

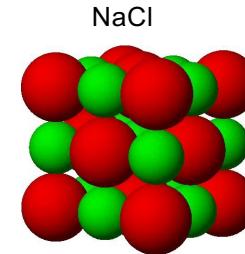
Lecture 12

M 19.08.2025

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Where is the sodium chloride molecule?



cae2k.com

NaCl structure = FCC lattice + 2 atom motif: $\text{Cl}^- \text{O} \text{O}$
 $\text{Na}^{\frac{1}{2}} \text{O} \text{O}$

Examples:
 $\text{NaCl}, \text{KCl}, \text{TiC}, \text{MgO}, \text{PbS}$

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The Structure of Silicates.¹

By Prof. W. L. BRAGG, F.R.S.

¹*NATURE*

[SEPTEMBER 17, 1927]

chemical attempts to give a formula to many of the silicates. Some of the very earliest structures which were analysed caused us to revise our ideas of what was meant by the 'molecule' of the chemist. In sodium chloride there appear to be no molecules represented by NaCl . The equality in numbers of sodium and chlorine atoms is arrived at by a chess-board pattern of these atoms; it is a result of geometry and not of a pairing-off of the atoms.

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Poor Common Salt!

NATURE
 [OCTOBER 1, 1927]

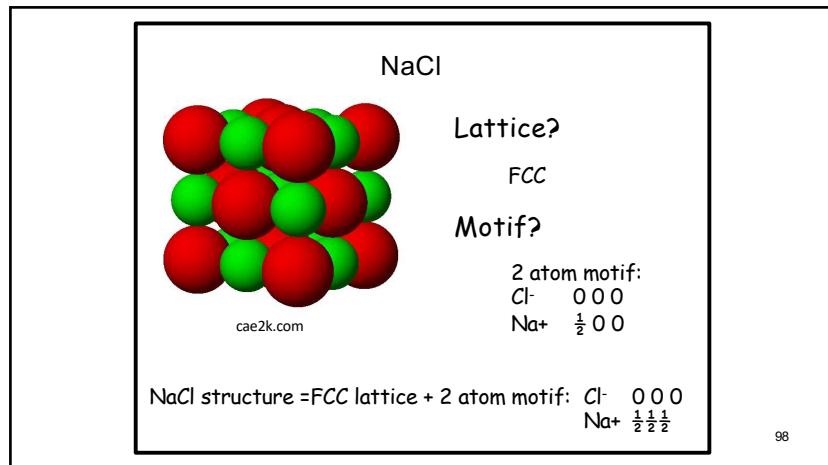
"SOME books are lies from end to end," says Burns. Scientific (save the mark) speculation would seem to be on the way to this state! Thus on p. 405 of *NATURE*, of Sept. 17, in a letter on Prof. Lewis's light corpuscles, the statement is made by the writer, that a 'speculation,' by Prof. Lewis, about the quantum, "is repugnant to common sense." Again, on p. 414, Prof. W. L. Bragg asserts that "In sodium chloride there appear to be no molecules represented by NaCl . The equality in number of sodium and chlorine atoms is arrived at by a chess-board pattern of these atoms; it is a result of geometry and not of a pairing-off of the atoms."

This statement is more than "repugnant to common sense." It is absurd to the nth degree, not chemical cricket. Chemistry is neither chess nor geometry, whatever X-ray physics may be. Such unjustified aspersion of the molecular character of our most necessary condiment must not be allowed any longer to pass unchallenged. A little study of the Apostle Paul may be recommended to Prof. Bragg, a necessary preliminary even to X-ray work, especially as the doctrine has been insistently advocated at the recent Flat Races at Leeds, that science is the pursuit of truth. It were time that chemists took charge of chemistry once more and protected neophytes against the worship of false gods; at least taught them to ask for something more than chess-board evidence.

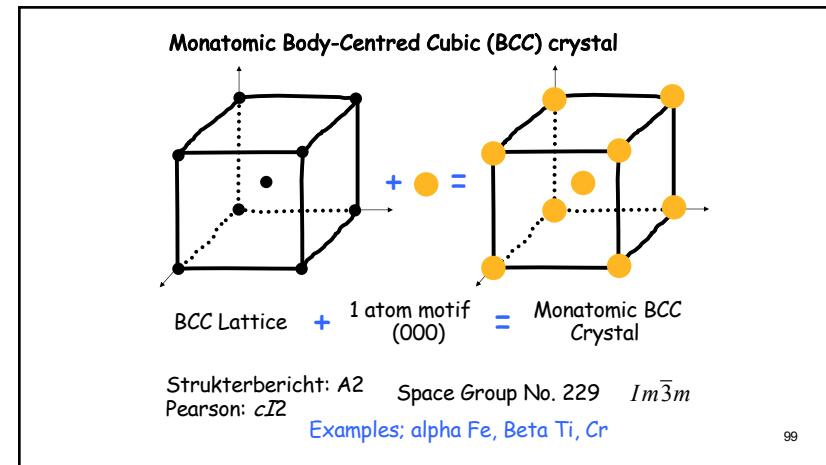
HENRY E. ARMSTRONG.

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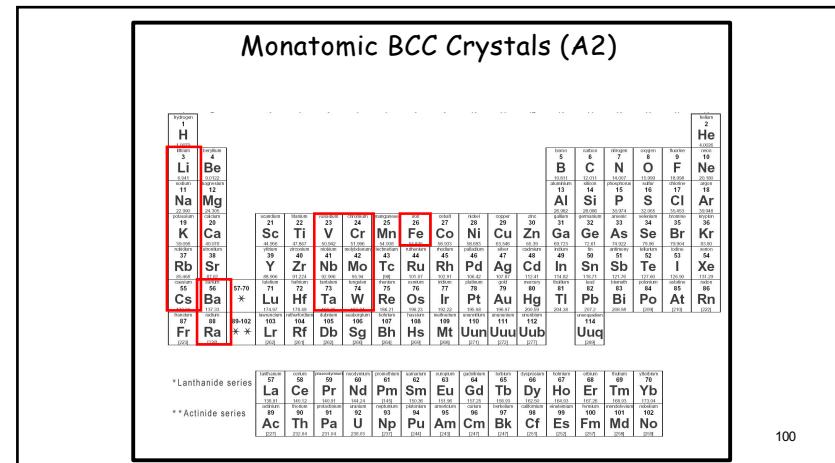
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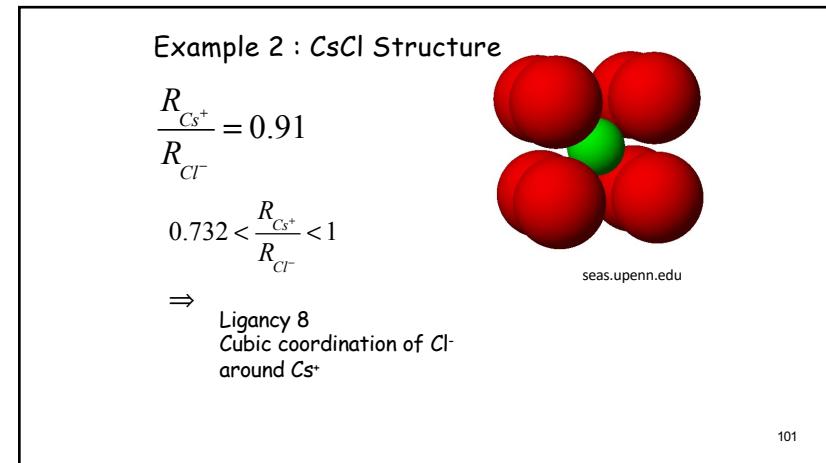
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Example 2 : CsCl Structure

Lattice?

SC or Cubic P

Motif?

2 atom motif:
 $\text{Cl}^- \quad 0 \ 0 \ 0$
 $\text{Cs}^+ \quad \frac{1}{2} \ \frac{1}{2} \ \frac{1}{2}$

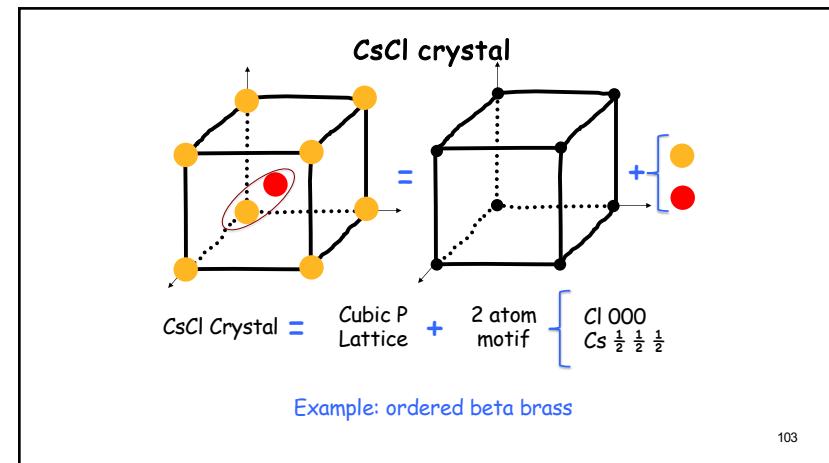
~~BCC~~

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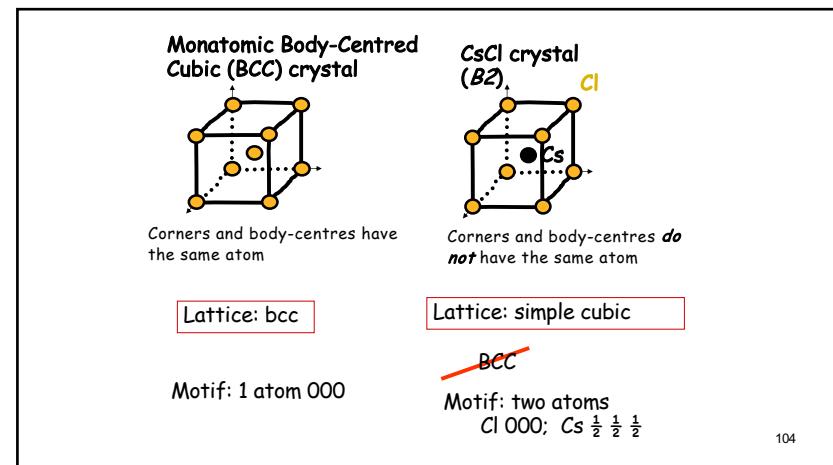
$\text{CsCl structure} = \text{SC lattice} + 2 \text{ atom motif: } \begin{cases} \text{Cl} & 0 \ 0 \ 0 \\ \text{Cs} & \frac{1}{2} \ \frac{1}{2} \ \frac{1}{2} \end{cases}$

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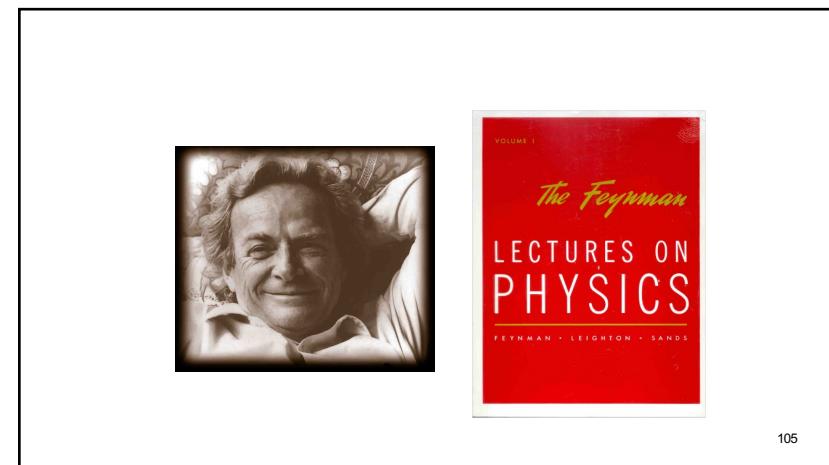
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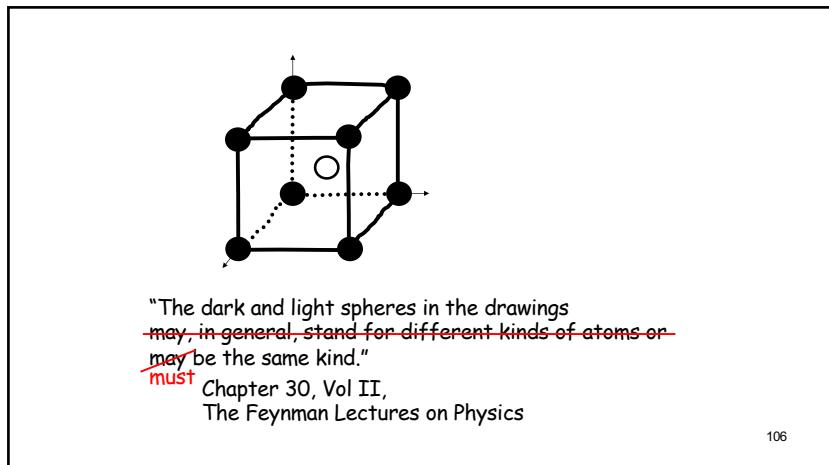
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GENERAL ARTICLE

Errors in *The Feynman Lectures on Physics*

Symmetry and Crystals

Rajesh Prasad

We discuss some errors in *The Feynman Lectures on Physics* related to the concept of symmetry. We also suggest a possible correction to Fig.1.4 of Vol. I. The discussion may be useful for students of crystallography, solid state physics and solid state chemistry.



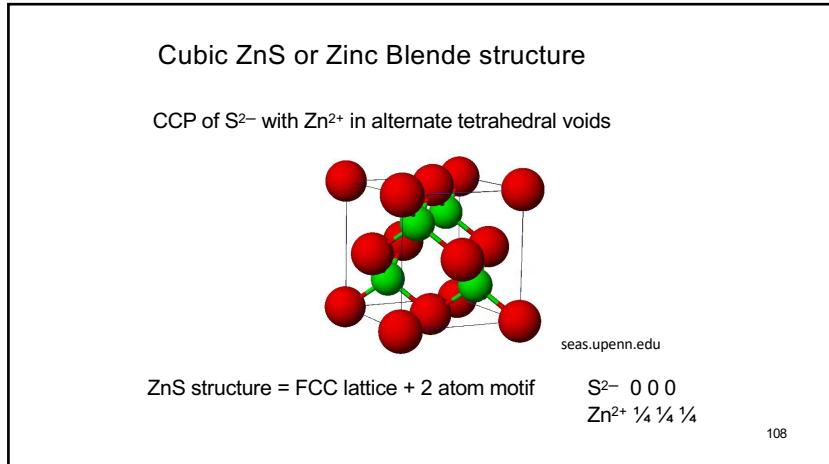
Rajesh Prasad teaches

RESONANCE | May 2016

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What is common to
1. glass of the window
2. sand of the beach, and
3. quartz of the watch?

 A small circular inset image showing a landscape through a window, divided into four quadrants by a grid.


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Structure of SiO_2
Bond is 50% ionic and 50 % covalent

$$\frac{R_{\text{Si}^{4+}}}{R_{\text{O}^{2-}}} = 0.29$$

$$0.225 < 0.29 < .414$$

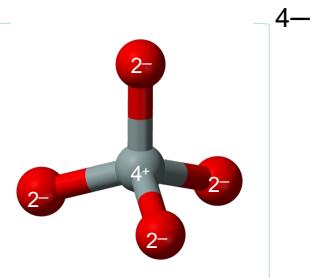
⇒ Tetrahedral coordination of O^{2-} around Si^{4+}

 A 3D ball-and-stick model of a silicate tetrahedron, showing a central grey silicon atom (Si) bonded to four red oxygen atoms (O). The model is labeled "Silicate tetrahedron".

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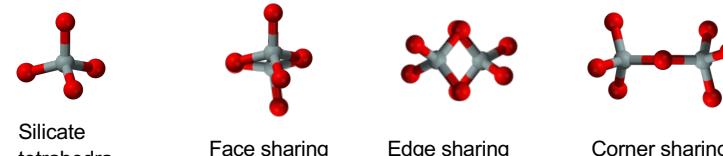
Silicate tetrahedron electrically unbalanced



O²⁻ need to be shared between two tetrahedra

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3D Network of Silicate tetrahedra



Silicate tetrahedra

Face sharing

Edge sharing

Corner sharing

1. O²⁻ need to be shared between two tetrahedra.

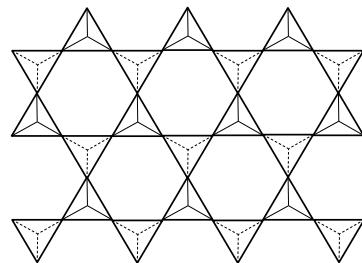
2. Si⁴⁺ need to be as far apart as possible

Silicate tetrahedra share corners

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Crystalline silica (Quartz): 3D Periodic arrangement of silicate tetrahedra

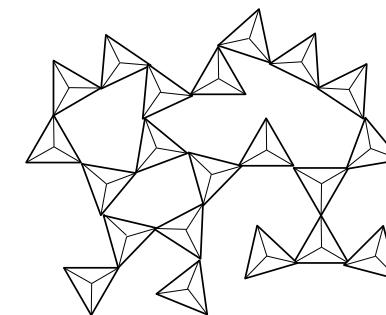
2D representation of 3D periodically repeating pattern of tetrahedra in crystalline SiO₂. Note that alternate tetrahedra are inverted



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Amorphous silica (Fused silica glass): 3D Random arrangement of silicate tetrahedra

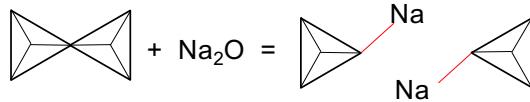
2 D representation of 3D random network of silicate tetrahedra in the fused silica glass



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Network Modification of Silica Glass by addition of Soda to produce soda-lime glass



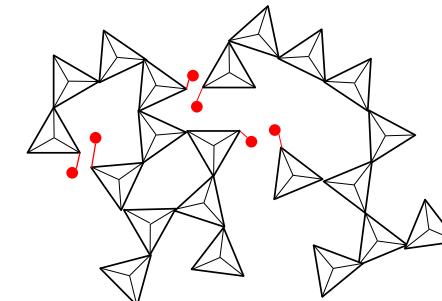
Modification leads to breaking of primary bonds between silicate tetrahedra.

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Network breaking in soda-lime glass

2 D representation of 3D random network of silicate tetrahedra in the soda-lime silica glass

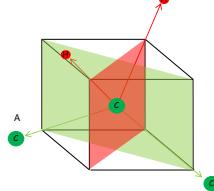
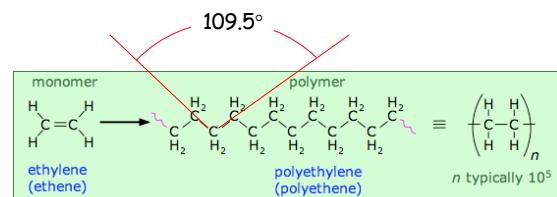


Network breaking:
lower softening
temperature, easier
workability, cheaper

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5.7 Structure of Long Chain Polymers

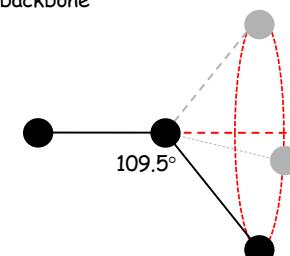


Degree of Polymerization:
No. of repeating monomers in a chain

120

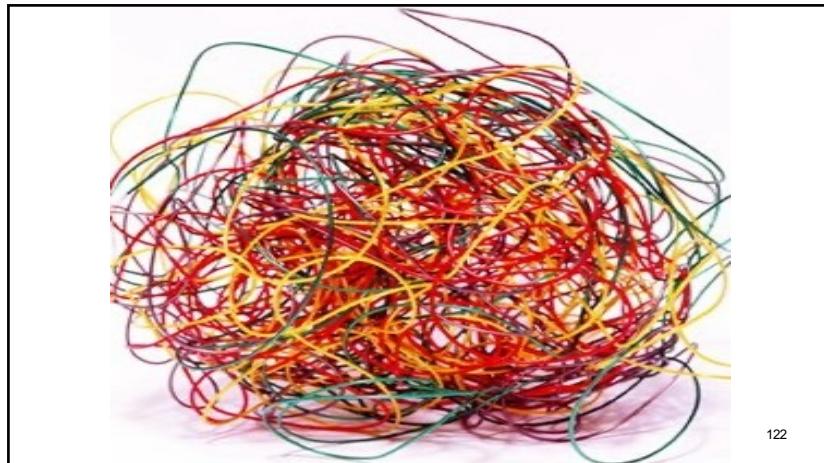
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Freedom of rotation about each bond in space leads to different conformations of C-C backbone

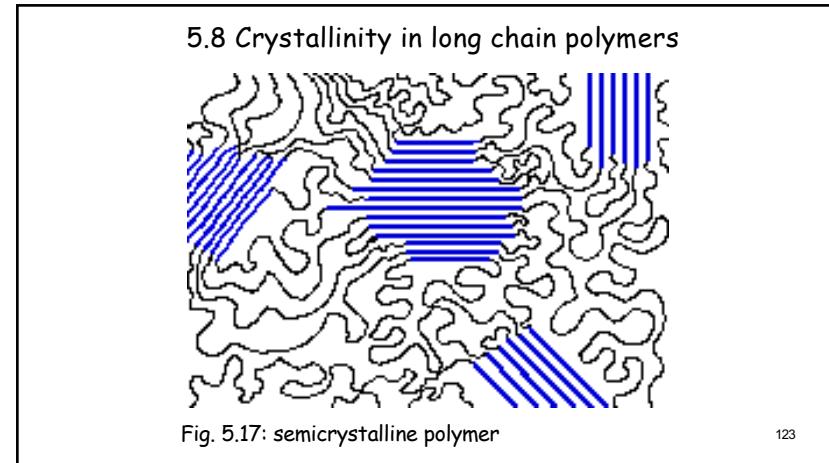


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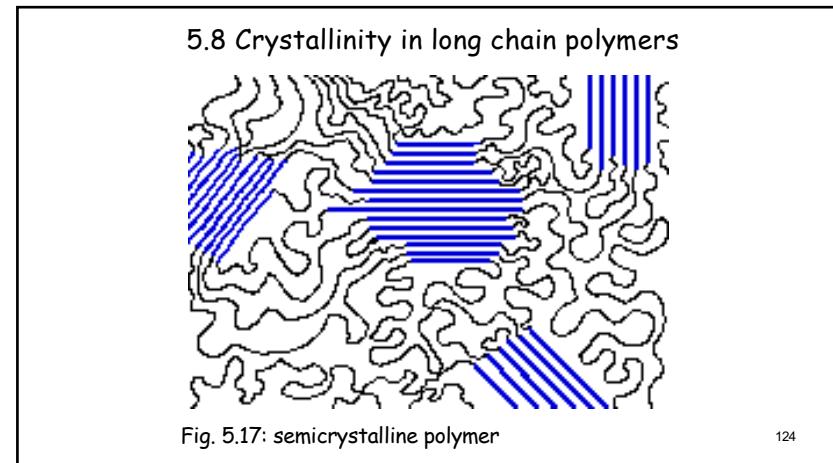
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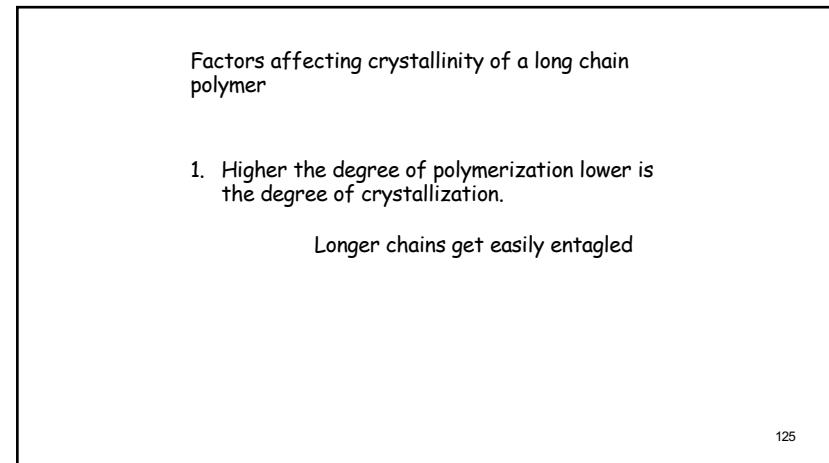
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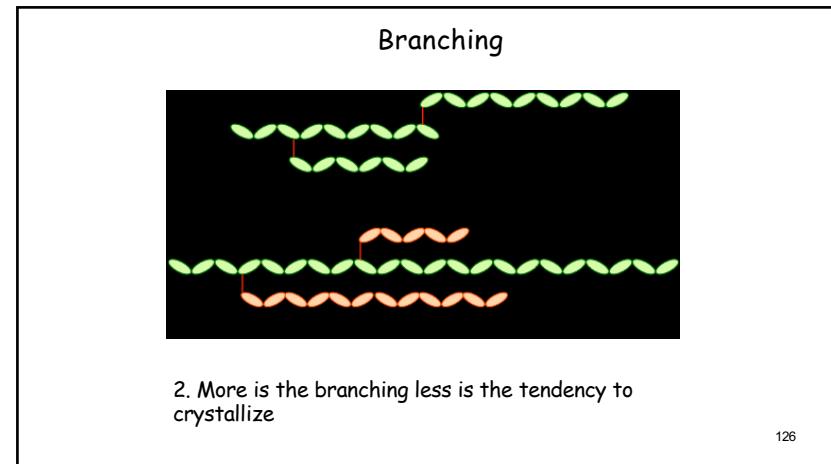
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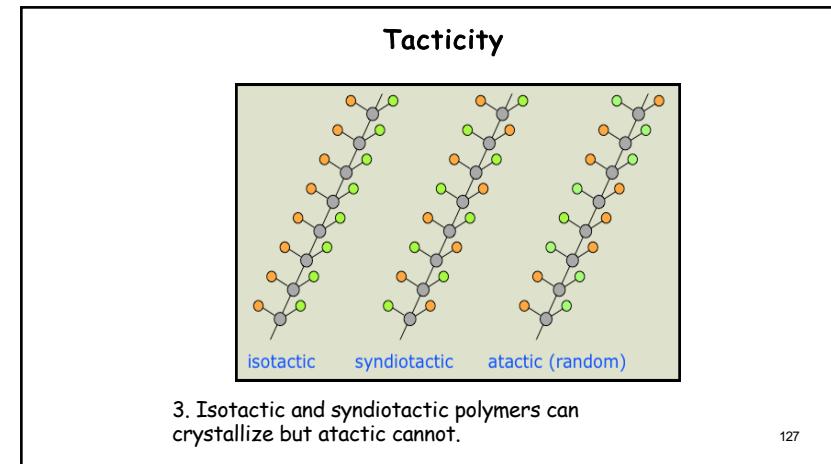
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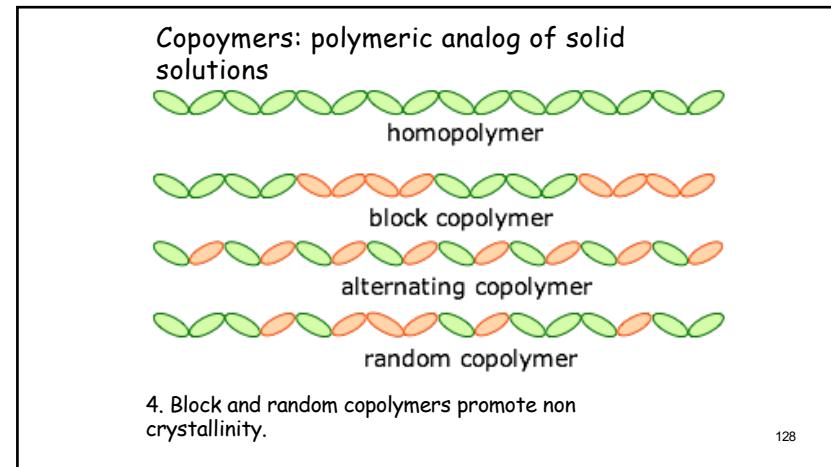
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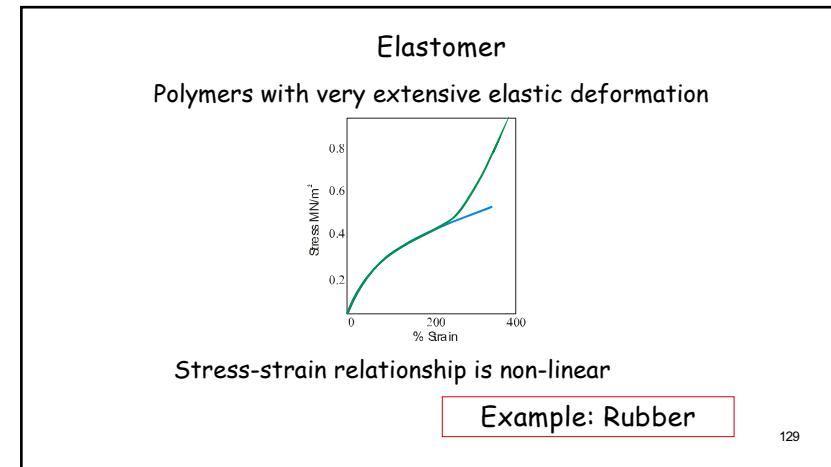
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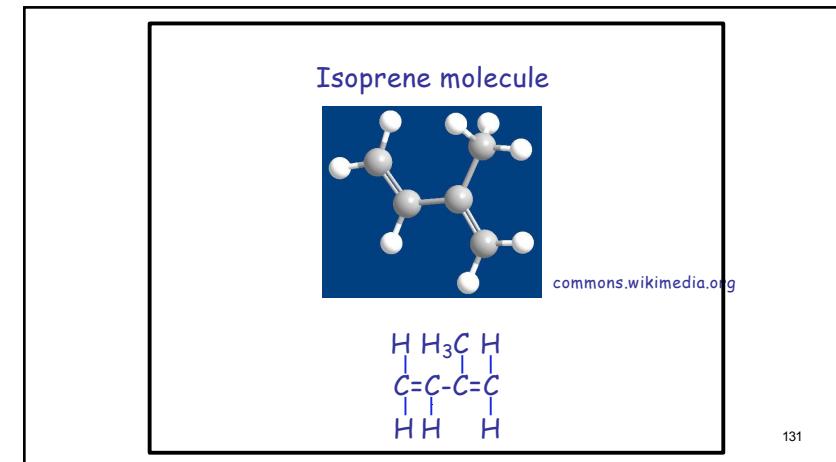
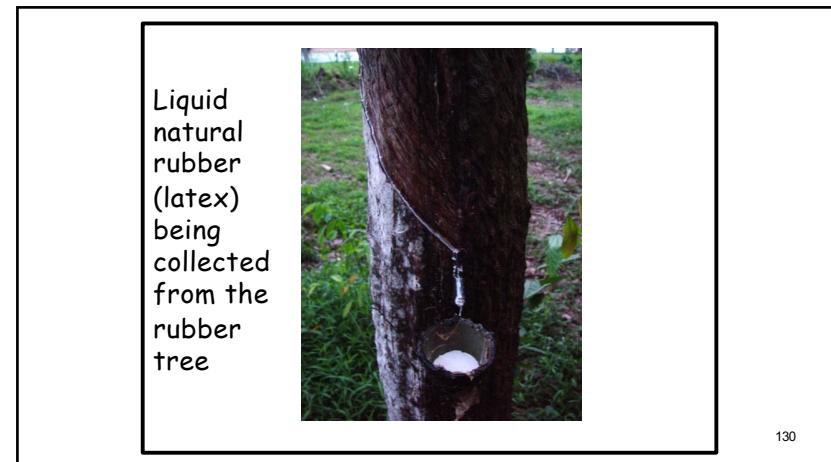
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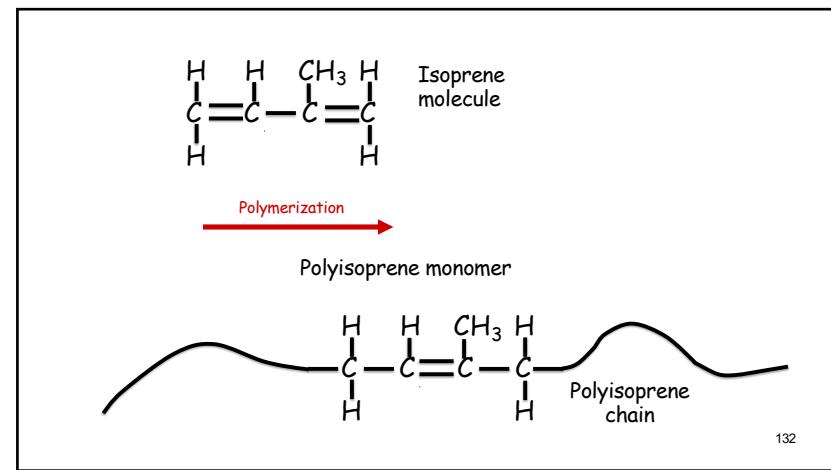


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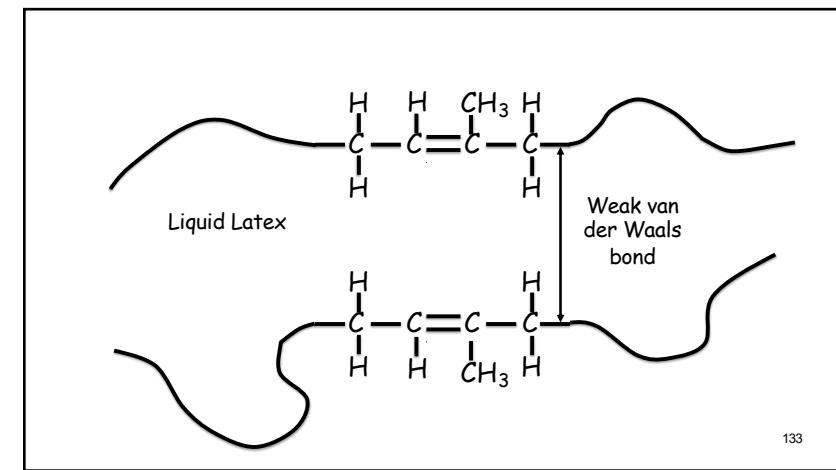


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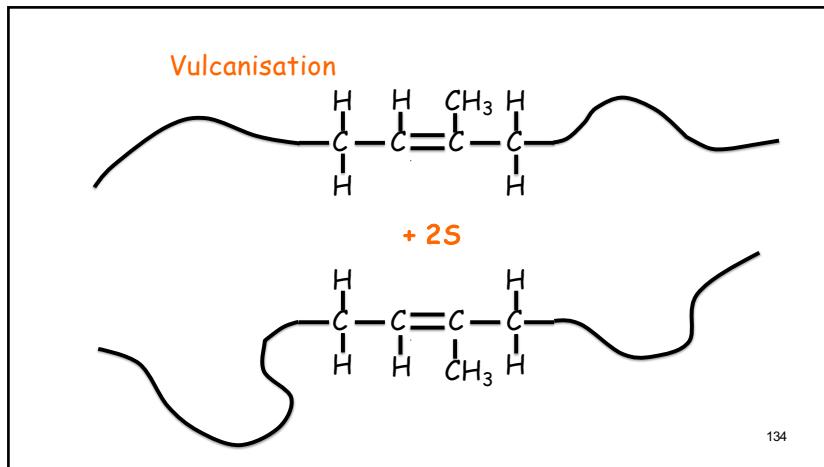
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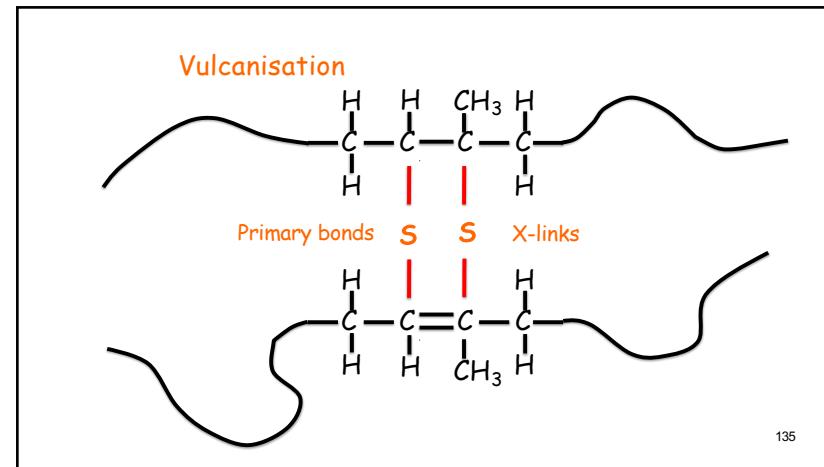
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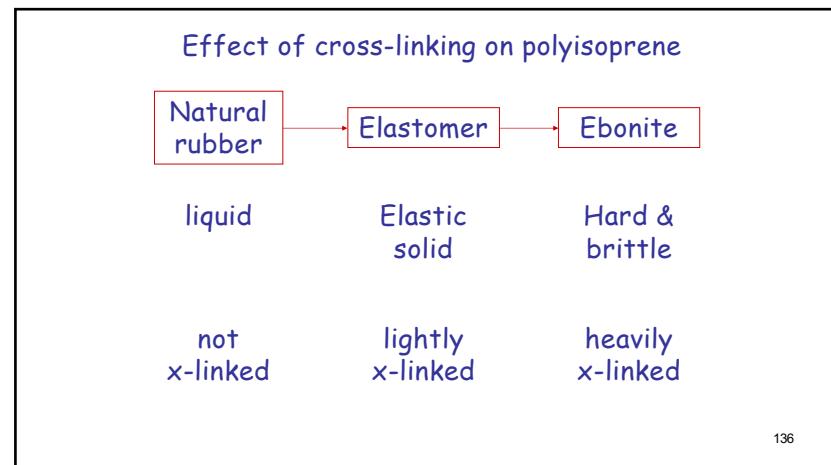
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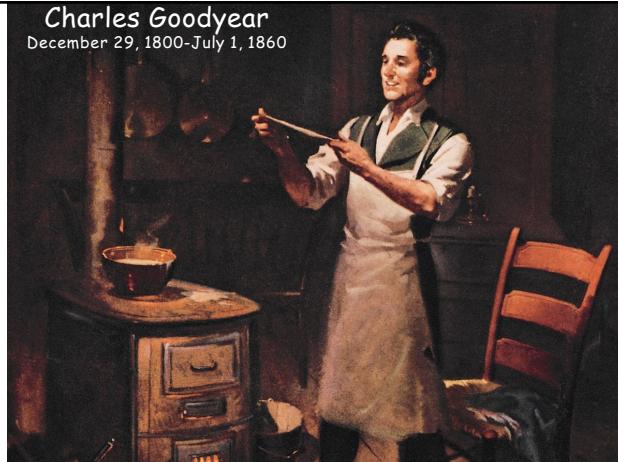


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Charles Goodyear
December 29, 1800-July 1, 1860



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Returning to Philadelphia, Goodyear was clapped into jail for debt.

It was not his first sojourn there, nor his last.

He asked his wife to bring him a batch of raw rubber and her rolling pin. Here, in his cell, Goodyear made his first rubber experiments, kneading and working the gum hour after hour.

<https://corporate.goodyear.com>

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<https://corporate.goodyear.com>

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That spring he went to Boston to look up friends, found none, was jailed for nonpayment of a \$5 hotel bill, and came home to find his infant son dead. Unable to pay for a funeral, Goodyear hauled the little coffin to the graveyard in a borrowed wagon. Of the 12 Goodyear children, six died in infancy.

<https://corporate.goodyear.com>

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After five futile years, Goodyear was near rock bottom. Farmers around Woburn, Mass., where he now lived, gave his children milk and let them dig half-grown potatoes for food.

<https://corporate.goodyear.com>

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He wanted to make everything of rubber: banknotes, musical instruments, flags, jewelry, ship sails, even ships themselves. He had his portrait painted on rubber, his calling cards engraved on it, his autobiography printed on and bound in it. He wore rubber hats, vests, ties.

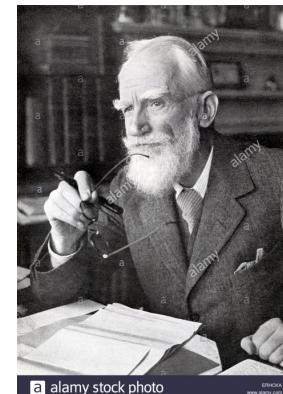
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"The reasonable man adapts himself to the world:
the unreasonable one persists in trying to adapt the world to himself.
Therefore

all progress depends on the unreasonable man."

— George Bernard Shaw,
Man and Superman



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