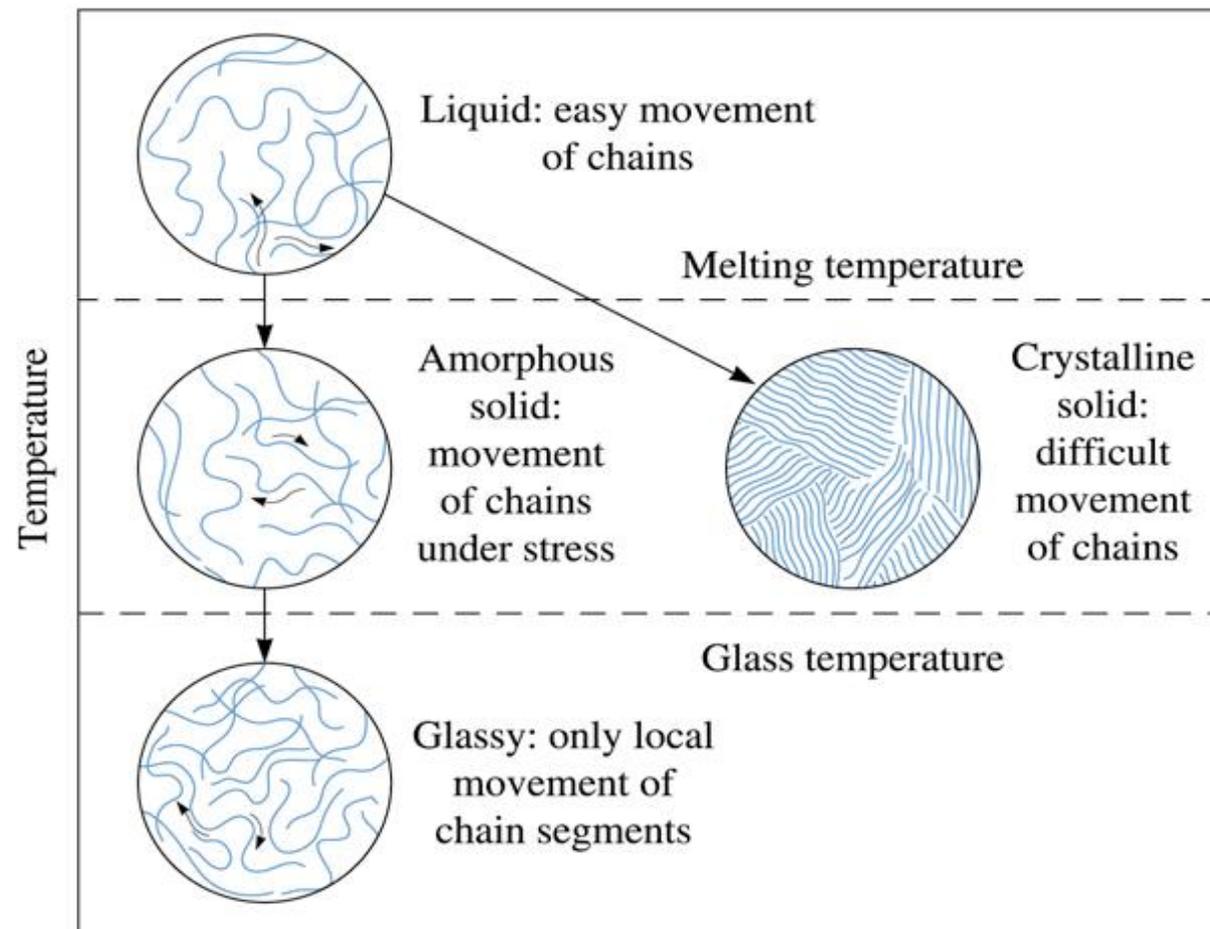
Efeito da cristalinidade e PM



Transição Vítre

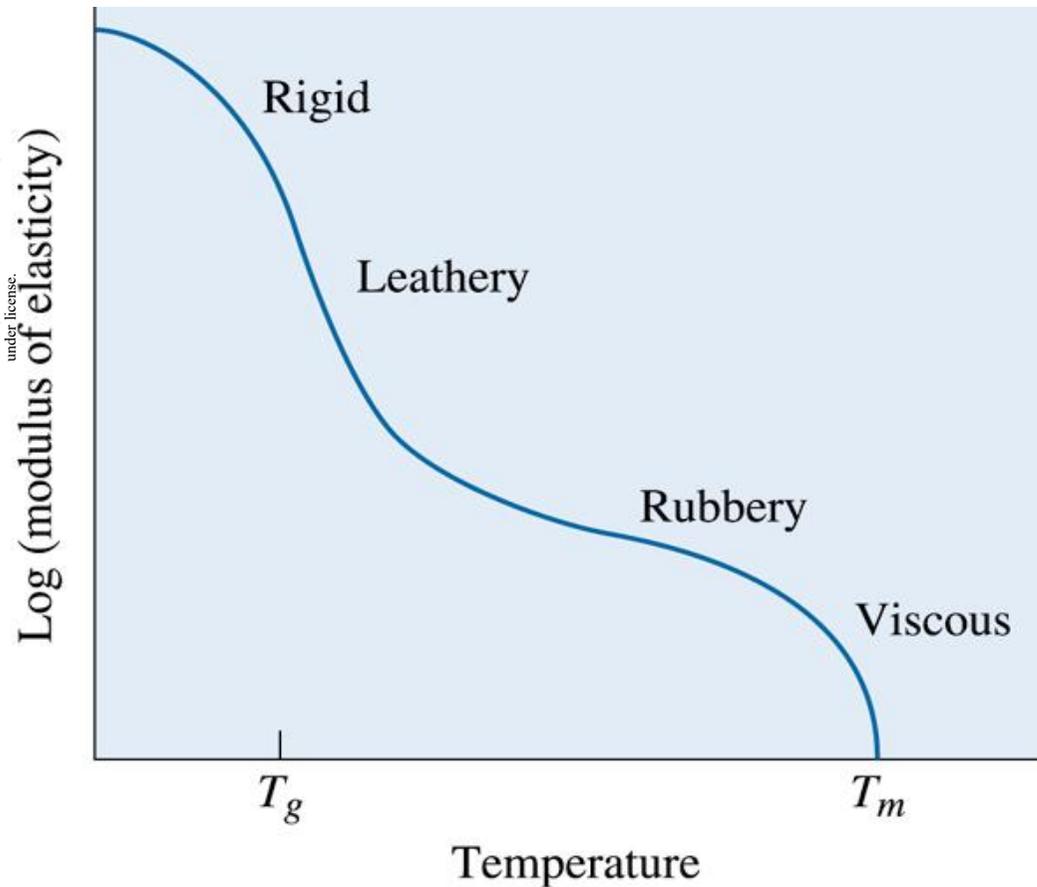


Transição vítrea



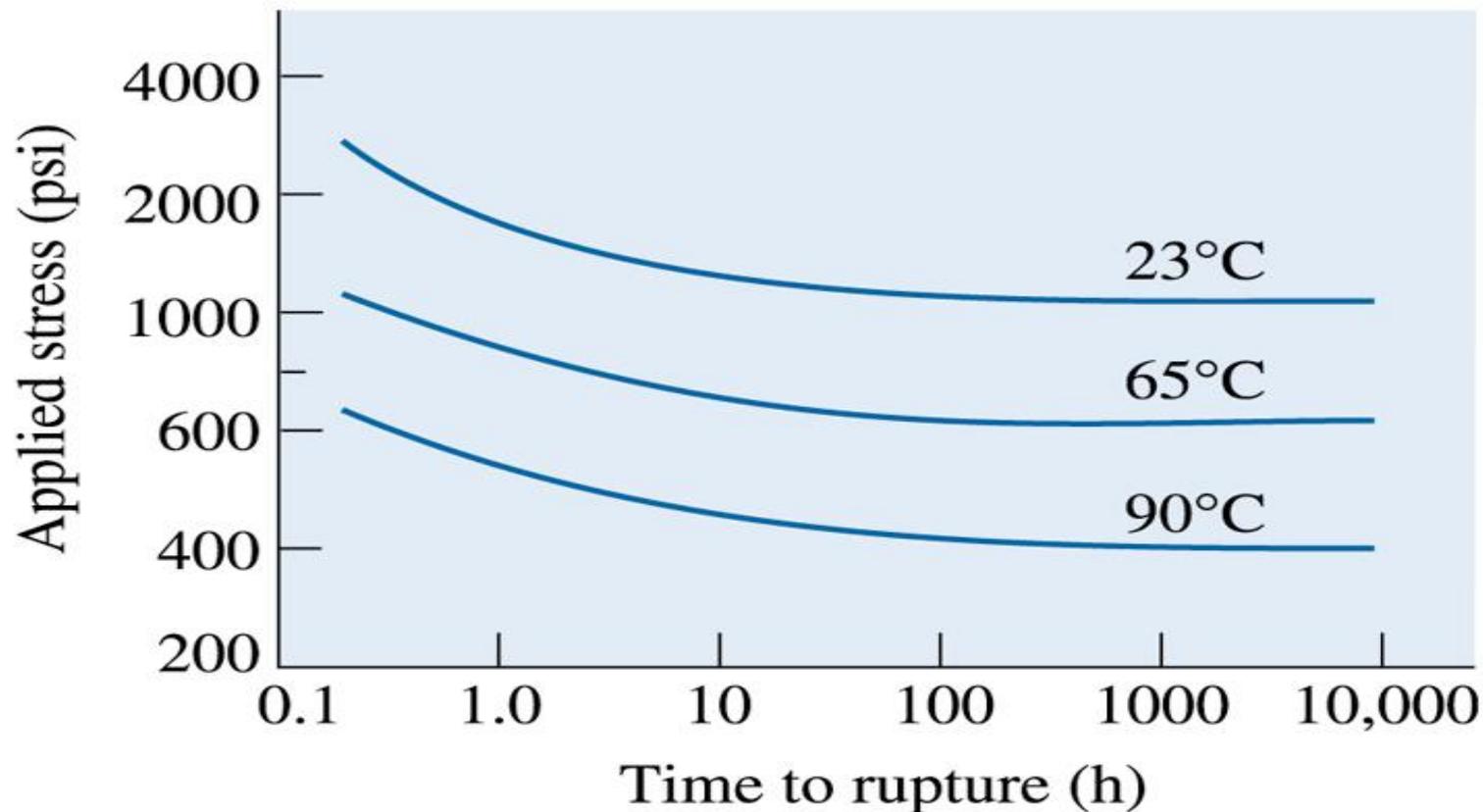
Efeito da temperatura no comportamento mecânico

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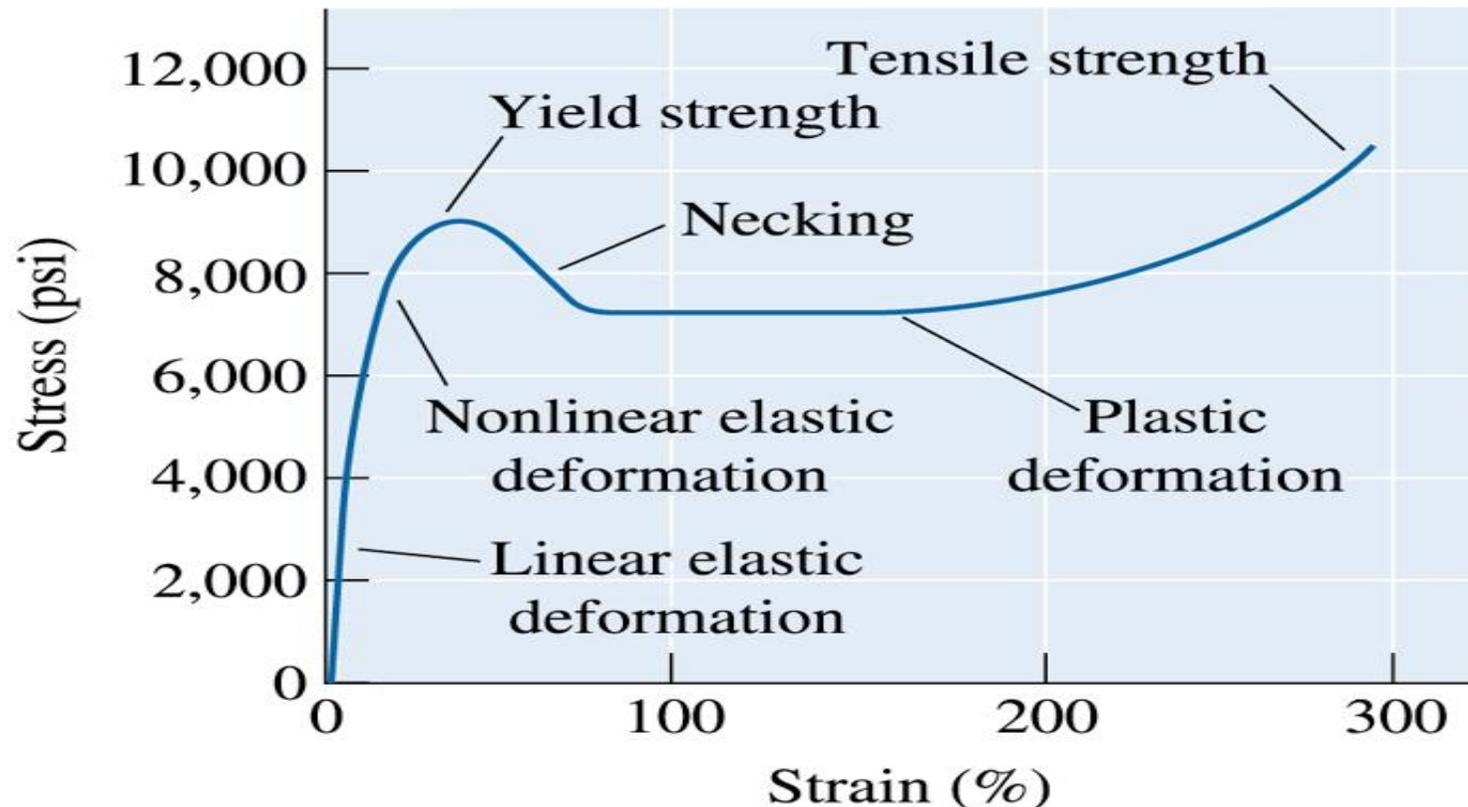
Relaxação de tensão

- Termoplástico acima de T_g

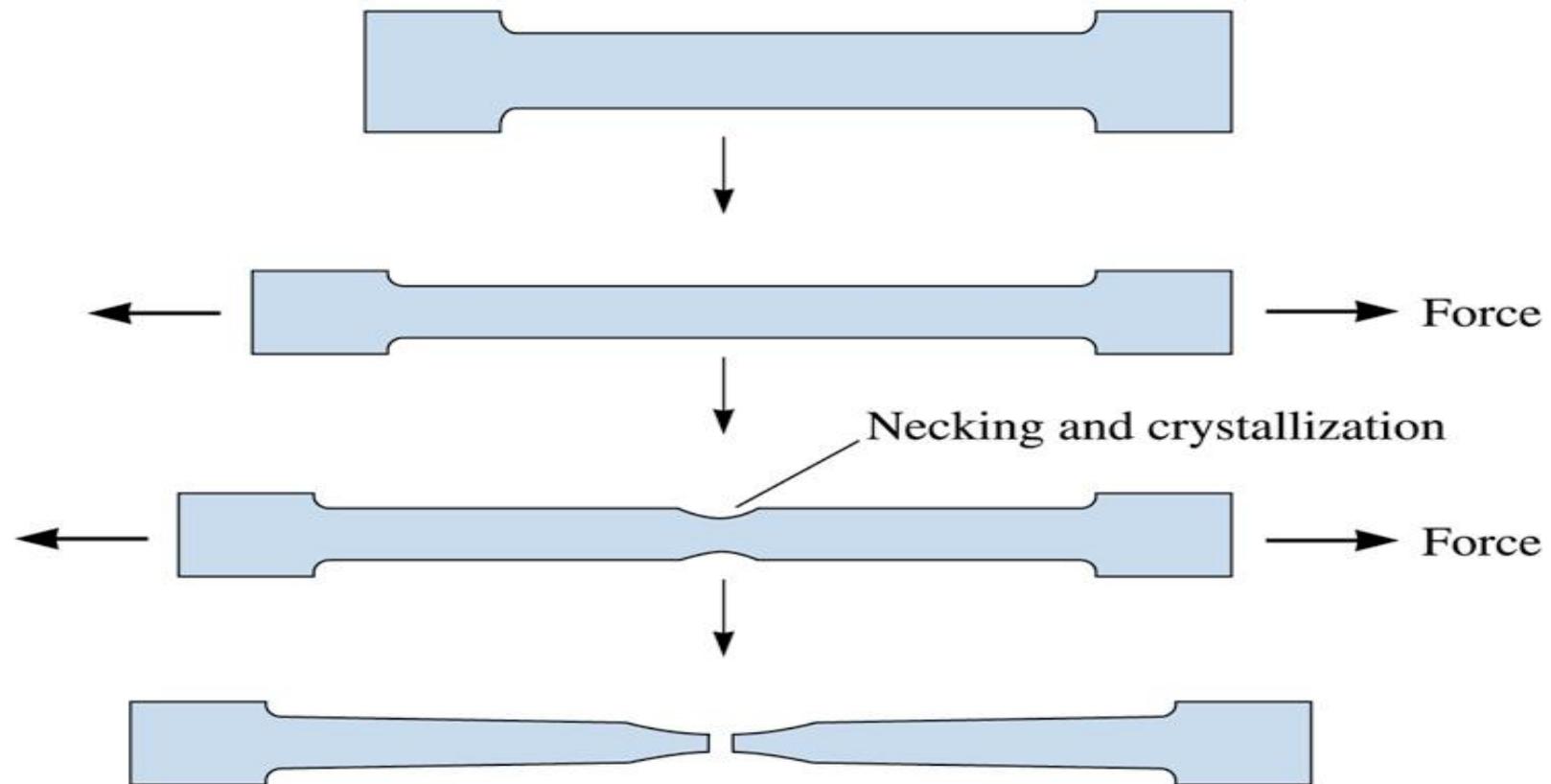


Comportamento Mecânico

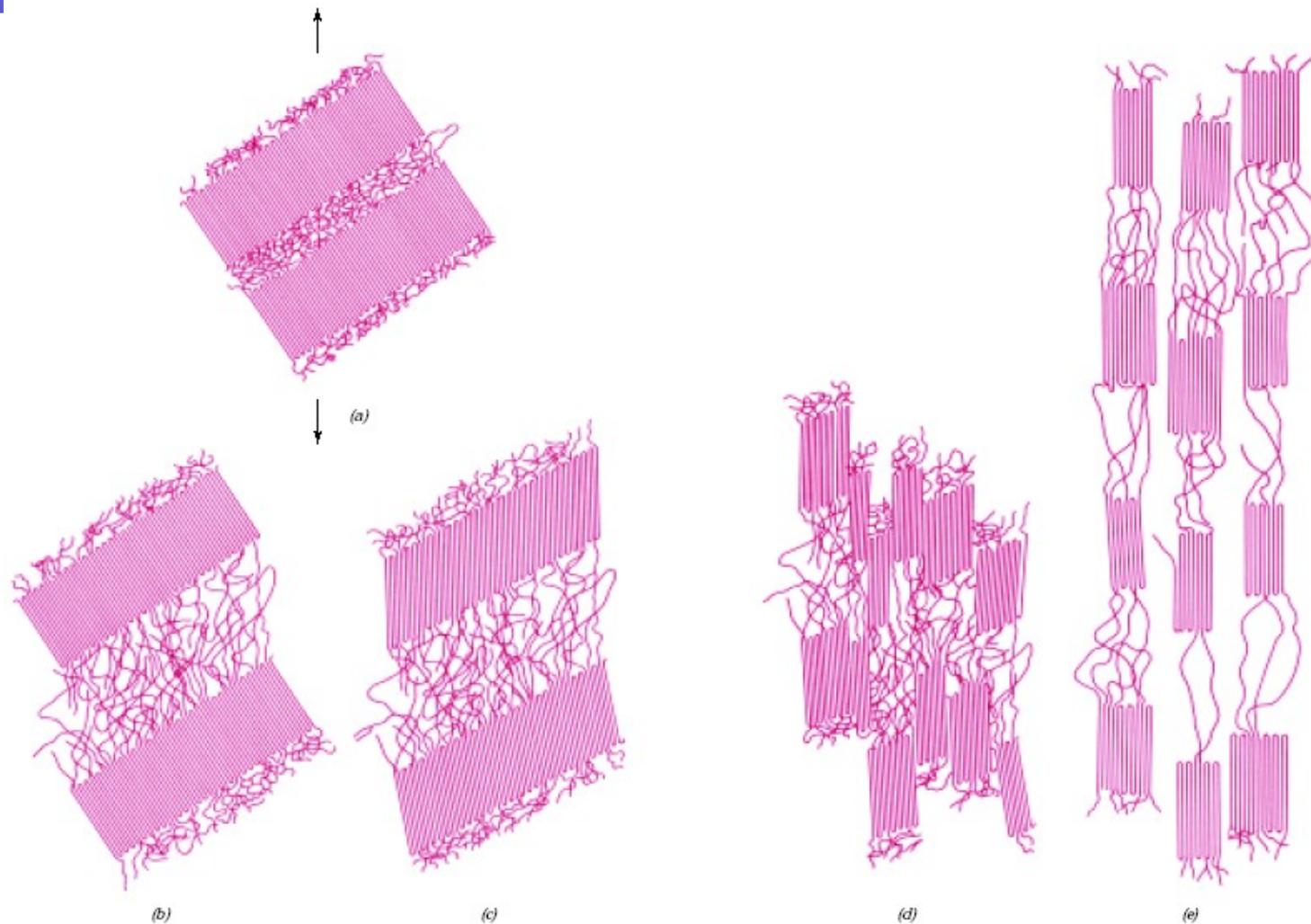
- Termoplástico acima de T_g



Cristalização induzida por deformação

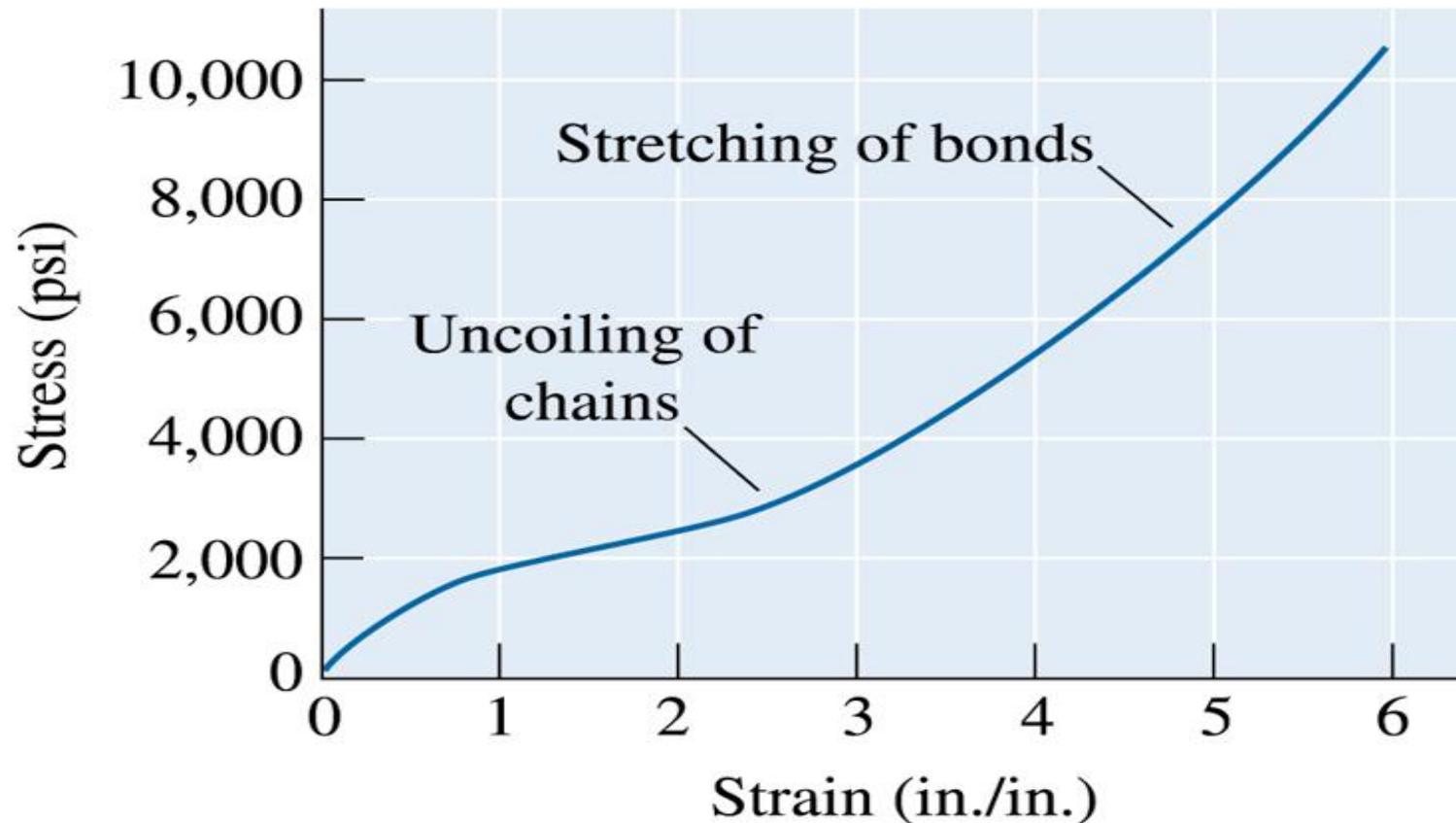


Deformação de Termoplástico (semicristalino)

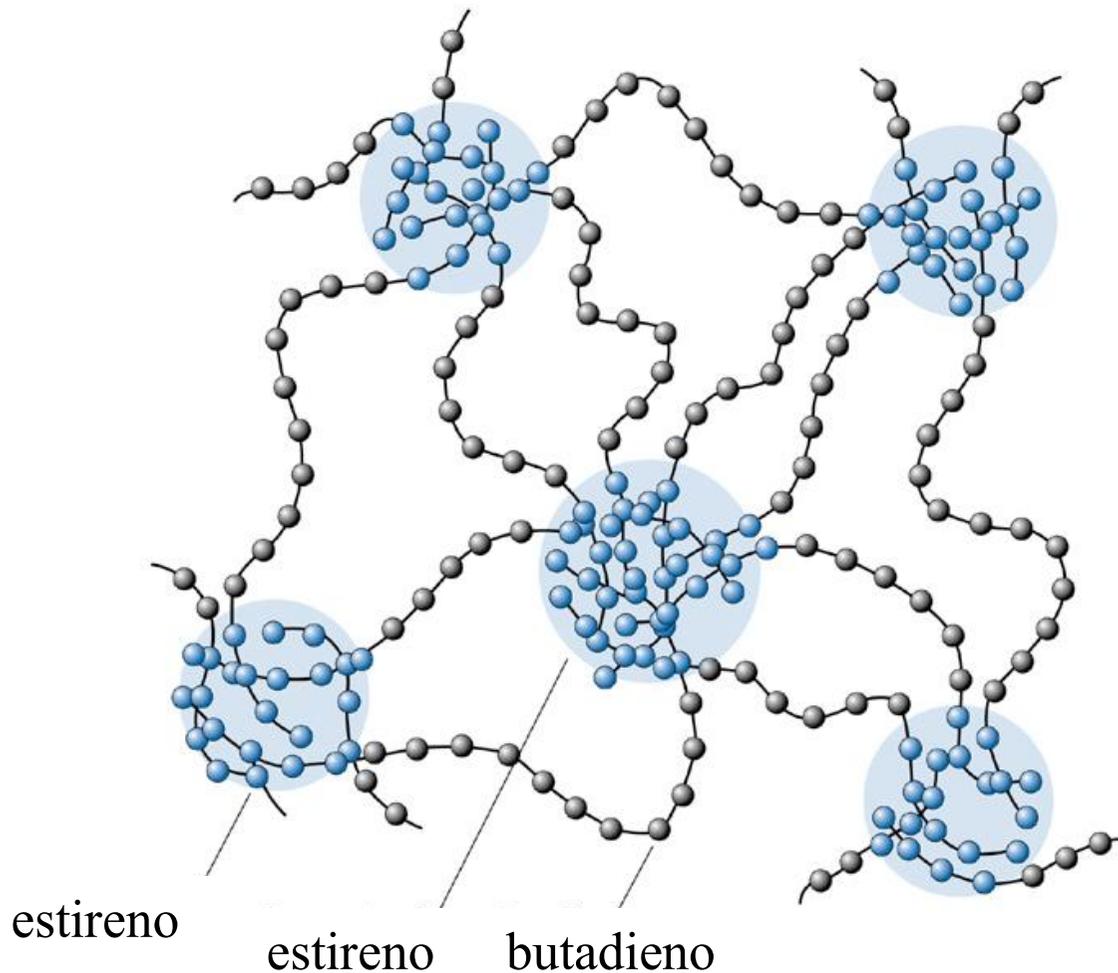


Comportamento Mecânico

■ Elastômero acima de T_g



Elastômero Termoplástico



Copolímero

Poli(estireno-butadieno-
estireno)

SBS