

# Types of Rubber and Their Essential Properties

# Characteristics

- ***Upper temperature aging limits - heat aging resistance***
- ***Chemical resistance and concentration***
- ***Chemical resistance and temperature***
- ***Mechanical properties and temperature:***  
Butyl rubber, a fairly non-resilient material at room temperature can have a significant higher resilience at 80 °C.

## ■ ***Grades within a type of rubber***

All synthetic (and natural) raw gum elastomers have subdivisions within their own family.

# ***Natural rubber NR***

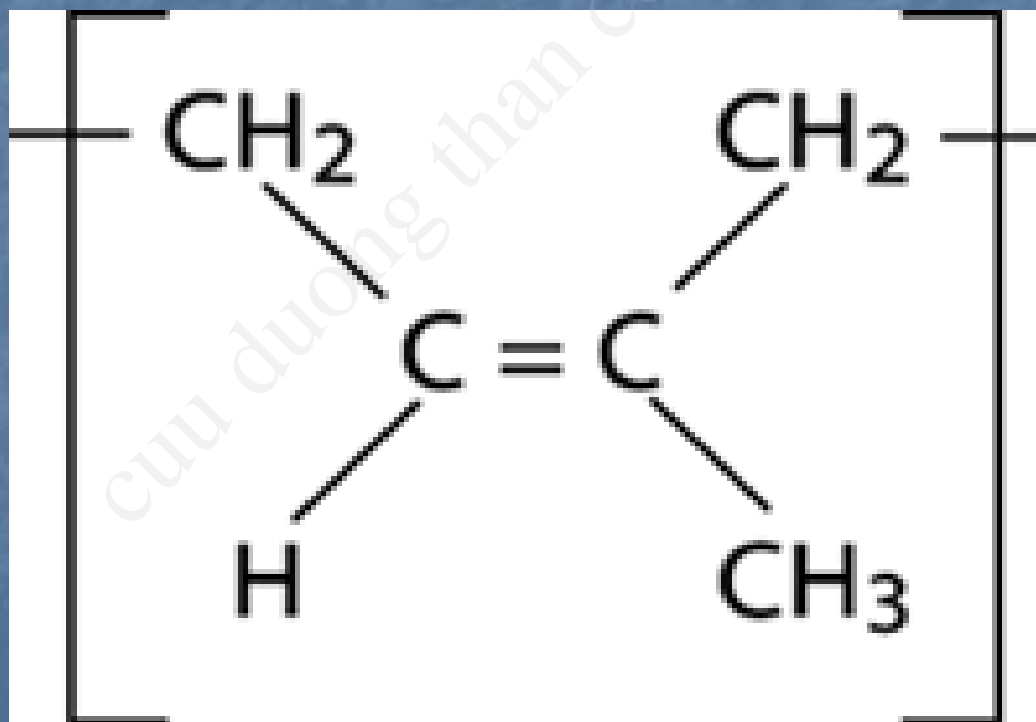
## Production of natural Rubber

- NR is tapped from rubber trees (*Hevea brasiliensis*) as latex.
- Latex is a colloidal dispersion of solid particles of polymer polyisoprene in water and dry rubber content in the emulsion is about 30%





# Chemical structure of natural rubber



# ***Natural rubber NR***

- Available in many grades related to its 'dirt' content and precise method of production.
- Popular grades are ribbed smoked sheet (RSS) and technically specified rubber such as SVR (Standard Vietnamese Rubber)



- Addition of carbon black to a compound gives resistance to UV, antiozonants
- Antiozonants and waxes support ozone resistance.

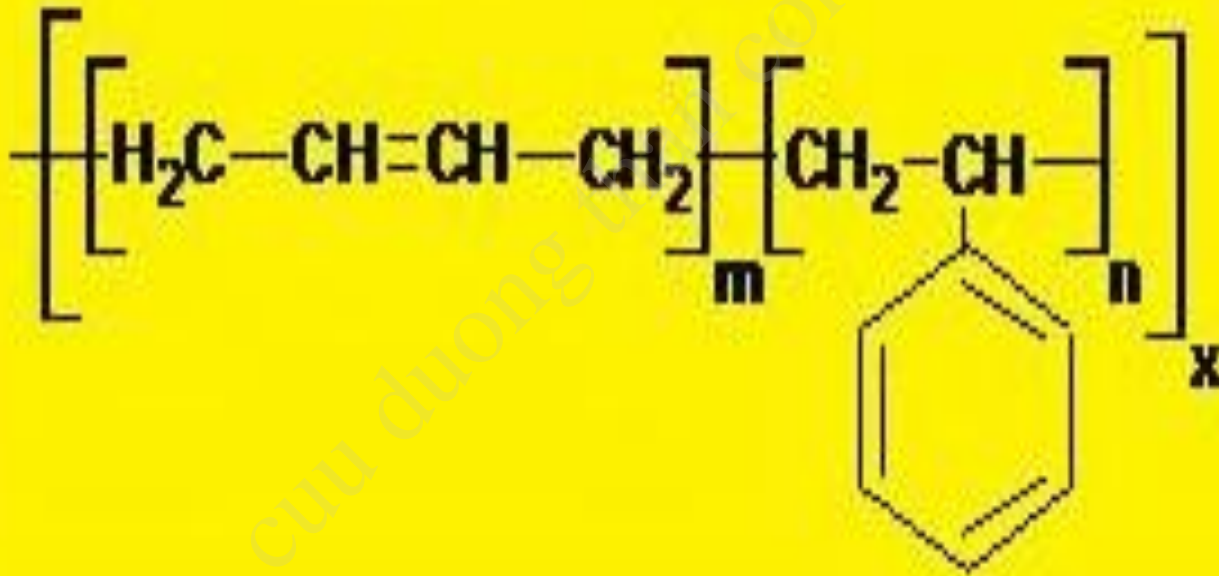
*Ozone attack is of most concern for thin products and those that are subjected to stretching during service.*



- Electrical insulation is very good and, like all elastomers, depends on compounding.
- Resistance to petroleum oils is poor
- Resistance to alcohols (such as ethanol and methanol) and ketones (such as methyl ethyl ketone (MEK) and acetone) is much better

- 20, 50: the lower the number, the cleaner the grade, and therefore the more expensive
- Specialized grade known as SMR CV with consistent viscosity control of NR (constant viscosity) is available. This grade has 0.15% of a hydroxylamine salt added to prevent a 'cross-linking'.

# *Styrene butadiene rubber SBR*



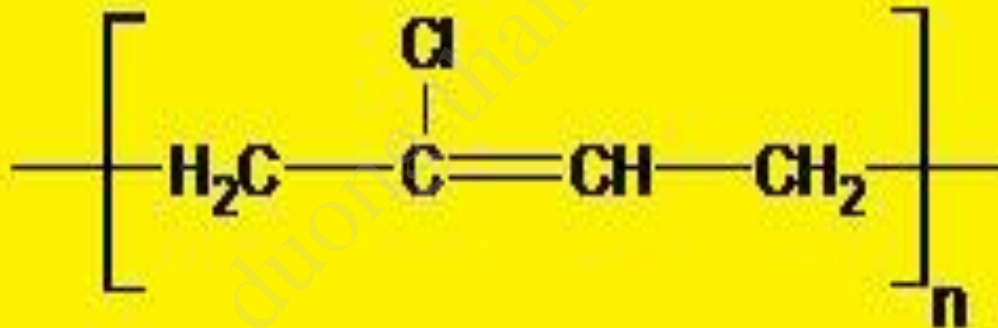
# ***Styrene butadiene rubber SBR***

- From petroleum oil
- There are many subgroups of the raw gum elastomer
- In comparison with natural and CR, gum vulcanizates made from SBR have poor mechanical properties therefore must have reinforcing fillers such as carbon black



- The properties of SBR are broadly similar to NR, for chemical, solvent, and weather resistance.
- The upper temperature heat aging resistance limit is a little higher.

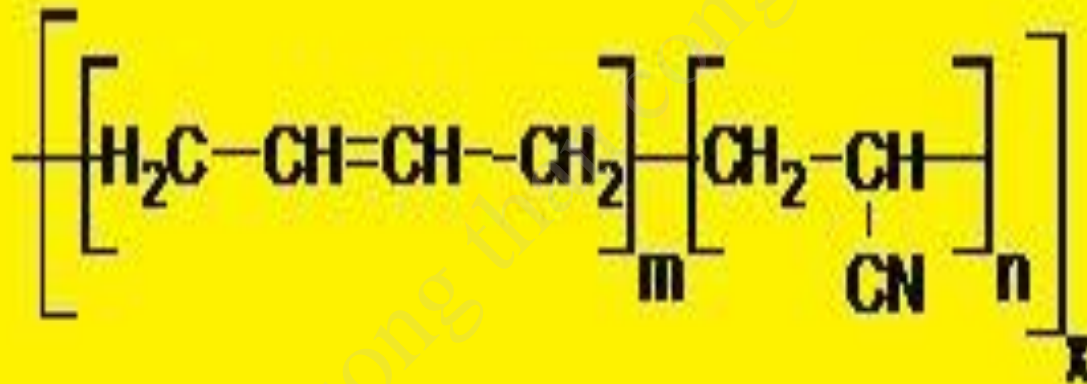
# ***Polychloroprene CR***



# ***Polychloroprene CR***

- Known as Neoprene
- More specialized than the two previous elastomers (oil and weather resistance)
- Ability to retard flame
- Resistance to dilute acids and bases is better than that of NR or SBR

# ***Nitrile Rubber NBR***





# ***Nitrile Rubber NBR***

- Known as acrylonitrile butadiene rubber, Buna-N and simply nitrile
- Oil resistant properties
- The higher the amount of ACN in the elastomer, the better the oil resistance
- The weather resistance of NBR is poor, similar to NR and SBR

- Better heat aging resistance than CR and is in the region of 107<sup>0</sup>C for continuous use.
- Needs reinforcing fillers.
- Poor resistance to polar liquids such as ketones, esters, chlorinated solvents, and many aromatic solvents such as benzene and toluene

# ***Ethylene propylene rubber EPM and EPDM***

- EPM is a copolymer consisting of ethylene and propylene units as part of the main polymer chain.
- It can be cross-linked with peroxides or radiation but not sulfur

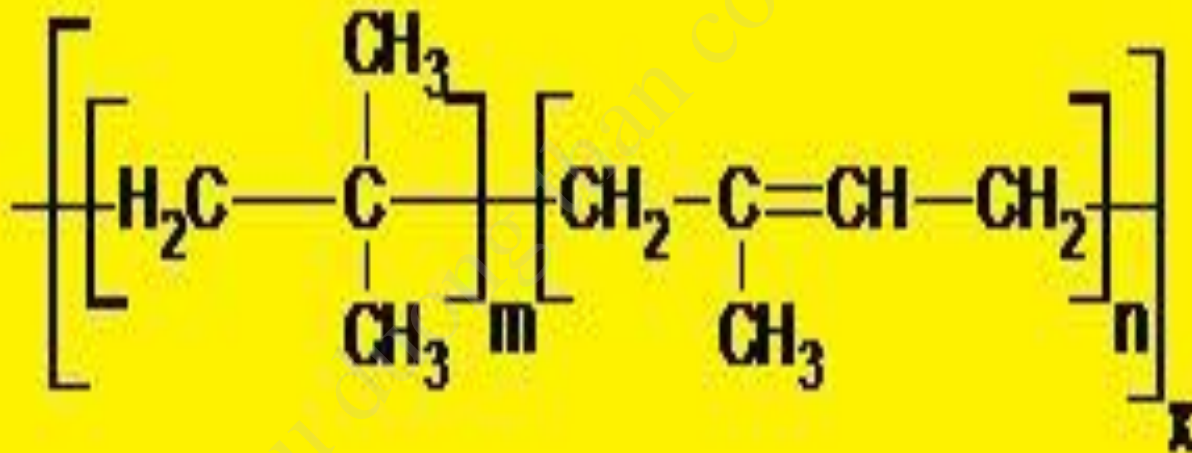
# Ethylene propylene diene terpolymer- EPDM

- Unaffected by weather with very good resistance to ozone
- Upper 'continuous' heat aging temperature limits in air, anywhere from 126<sup>0</sup>C to around 150<sup>0</sup>C



- Low temperature flexibility is very good and even better when compare with NR.
- Very poor oil resistance.
- Resistance to a number of concentrated mineral acids and bases is significantly better than that of NR or SBR
- Excellent electrical resistance of EPDM

# ***Butyl rubber IIR***



# ***Butyl rubber IIR and halobutyl rubber ClIR and BIIR***

- Some properties similar to those of EPDM.
- Good mineral acid and base resistance.
- Good weather resistance (similar to that of EPDM).
- Excellent resistance to gase permeability
- Poor resistance to petroleum oils

- Upper continuous heat aging temperature limit is around 121<sup>0</sup> C degree.
- Applications for vibration and shock prevention, roof and tank linings, curing bladders and inner tubes for tires.
- Halobutyls can be blended with unsaturated elastomers such as NR, whereas for IIR it is not recommended



# ***Silicone rubber***

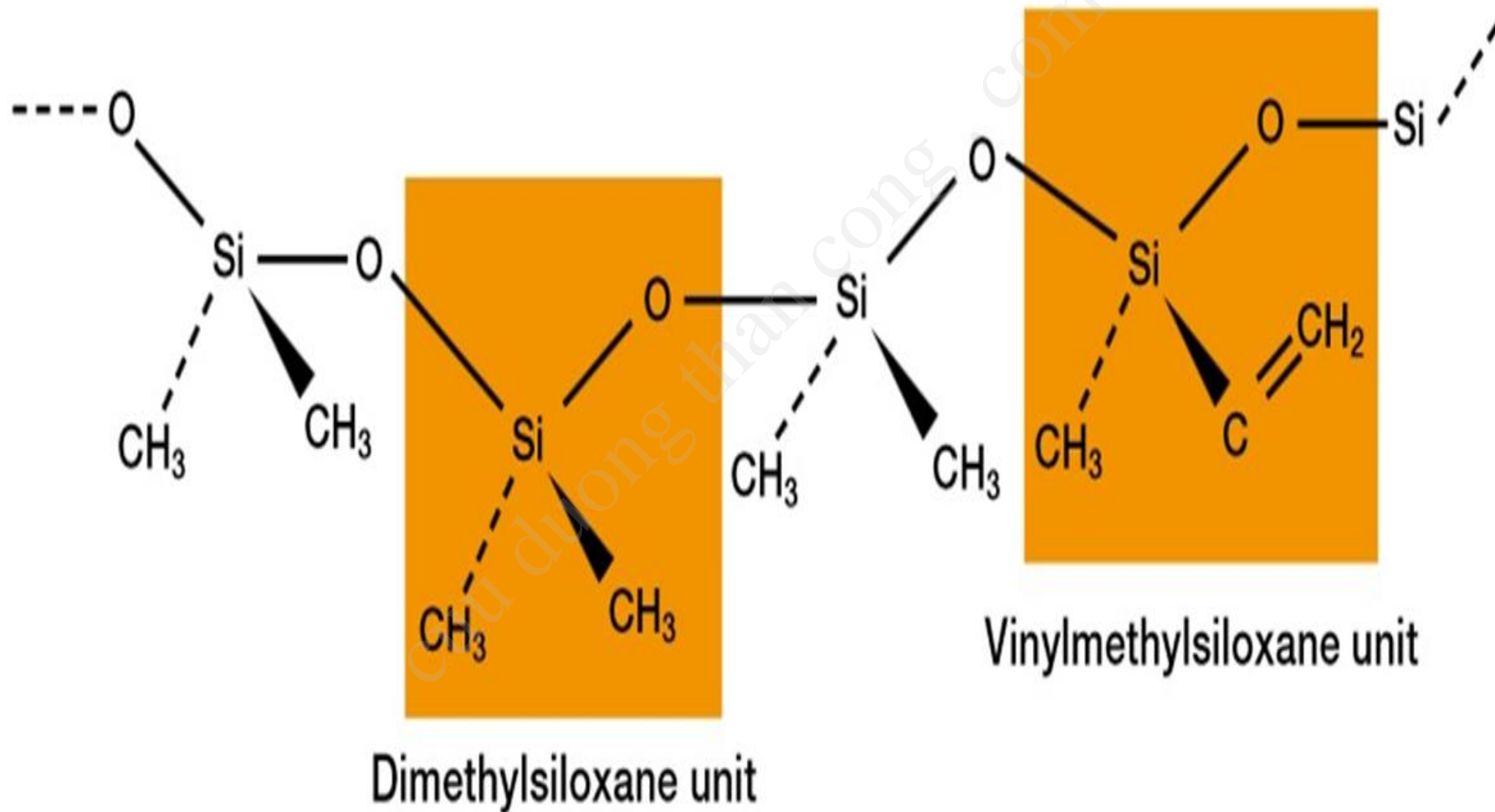
MQ = Methyl-Polysiloxane

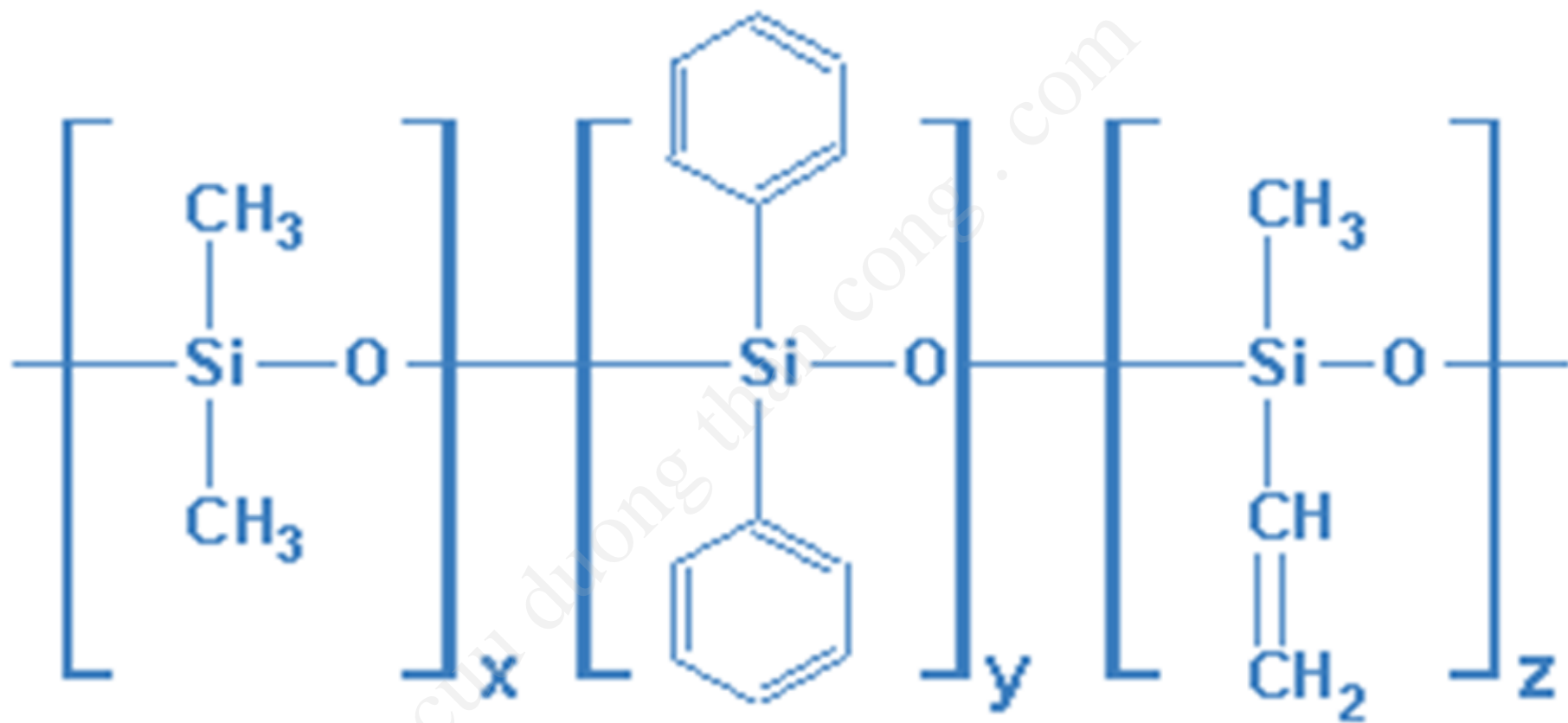
VMQ = Vinyl-Methyl-Polysiloxane

PMQ = Phenyl-Methyl-Polysiloxane

PVMQ = Phenyl-Vinyl-Methyl-Polysiloxane

# Chemical Structure





# ***Silicone rubber***

- Most elastomers have a carbon main chain, while Q (Quaternary group) has a silicone oxygen backbone.
- The best elastomers for both high and low temperature resistance (-54<sup>0</sup>C and 200<sup>0</sup>C for general purpose compounds and -115<sup>0</sup>C and 260<sup>0</sup>C for special compounds)



# ***Silicone rubber***

- Excellent ozone, weather resistance and electrical insulation.
- Low tensile strength, poor tear strength and little wear resistance.
- Applications include aerospace, medical, food contact, and automotive ignition cable.

# ***Hydrogenated nitrile rubber HNBR (HSN)***

- New elastomer - first appearance in 1984
- Very good weather and abrasion resistance, plus good mechanical strength.
- Used in oilfields where it has resistance to amine corrosion inhibitors and better hydrogen sulfide resistance than NBR.
- Peroxide cured HNBR has heat aging resistance up to 150°C.

# *Chlorosulfonated polyethylene **CSM***

- Best known as Hypalon.
- Excellent ozone, acid, and weathering resistance.
- Oil and heat aging resistance.

# Urethane rubber

- Produced by reacting a diisocyanate (TDI, MDI) with either a polyether polyol (1,4-butanediol) or a polyester polyol (from adipic acid and ethylene glycol)



- Low molecular weight polyols produced hard polymers.
- High molecular weight polyols give soft polymers.
- High tensile strength and abrasion resistance combined with good oil and tear resistance.

