ELASTOMERS

Gayathri & Yamuna

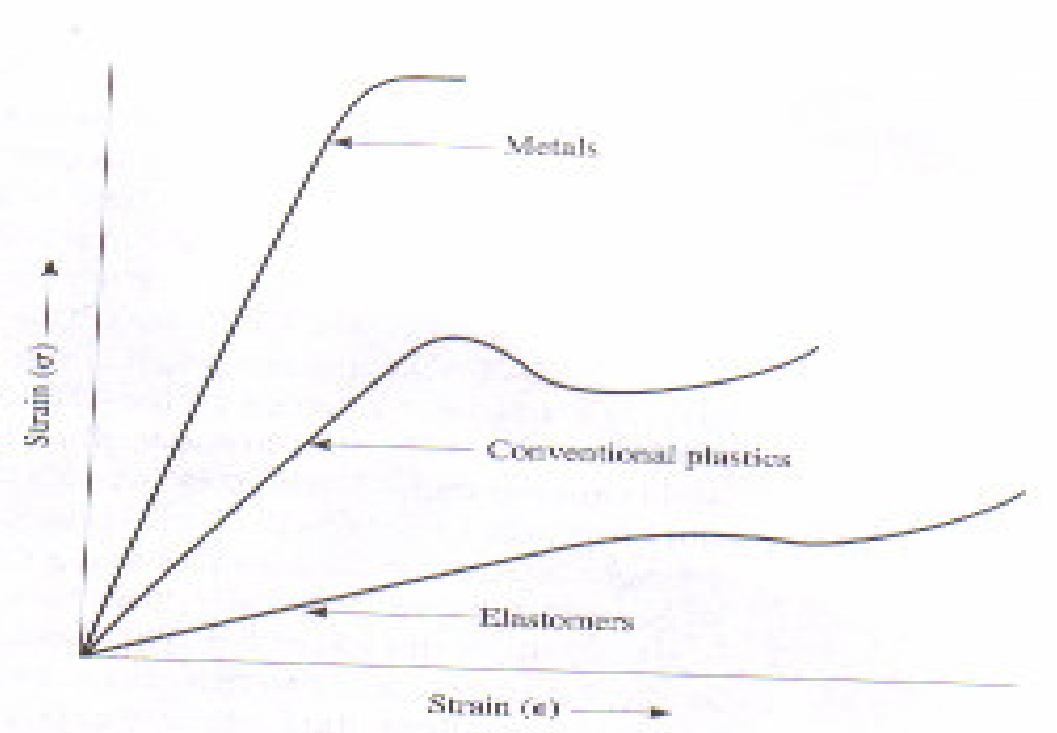
Topic

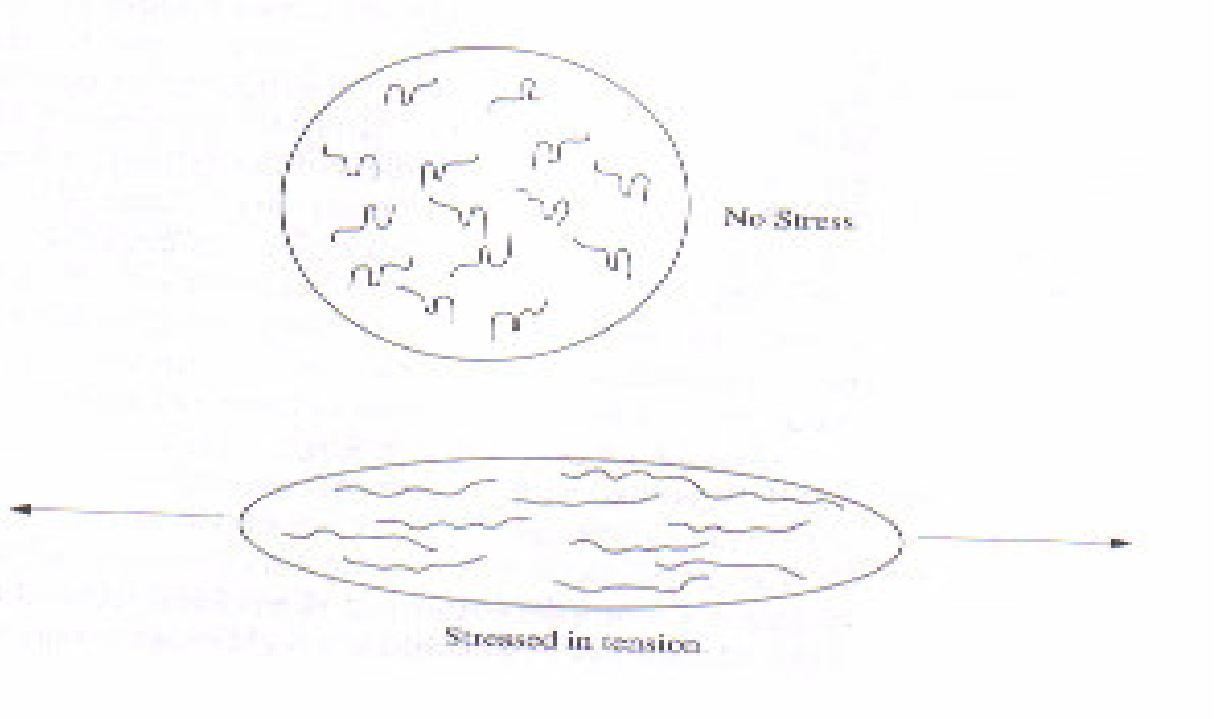
- Elastomers and their properties
- Rubber
- Vulcanisation
- Synthetic Rubbers
- Applications

Elastomeric Materials

- All materials have some elastic elongation
- "elastic elongation = extent of stretching of any material when that material is at its yield point"
- Ceramic & metal- small elastic elongation about 2%
- PE- elastic elongation is upto 50%

Elongation / Elasticity





Elastomers can stretch upto 200%

Common characteristics

- Large elastic elongation
- Can be stretched and then immediately return to their original length when the load is released
- Elastomers are sometimes called rubber or rubbery materials
- The term **elastomer** is often used interchangeably with the term rubber

Types of Elastomers

- Two types – Thermoplastics (TPE) and Thermosets (TSE)
- TP elastomers -

1.styrenic block copolymers

2.polyolefin blends

- TS elastomers –

1. vulcanised rubber

Rubber

Natural

- Hevea rubber (cis isoprene)
- Gutta percha (trans isoprene)

Synthetic

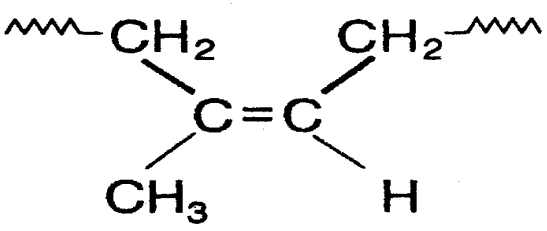
Butyl rubber (BR)

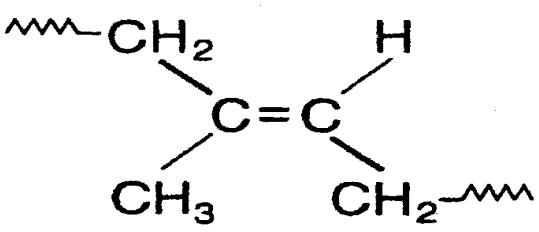
Styrene Butadiene Rubber (SBR)

Natural Rubber

Principal source : Hevea Braziliensis
(Malaysia , Indonesia Brazil etc.,)

Crude rubber is cis- isoprene





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Manufacture

Steps involved

- latex tapped and filtered
- Filtered latex is coagulated (AcOH)
- Soaked and washed (water)
- Dried (air / smoke)
- rolled into sheets

Properties

- Natural rubber is highly elastomeric (elongation 1000% for vulcanized natural rubber)
- Compared to other elastomeric materials, natural rubber shows higher tensile strength, high tear strength, high resilience (regain original shape), resistance to wear, etc
- application temperature: -50 **to** + 80°C

Vulcanisation

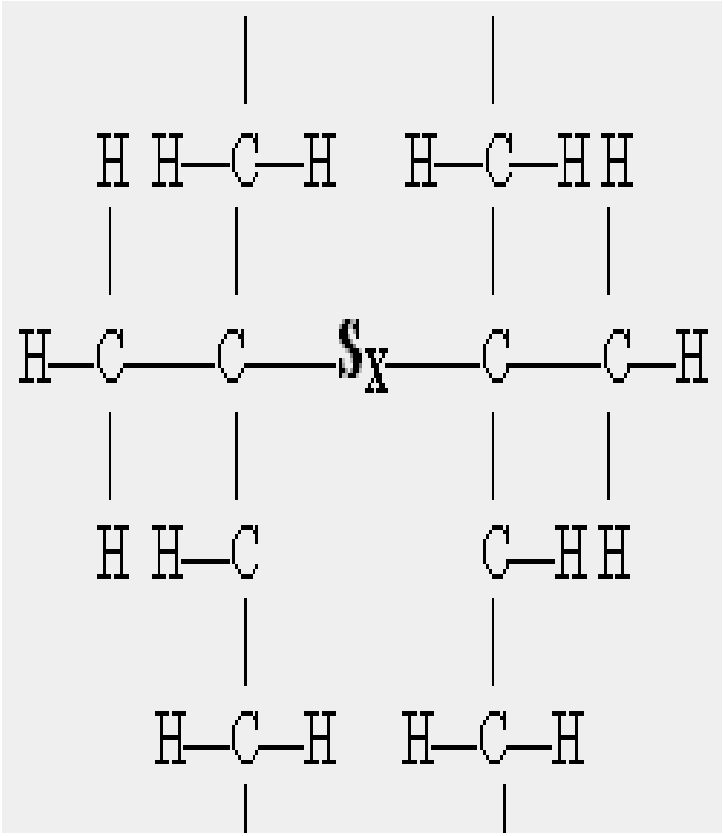
- Uncured natural rubber is sticky
- It can be easily deformed on warming
- It is brittle when cold.

In this state it cannot be used to make articles with a good level of elasticity

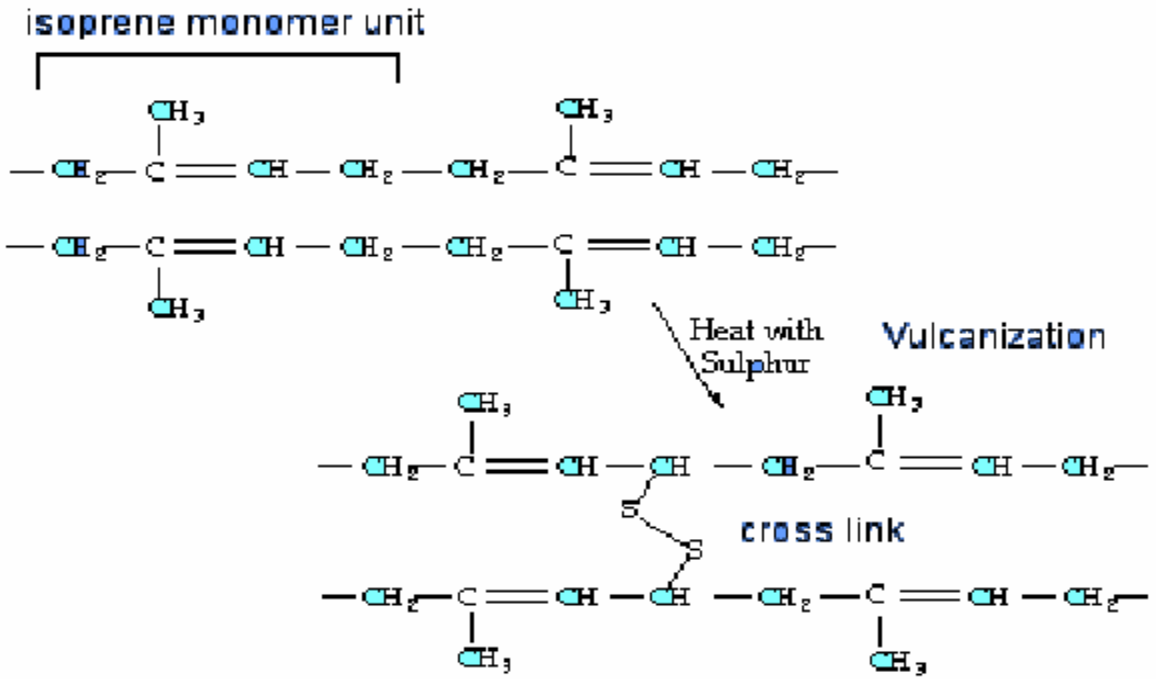
Hence to increase strength it has to be vulcanised

- cooking the crude natural rubber with sulphur is called vulcanization

- Vulcanization creates cross linking between rubber molecules



Vulcanisation



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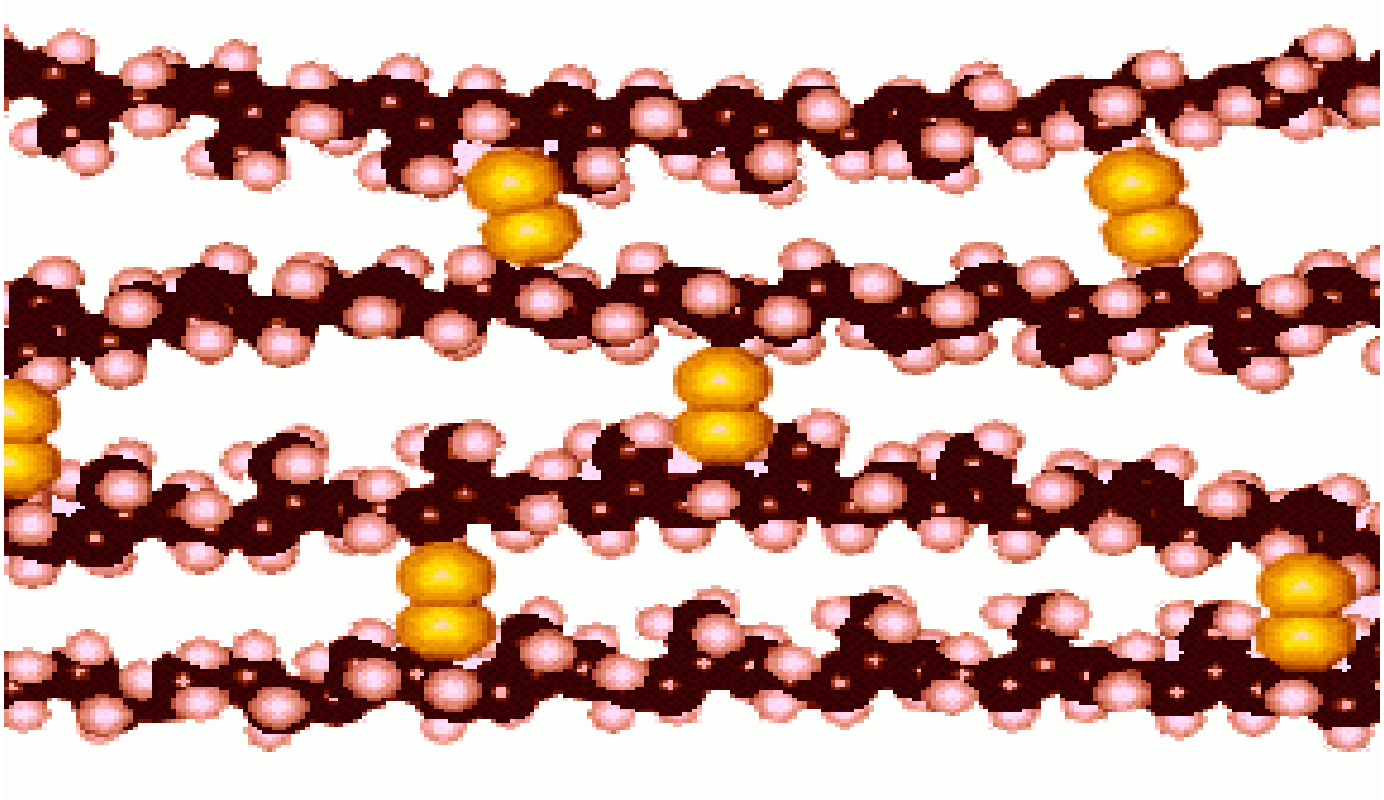
.....vulcanisation



Uses of vulcanised

- balloons, hot water bottles, toys etc
- Tyres
- envelope seals, glues, adhesives
- carpets and mats
- mattress covers
- clothing

Synthetic rubbers

- Disruption of supplies of natural rubber during world war I and II & increased needs for elastomeric materials – precipitated the need for synthetic rubber
- Synthetic poly isoprene was first prepared in the early 1900s and was used for tyres of lightweight vehicles
- Synthetic isoprene was a mixture of cis and trans molecular forms - mixture of properties

Isoprene

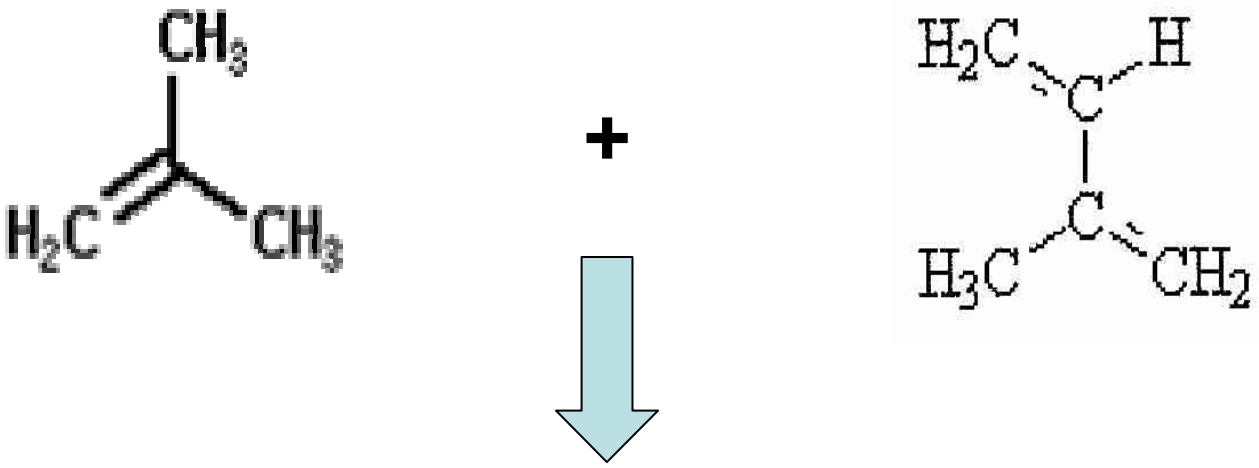
- on using Ziegler-Natta catalyst which was developed in 1950s, 90% pure cis-isoprene was produced

- However, natural isoprene is used more than synthetic isoprene extensively because of its low cost

Butyl Rubber (GR – I)
Poly iso butylene - PIB

- Prepared by polymerization of about 98% of isobutylene with about 2% of isoprene.
- Structurally, polyisobutylene resembles polypropylene, having two methyl groups substituted on every other carbon atom.
- It has excellent impermeability and good flexibility.

Preparation



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Properties

- colour : White to pale yellow
- Physical state : viscoelastic
- It is generally odorless and tasteless
- Polyisobutylene is impermeable to air and resistant to ozone
- electrical insulator

…..properties

- Excellent resistance to heat and abrasion
- Resistance to ageing
- Chemically inert (even to mineral acids like HCl , HF , HNO_3 & H_2SO_4)
- Soluble in non polar solvents(C_6H_6 , CCl_4) and insoluble in polar solvents (ROH)

Applications

- The first major application of butyl rubber was (tyre) inner tubes of bicycles and other heavy vehicles

- Due to its impermeability (to air) it finds applications in equipments requiring an airtight rubber

…..applications

Other uses

- ✓ Used in adhesives
- ✓ agricultural chemicals
- ✓ fiber optic compounds
- ✓ sealants
- ✓ Water hoses
- ✓ Making conveyer belts in food and other industries
- ✓ Tank linings
- ✓ Insulation for high voltage wires and cables

Special Butyl Rubbers

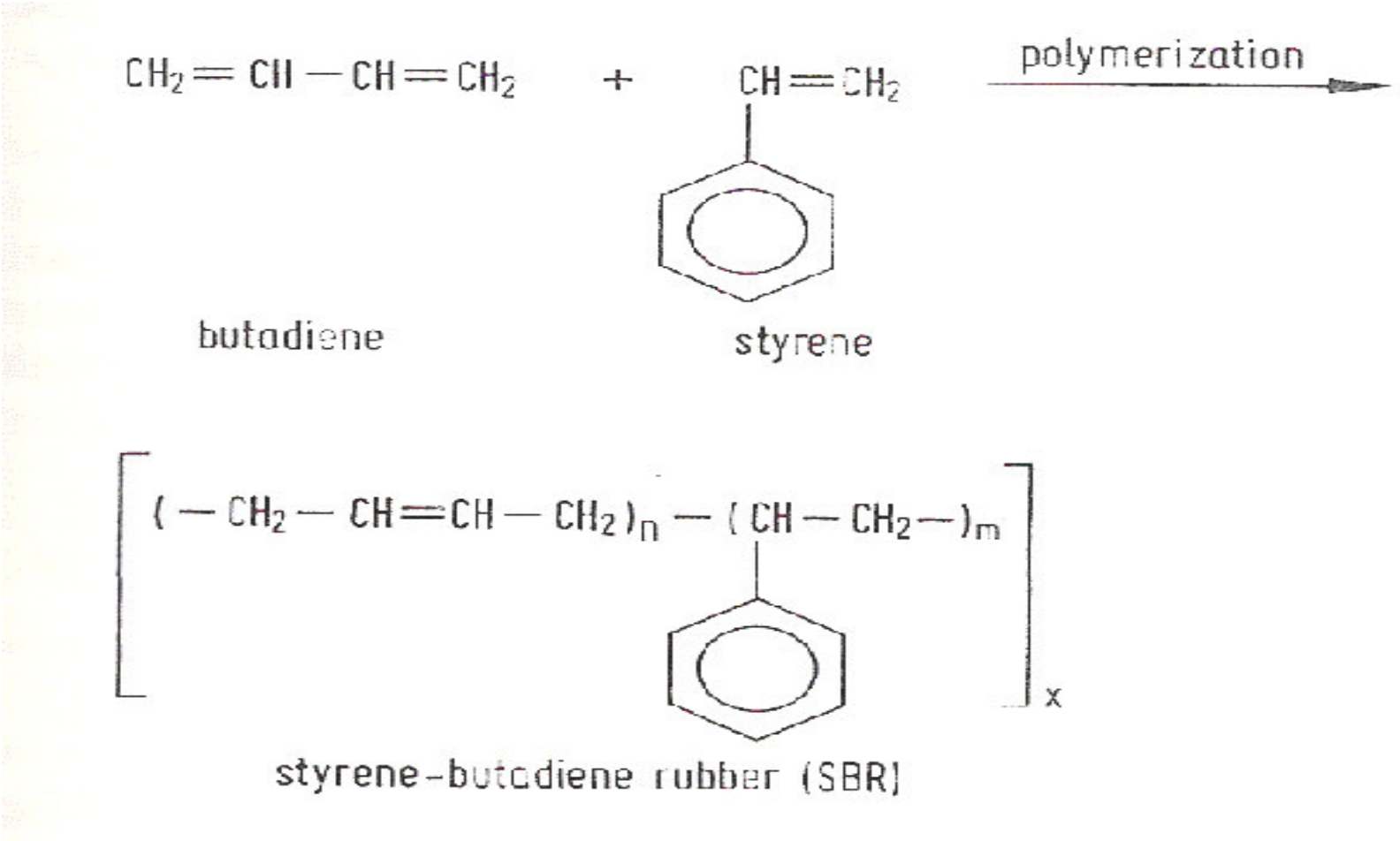
- Between 1950 & 1960 , halogenated butyl rubber (**halobutyl**) were developed
- Chlorinated butyl rubber (**chlorobutyl**) and brominated BR (**bromobutyl**) have higher curing rates than BR
- They can also be co vulcanised with other rubbers like natural rubber and SBR.
- Halo butyl rubbers are the most important material for inner tubes as on date

Styrene Butadiene Rubber (SBR)
Buna–S-Rubber (GR- S)

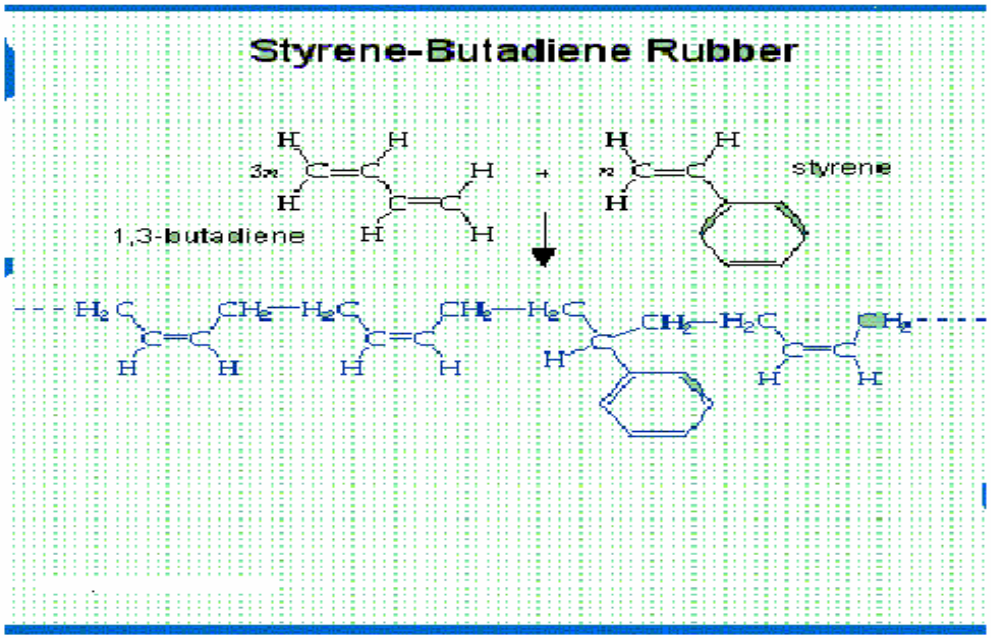
- **Buna S** or Styrene-butadiene rubber (**SBR**) is an elastomeric copolymer consisting of styrene and butadiene

- The rubber was named **Buna S**, were Bu stands for butadiene, (N)na for sodium (natrium in Latin) and S for styrene.

Preparation (Random co polymer 1:1)



SBR – Co polymer (block - 3:1)



Properties

- High abrasion resistance
- Useful temperature range: -60 to +120 degrees Celsius
- GTT is -55 degrees Celsius
- Good aging stability.
- SBR is stable in: mineral oils, fats, aliphatic, aromatic and chlorinated hydrocarbons.

....properties

- High load bearing capacity
- Good resilience
- Appreciable electrical insulation
- Swells in oils and solvents
- Easily oxidized by ozone

Applications

- Manufacture of motor tyres
- Floor tiles (rubber flooring for AC rooms)
- Shoe soles
- Gaskets
- Foot-wear components
- Wire and cable insulations
- Adhesive
- Tank lining, etc.

Unique application of elastomer **(Earth quake resistance)**

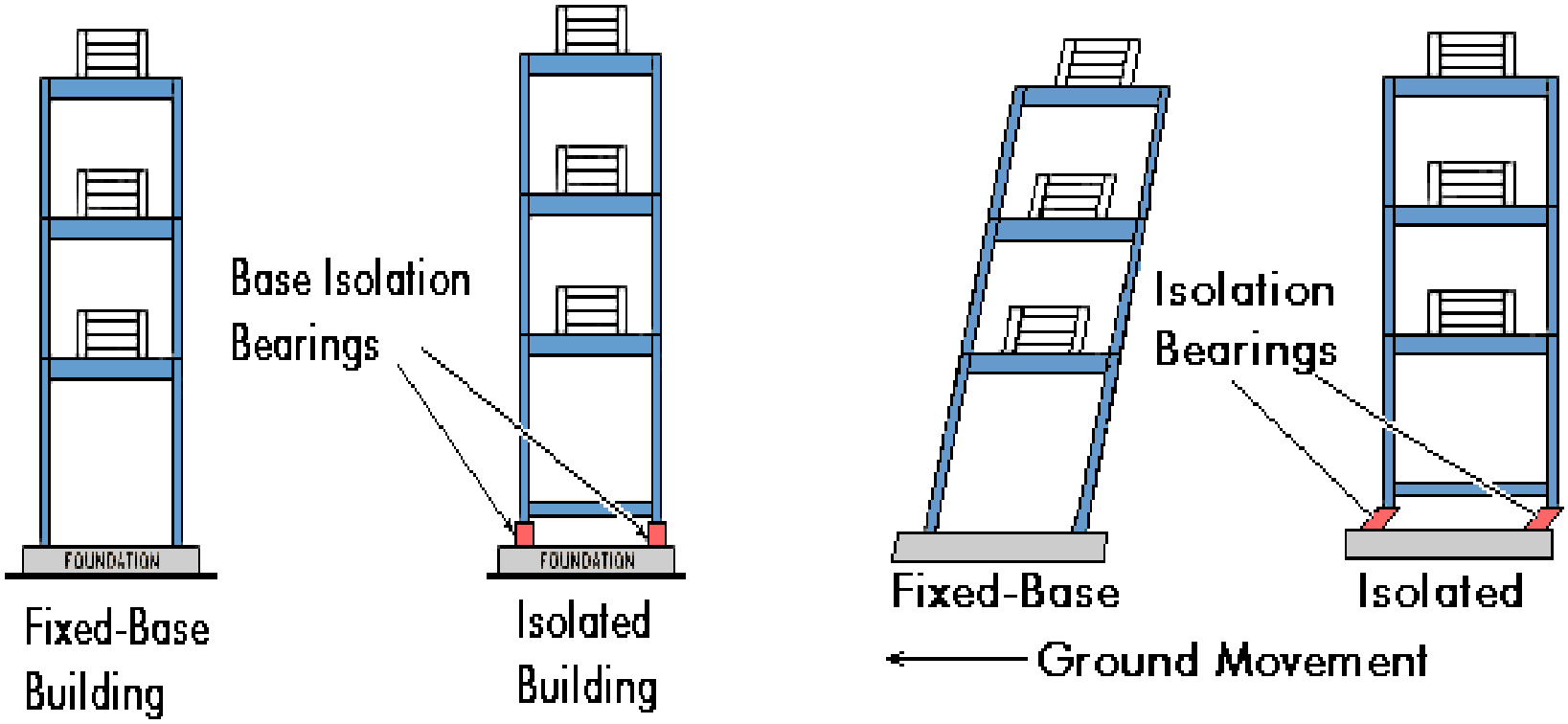
- structural joints (Bearings) are installed between a structure and its foundation.
- These bearings are very stiff and strong in the vertical direction, but flexible in the horizontal direction.

Model 1

Model 2

A base isolated structure is supported by a series of bearing pads which are placed between the building and the building's foundation

- As a result of an earthquake, the ground beneath each building begins to move.
- Each building responds with movement which tends toward the right.
- The building's displacement in the direction opposite the ground motion is actually due to **inertia**


Base Isolation
Bearings
FOUNDATION
FOUNDATION
Fixed-Base
Building
Isolated
Building
Isolation
Bearings
Fixed-Base
Isolated
Ground Movement