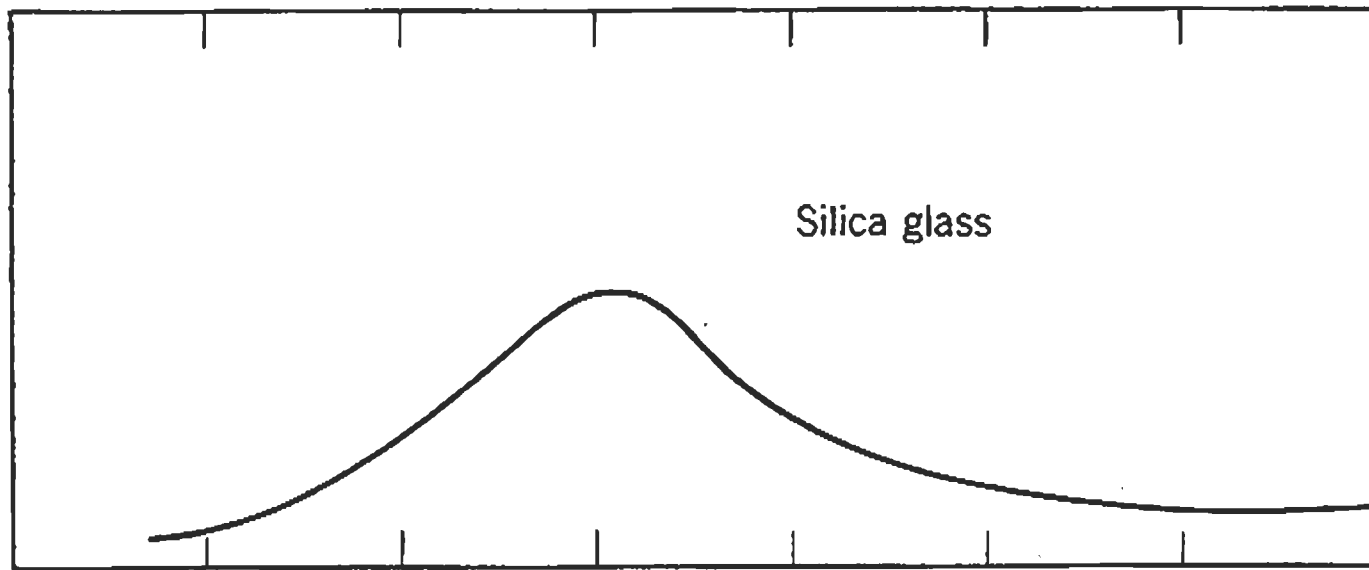
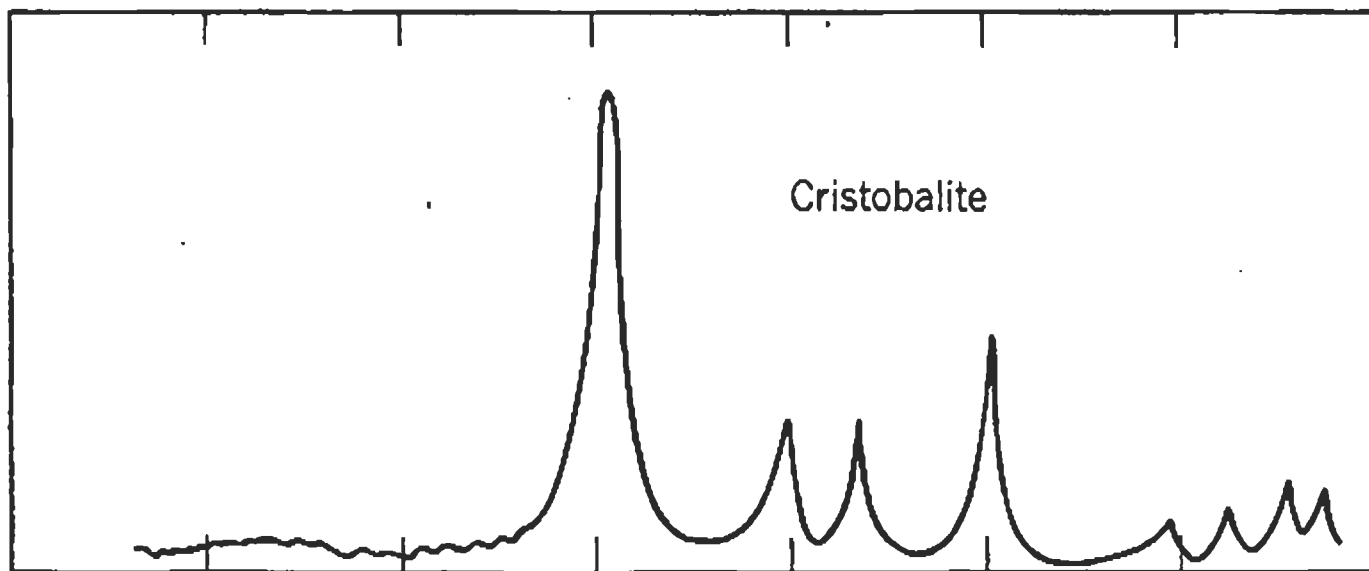


Welcome to 3.091

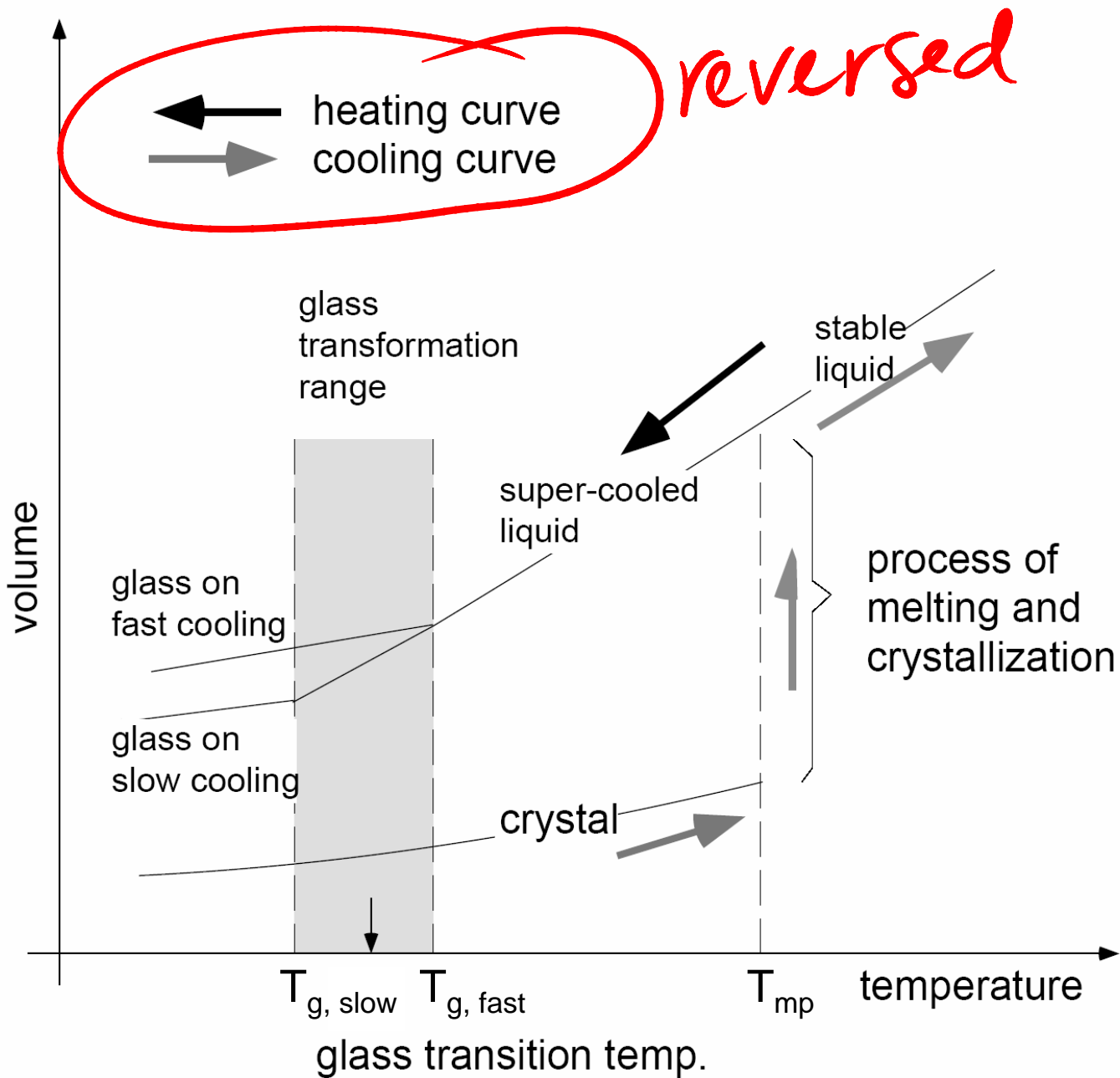
Lecture 21

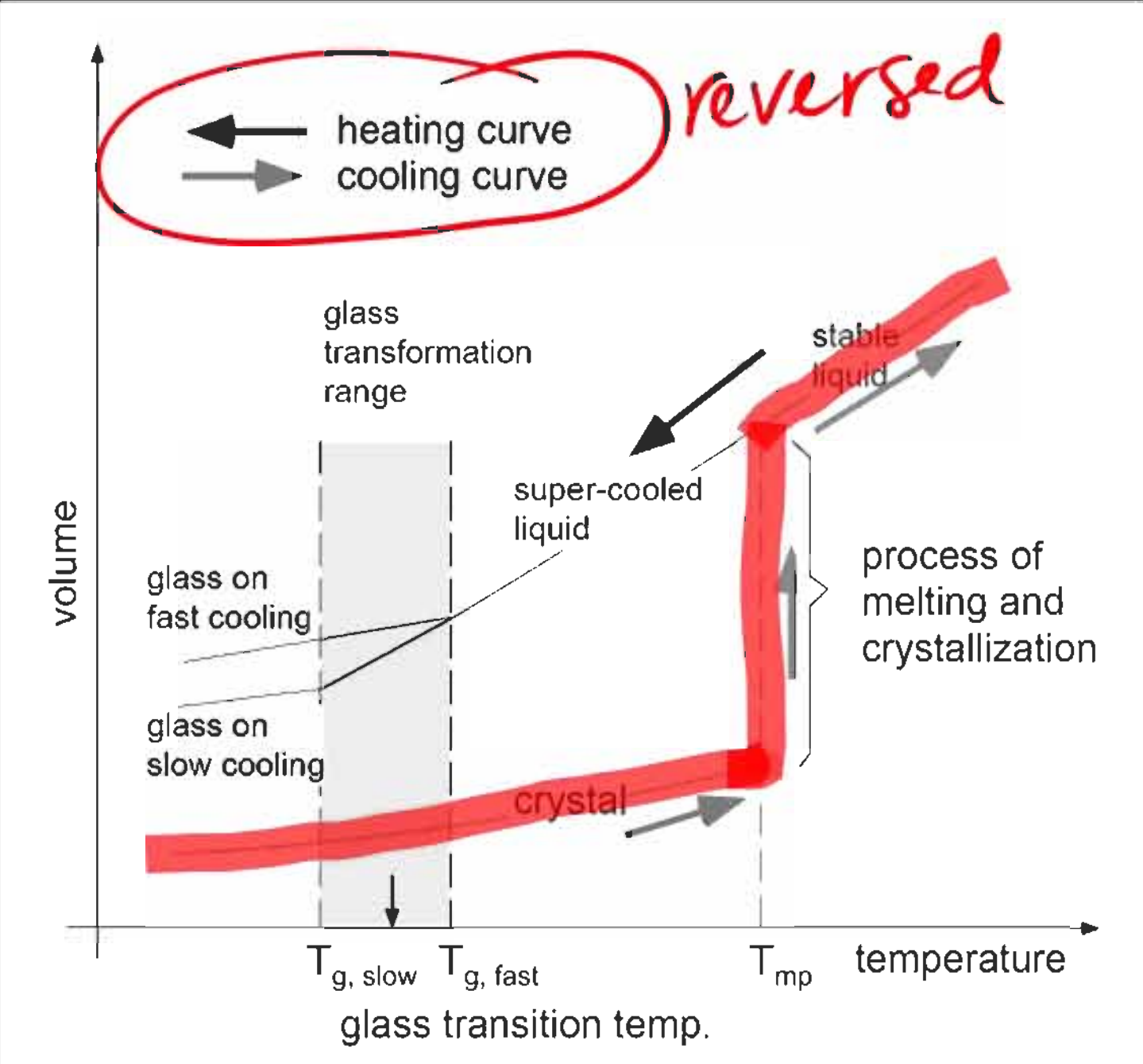
November 1, 2004

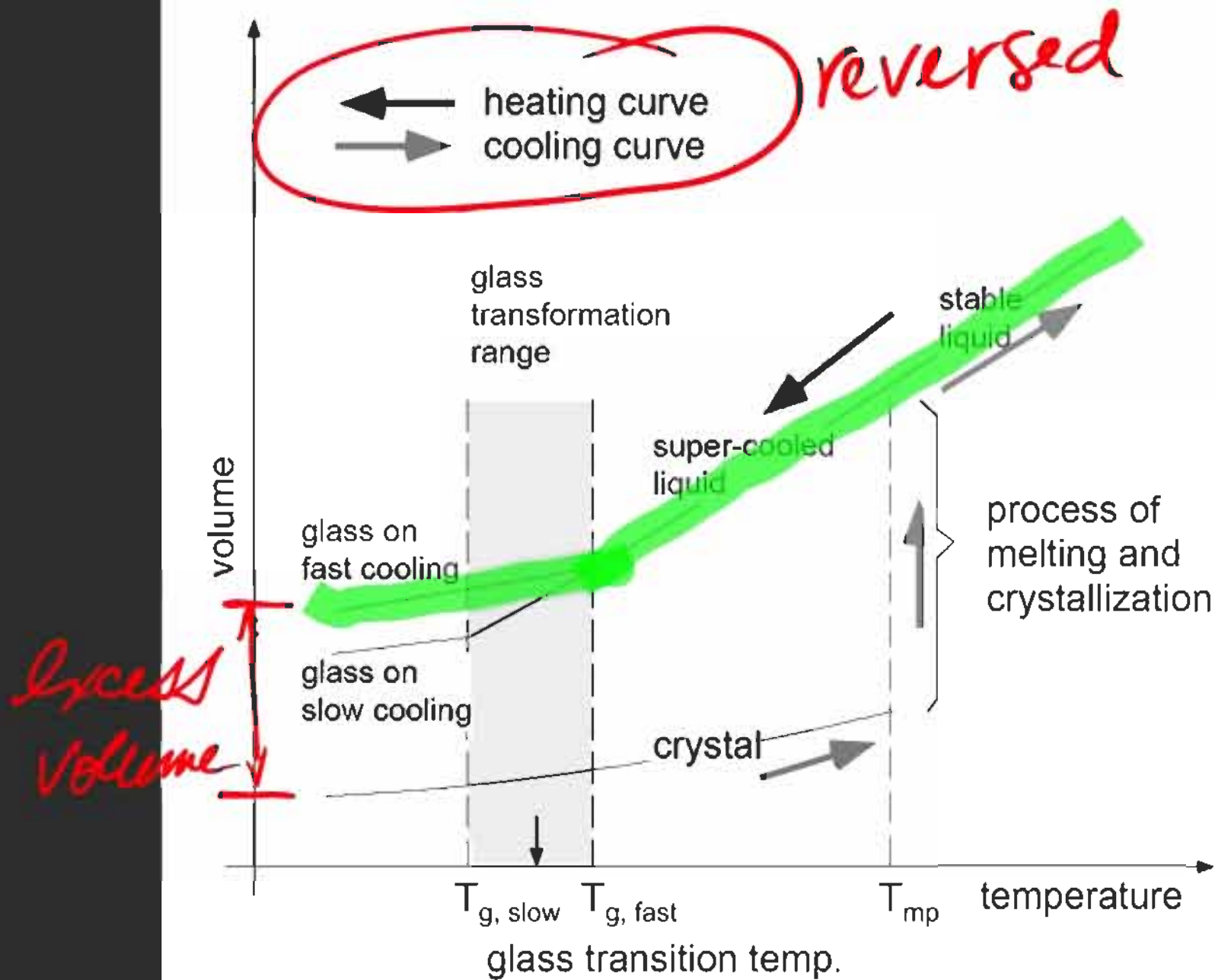


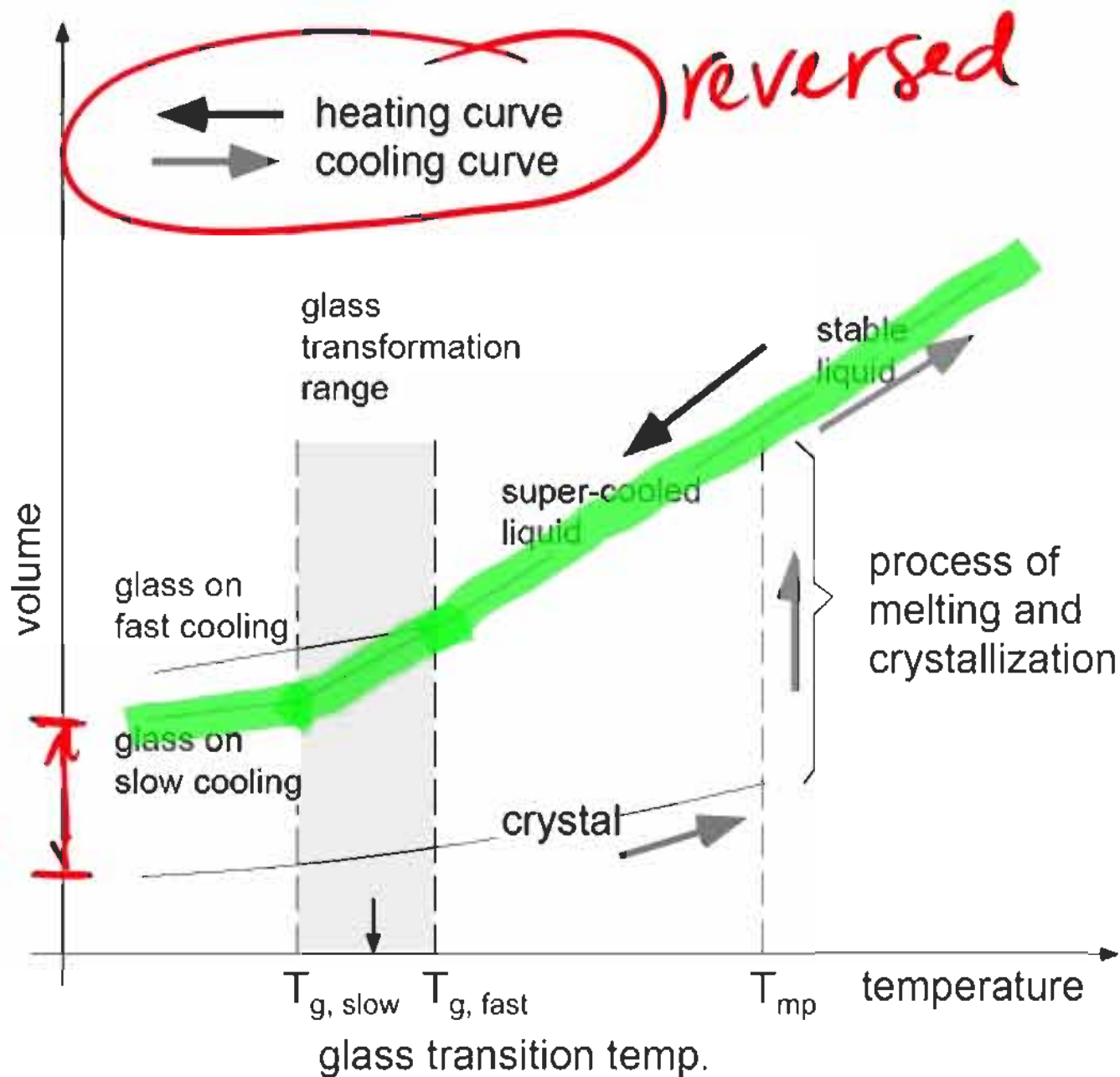
0 0.04 0.08 0.12 0.16 0.20 0.24 0.28

$\frac{\sin \theta}{\lambda} \rightarrow$

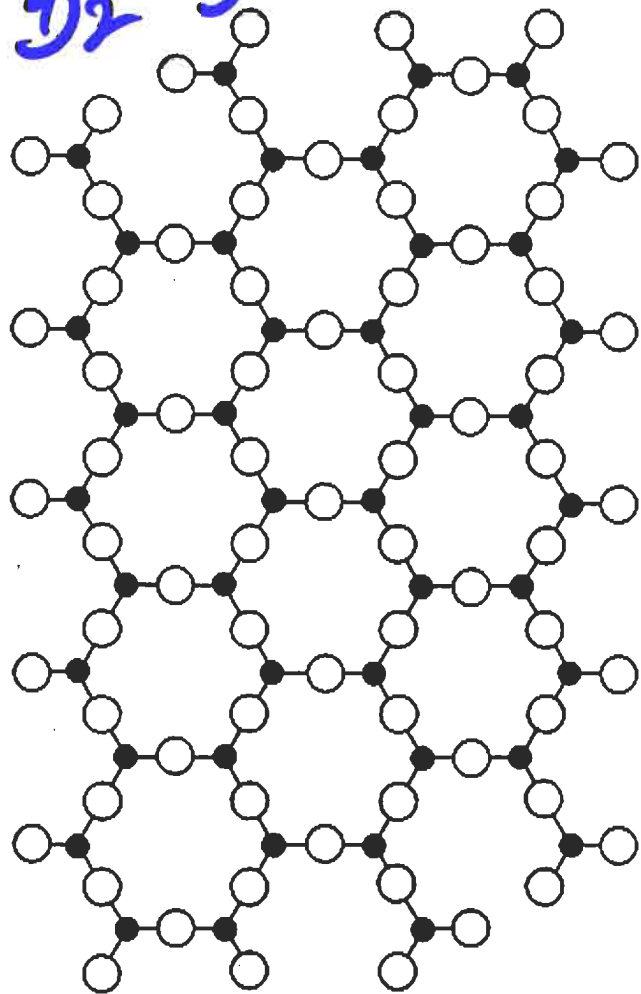




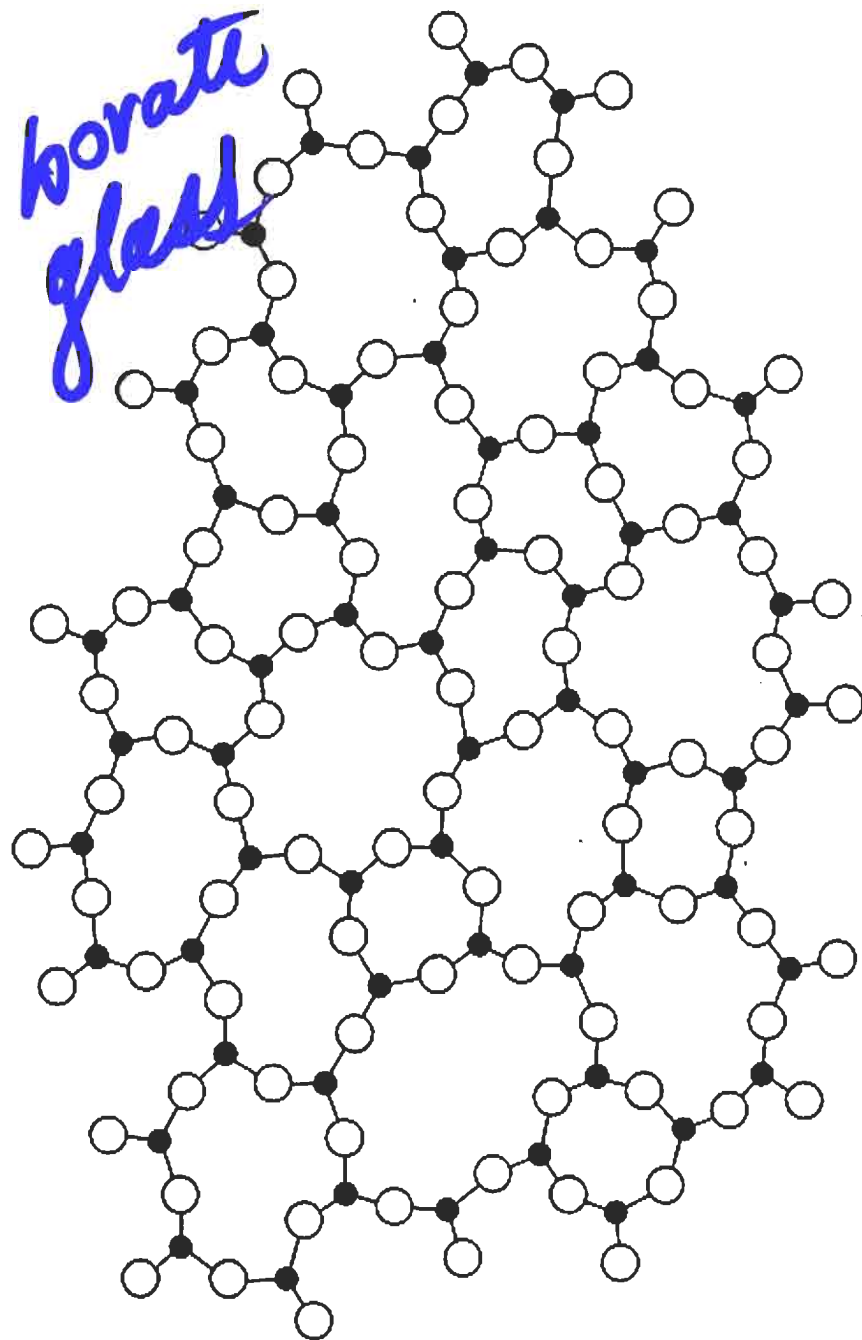




B_2O_3 (xtal)



borate
glass

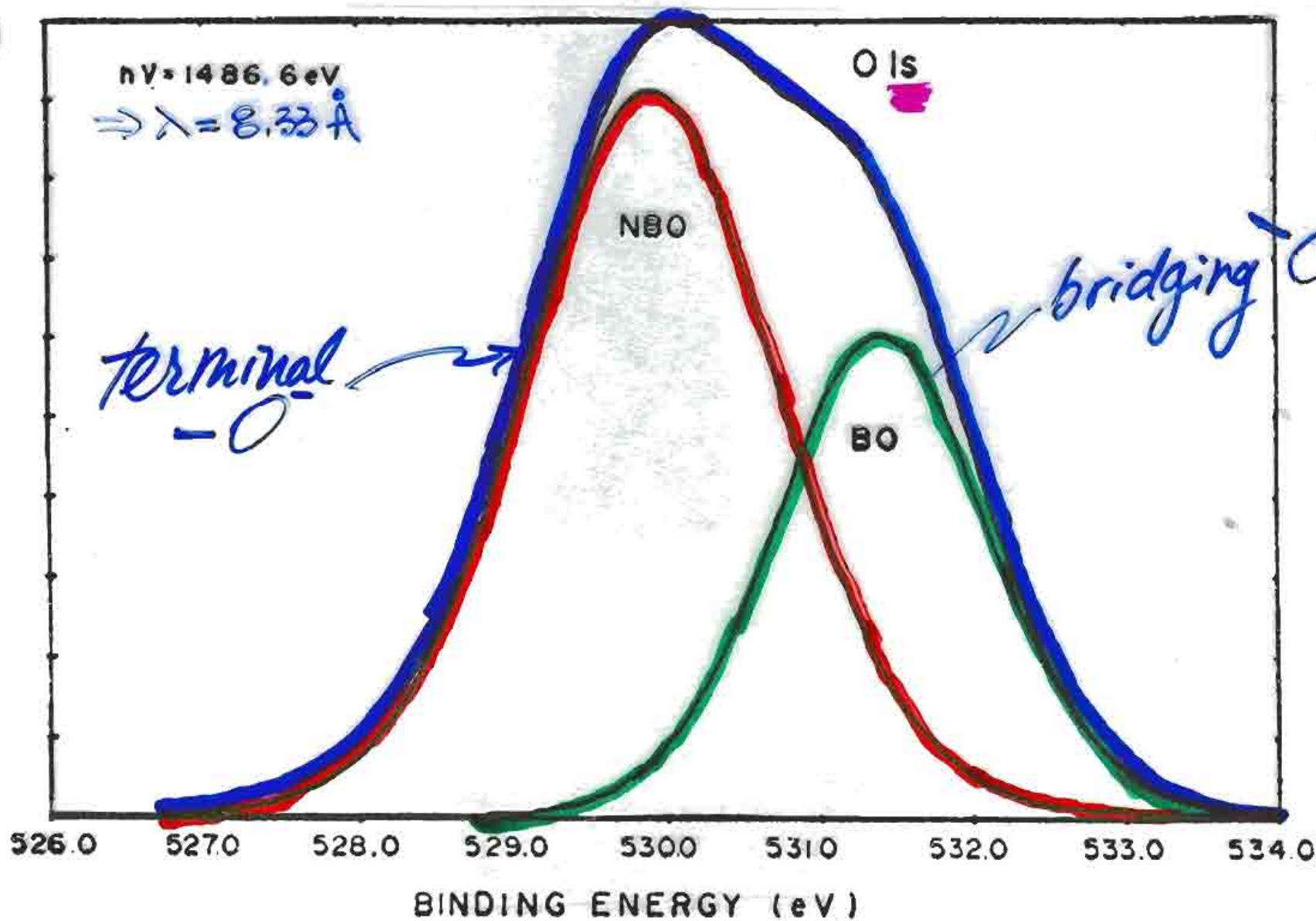


Properties of Oxide Glasses

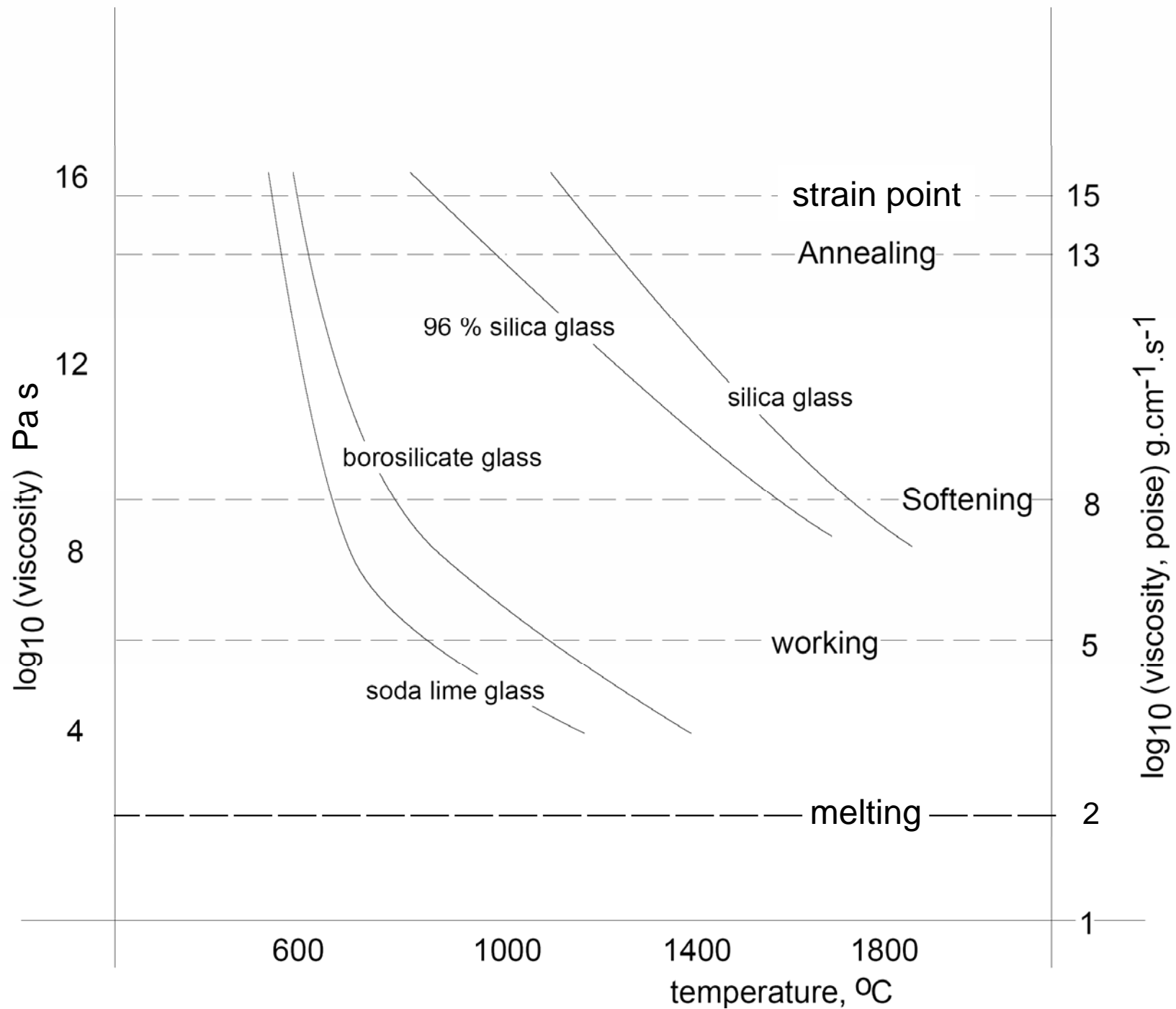
1. *chemically* inert
2. *electrically* insulating
3. *mechanically* brittle
4. *optically* transparent
5. *visually* arresting

(b)

INTENSITY (ARBITRARY UNITS)



Type	Composition, w/o								Properties or uses
	SiO ₂	Na ₂ O	K ₂ O	CaO	MgO	B ₂ O ₃	Al ₂ O ₃	Other	
Soda-lime	72	14		9	4		1		Window glass
Silica glass (fused quartz)	99.5+								High-temperature applications; low coefficient of expansion
96% silica glass	96.3	<0.2	<0.2			2.9	0.4		Comparable to fused quartz
Borosilicate	80.5	3.8	0.5			12.9	2.2		Resistant to heat and to chemicals
Light flint optical	54	1	8					37PbO	High index of refraction
Surface-strengthened glass	55	16	2	2		2	19	4TiO ₂	Cookware
Glass-ceramic	56				15		20	9TiO ₂	Radomes



working point: ($\eta \approx 10^5$ poise) temperature above which it is possible to *form* the glass, *i.e.*, press, draw, shape

softening point: ($\eta \approx 10^8$ poise) temperature above which glass *flows under its own weight*

annealing point: ($\eta \approx 10^{13}$ poise) temperature above which *residual stresses can be relieved within 15 min*

strain point: ($\eta \approx 10^{15}$ poise) temperature below which glass can be *rapidly cooled* without introducing internal stresses capable of fracture

1 Pa s = 10 poise; $\eta_{\text{water}} \approx 10^{-2}$ poise

Recrystallized Glass or Glass Ceramics

- 1950s at Corning by S.D. Stookey
- add nucleating agents to glass melt
- via heat treatment, homogeneous amorphous phase is transformed into mixed crystalline / amorphous polyphase material

☞ a crystalline / glassy composite!

$\text{Li}_2\text{O} - \text{Al}_2\text{O}_3 - \text{SiO}_2$ is the basic chemistry

Pyroceram™: TiO_2 nucleating agents produce crystals
 $\approx 1 \mu\text{m}$ in diameter, large enough to scatter light:
☞ white (porcelain china)

Image removed due to copyright concerns.

Visions™: TiO_2 and ZrO_2 nucleating agents produce submicron-size crystals index-matched with residual glass; \therefore no interface, \therefore transparent

now tinted by addition of CoO & Cr_2O_3

☞ upscale differentiation from Pyrex™

- both are transparent to IR ☞ more efficient cooking

Image removed due to copyright concerns.