A presentation on

Polymer

by

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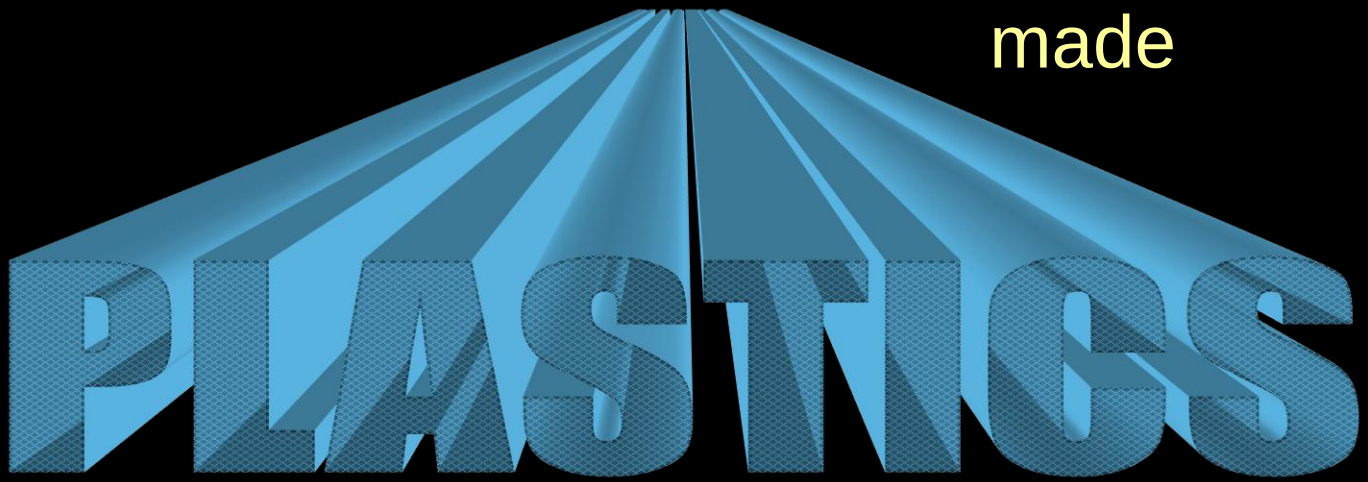
WELCOME TO
POLYMER
PLANET

POLYMERS ARE EVERYWHERE

Polymer

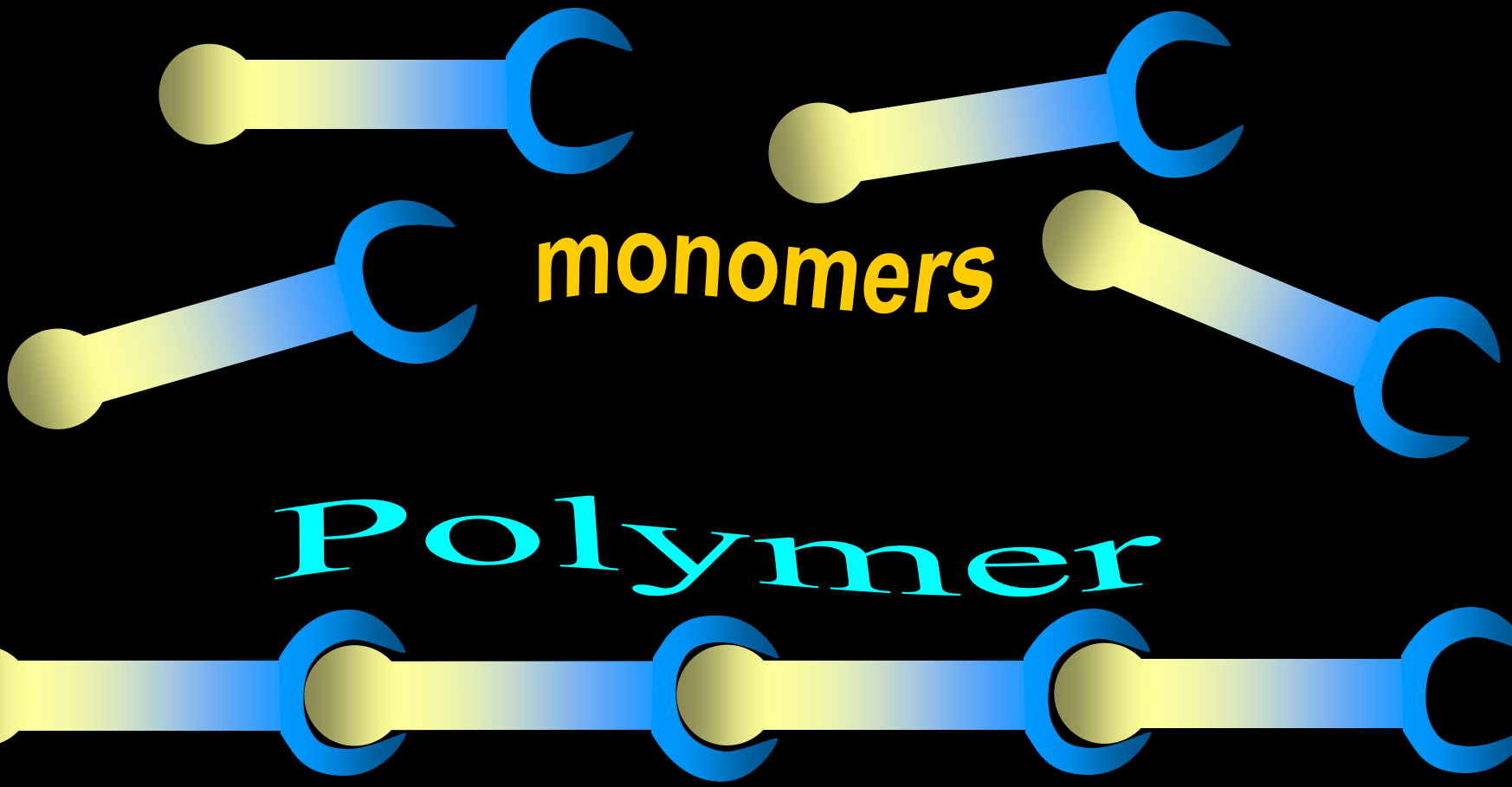
Many + Parts

This name hints at how polymers are made

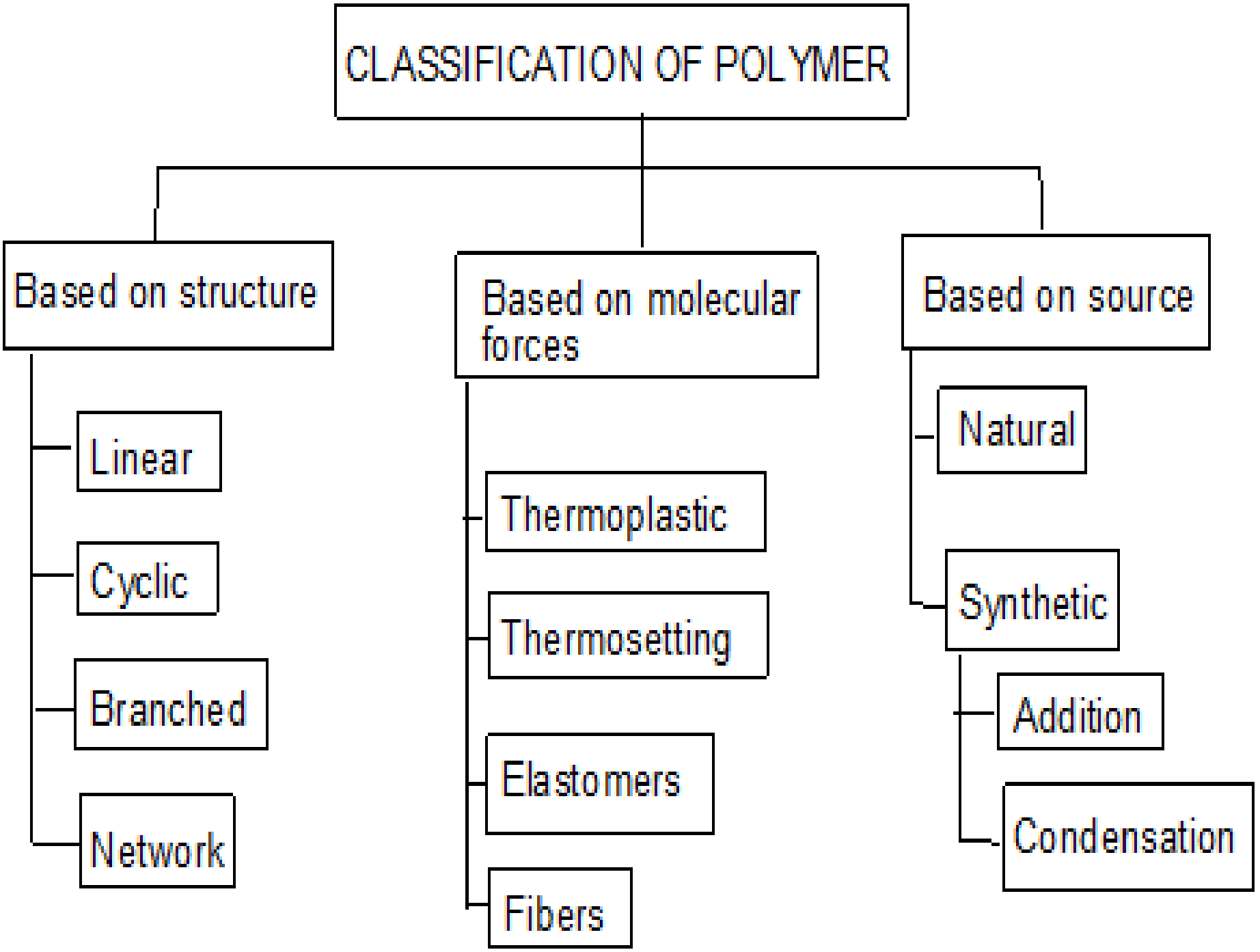


Latin: Plasticus, that which can be molded

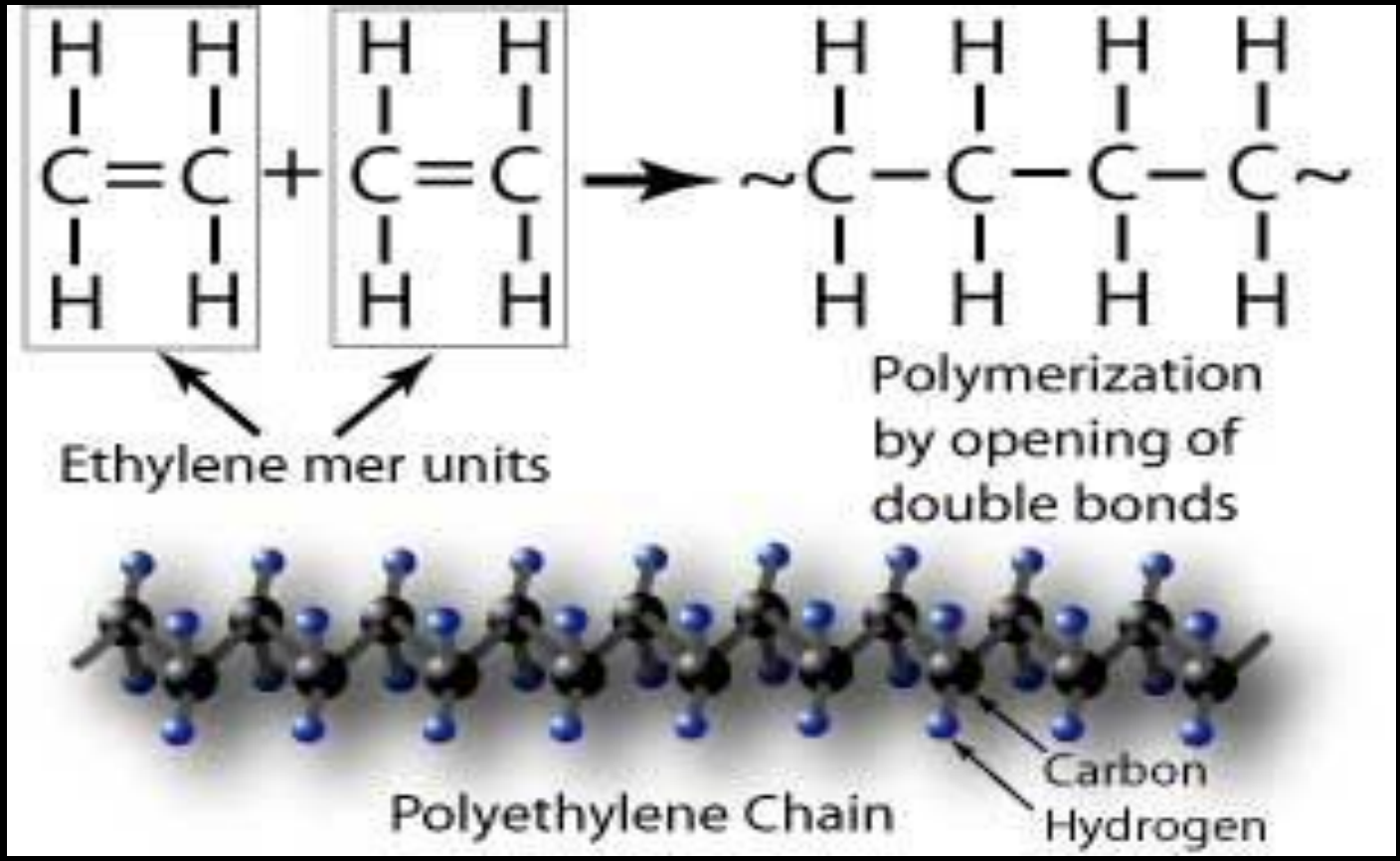
This name honors plastics useful property of being easily molded



The word, polymer, implies that polymers are constructed from pieces (monomers) that can be easily connected into long chains (polymer). When you look at the above shapes, your mind should see that they could easily fit together.

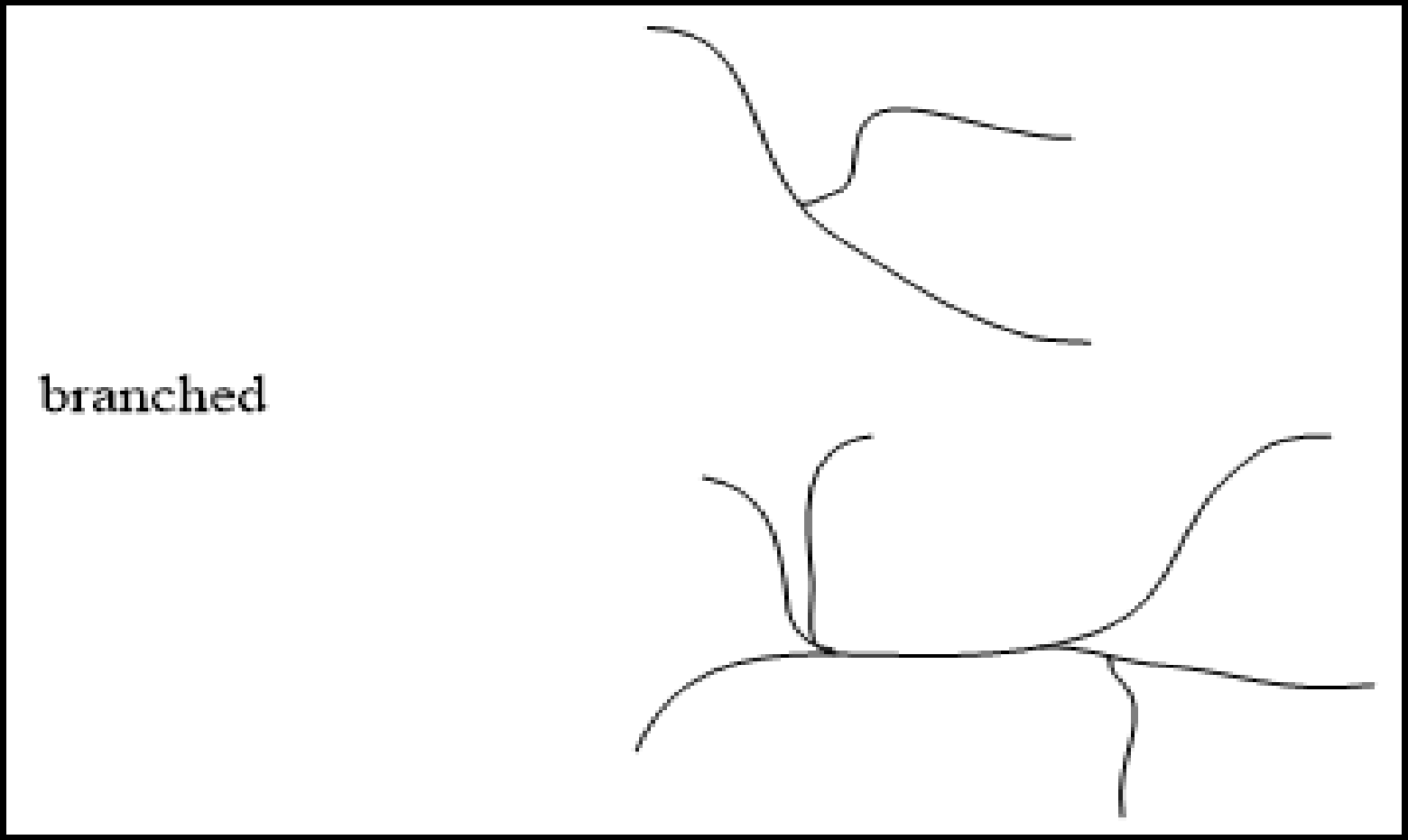

CLASSIFICATION OF POLYMER
Based on structure
Linear
Cyclic
Branched
Network
Based on molecular forces
Thermoplastic
Thermosetting
Elastomers
Fibers
Based on source
Natural
Synthetic
Addition
Condensation

Linear Polymer



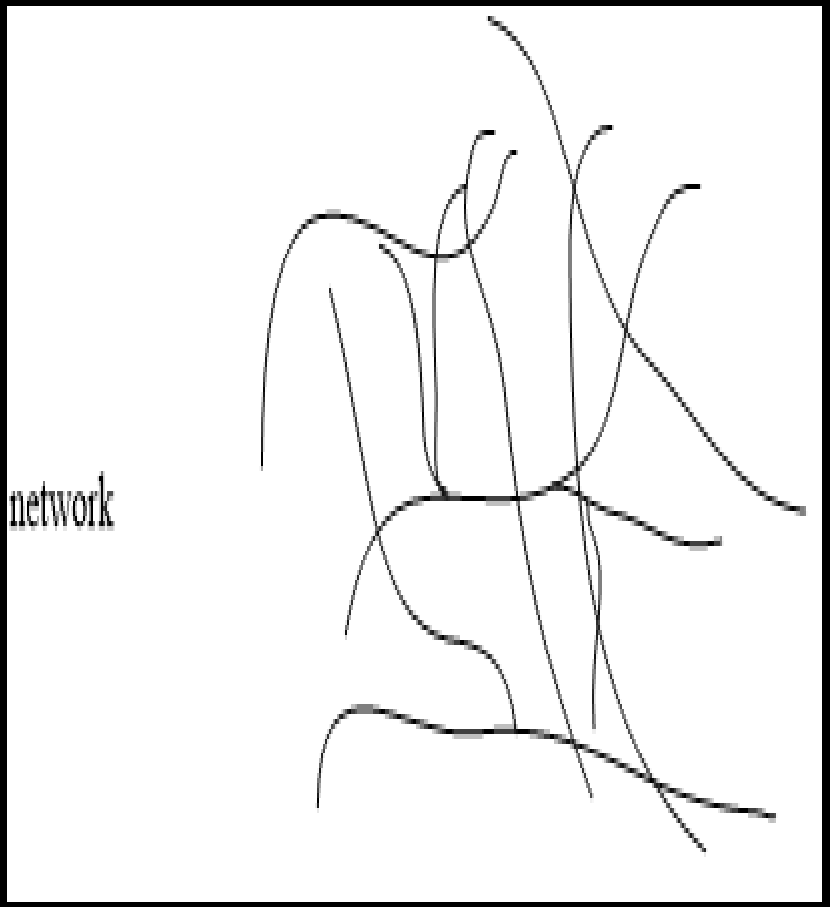
A linear polymer is represented by a chain with two ends

Branched Polymer



Branched polymers have side chains, or branches, of significant length which are bonded to the main chain at branch points, and are characterized in terms of the number and size of the branches

Network polymer



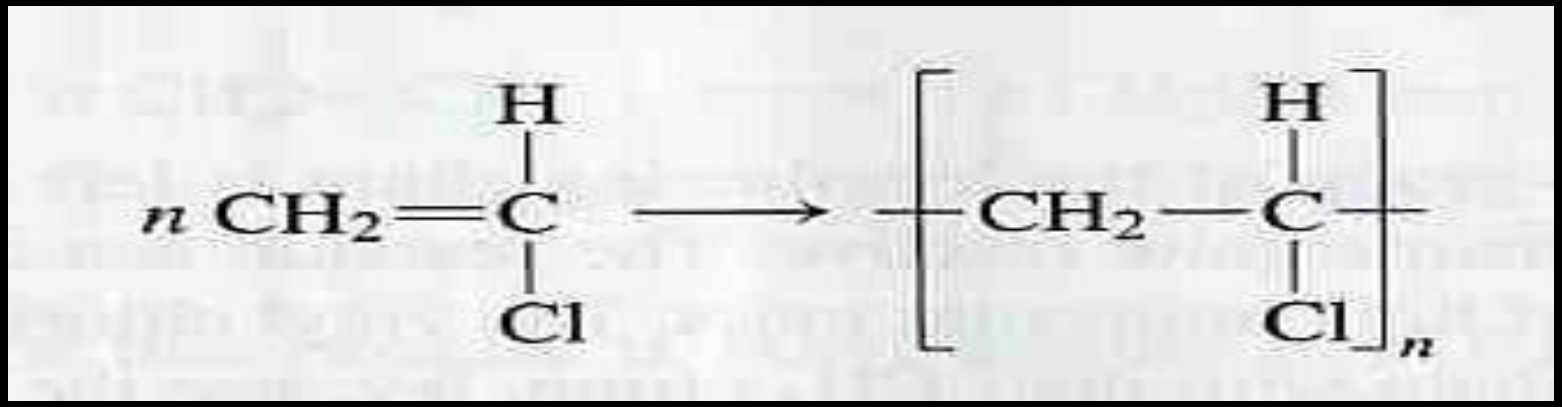
•Network polymer or cross-linked polymer have three dimensional structures in which each chain is connected to all others by a sequence of junction points and other chains. But it does not contain any main chain when compare with branched polymer.

Methods for making polymers

Addition polymerization:

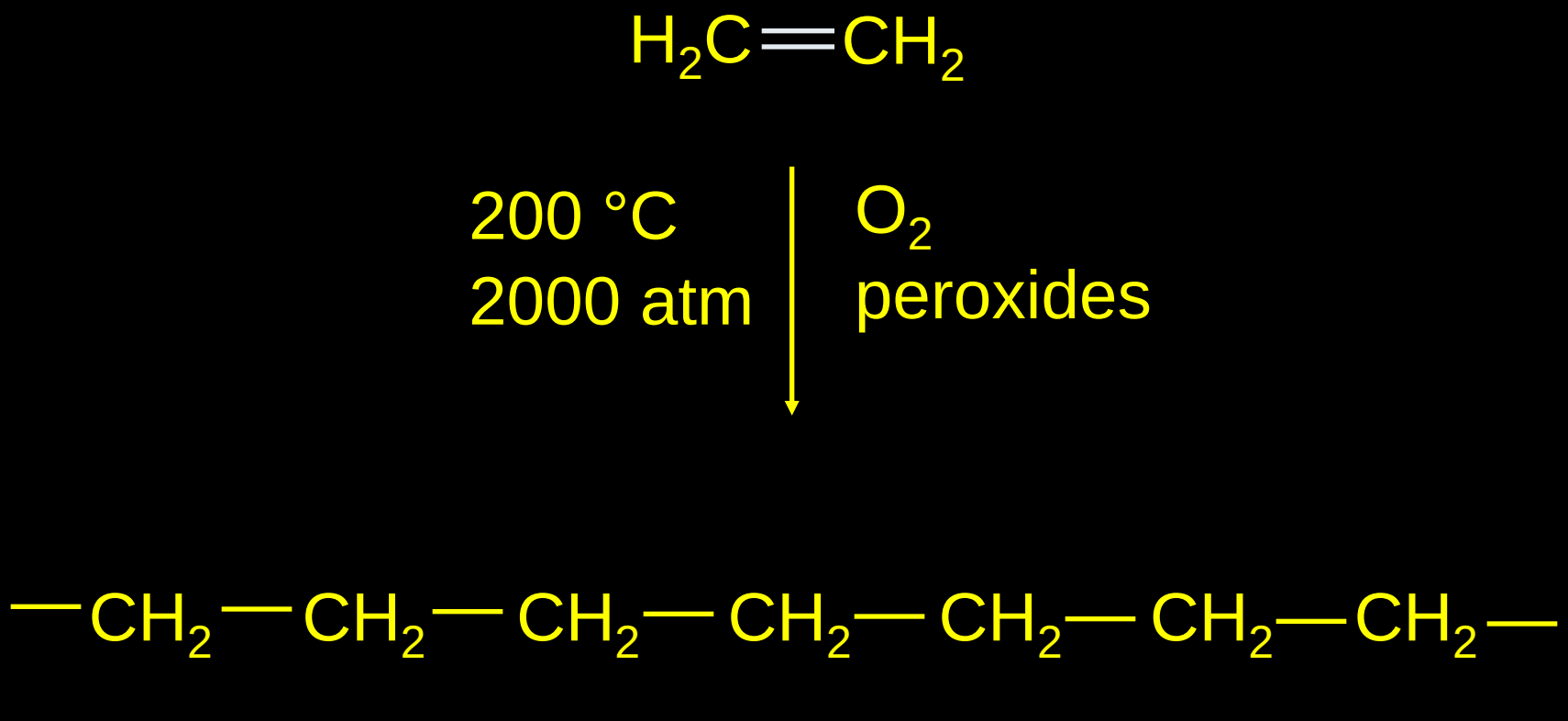
monomers react to form a polymer without net loss of atoms.

Most common form: free radical chain reaction of ethylenes



n monomers one polymer molecule

Free-Radical AdditionPolymerization of Ethylene



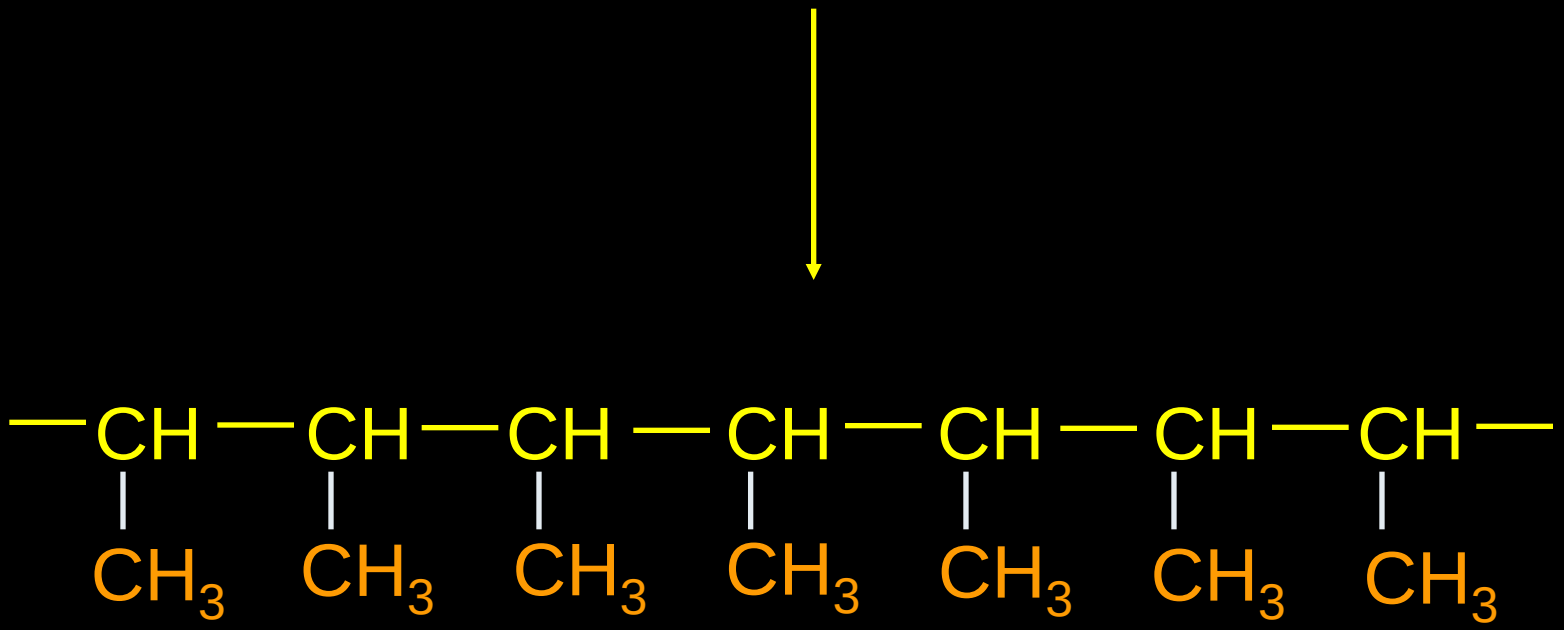
Polyethylene :

A polymer made form just one monomer is polyethylene. It is the most common plastic you see.

It is used for bottles, buckets, jugs, containers, toys, even synthetic lumber, and many other things.

Free-Radical Polymerization of Propene

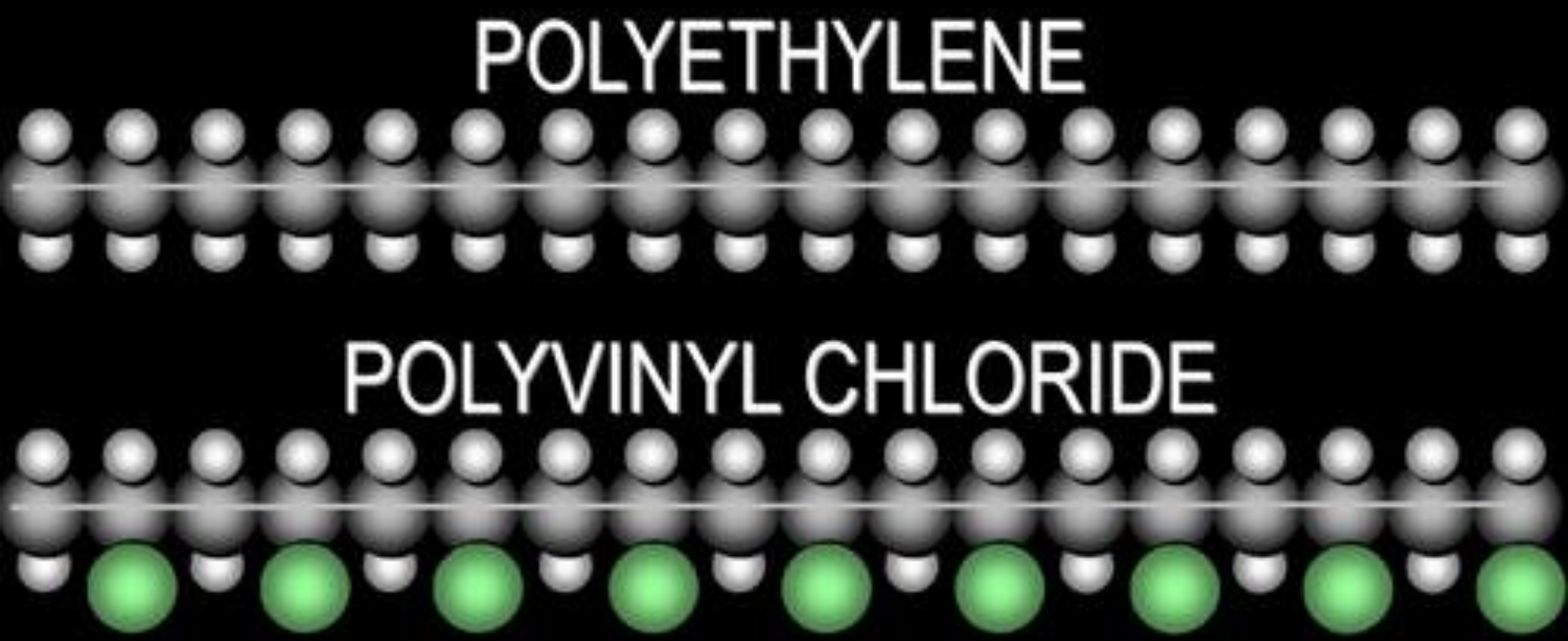
$H_2C{=}CHCH_3$



polypropylene

Polyvinyl chloride (PVC) :

Another polymer, which is almost the same as polyethylene, is **P**oly**V**inyl **C**hloride or PVC. The difference is that every other hydrogen is replaced with a chlorine atom (green sphere).



$(CH_2CHCl)_n + O_2 \rightarrow CO_2 + CO + HCl + H_2O$

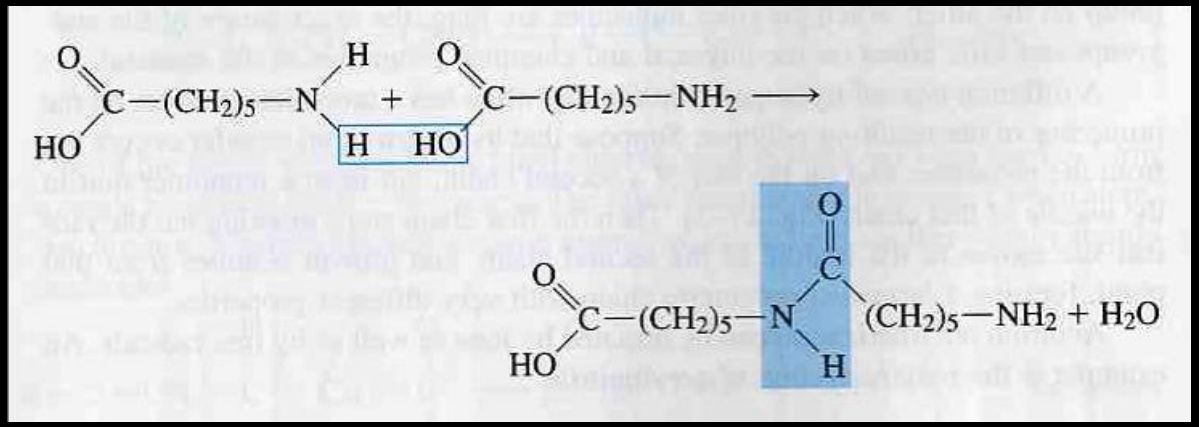
PVC pipes are used in our homes and they are even handy for making a table or chair. PVC is also used as insulation around electric wires in the home and the automobile. PVC is quite safe until it burns. The chlorines in the PVC combine with the hydrogen atoms in the PVC to form hydrogen chloride gas (HCl). When this contacts water in lungs or mouth, it turns to hydrochloric acid ($HCl_{(aq)}$).

Condensation polymerization

Condensation polymerization: the polymer grows from monomers by splitting off a small molecule such as water or carbon dioxide.

Example: formation of amide links and loss of water

Monomers



First unit of polymer + H_2O

NYLON

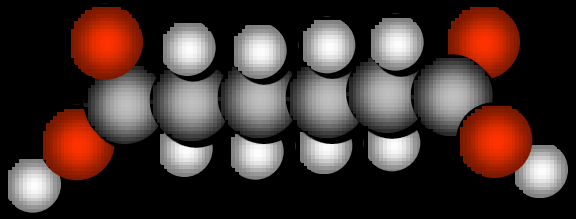
A man-made polymer

Two ingredients are mixed and a solid begins to form at the junction between the two layers of liquid.

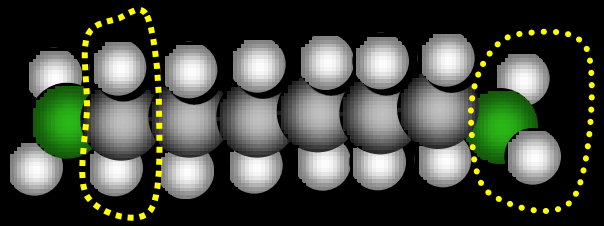
Hot nylon spaghetti can be extracted.

We say certain polymers are man-made, but the truth is they make themselves. Humans only have to get the ingredients near each other. The chemicals will assemble themselves.

Tetramethylene dicarboxylic acid (adipic acid)



Hexamethylene diamine

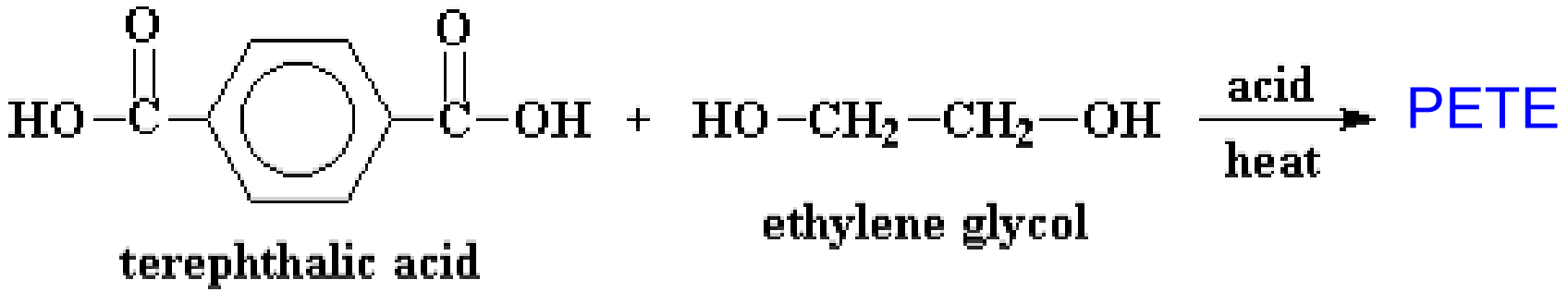


methylene x 6 (hexa)

amine x 2 (di)

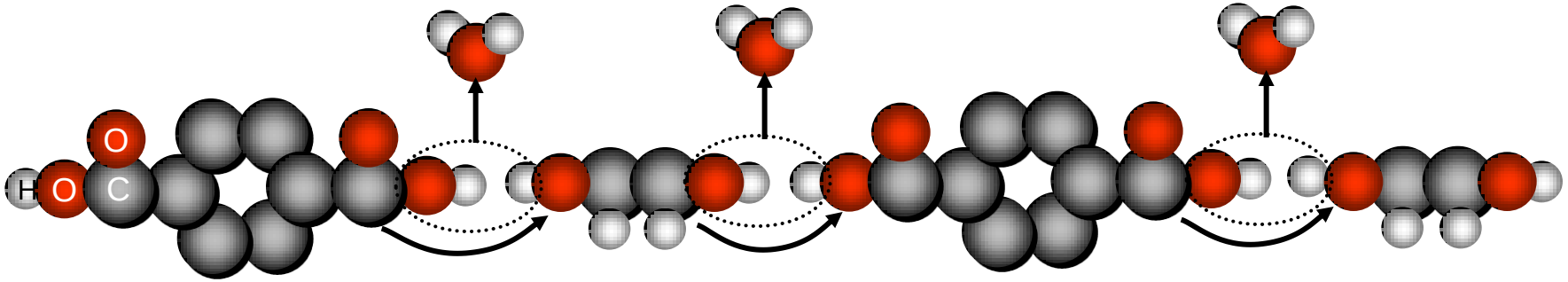
Nylon is actually a “copolymer” because is it made from two monomers. When these two monomers are in the same beaker, they combine and give off a molecule of water. This is called a “dehydration” reaction because we are taking away (*de*) water (*hydra*). (regarding odor: amines smell like fish or worse. Adipic acid is odorless)

Polyester is made from the two monomers, terephthalic acid (note: "ph" is silent) and ethylene glycol (car antifreeze). This makes a popular plastic called PETE, which is short for Polyethylene Terephthalate. The synthesis is also a *dehydration* reaction because water is given off.



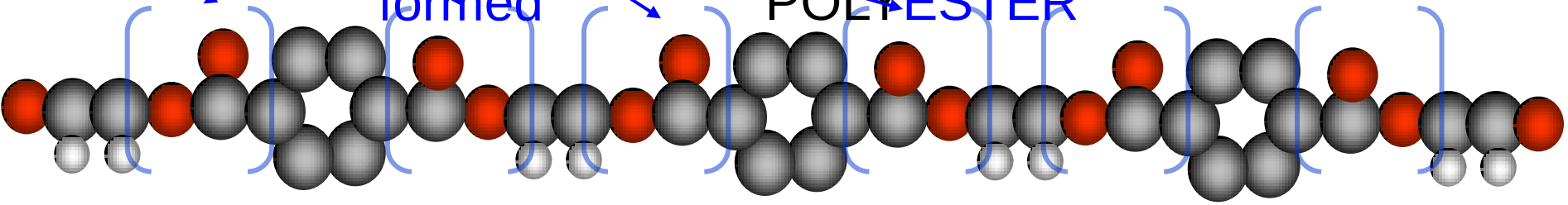
terephthalic acid

ethylene glycol



ESTER groups formed

Hence the name POLYESTER

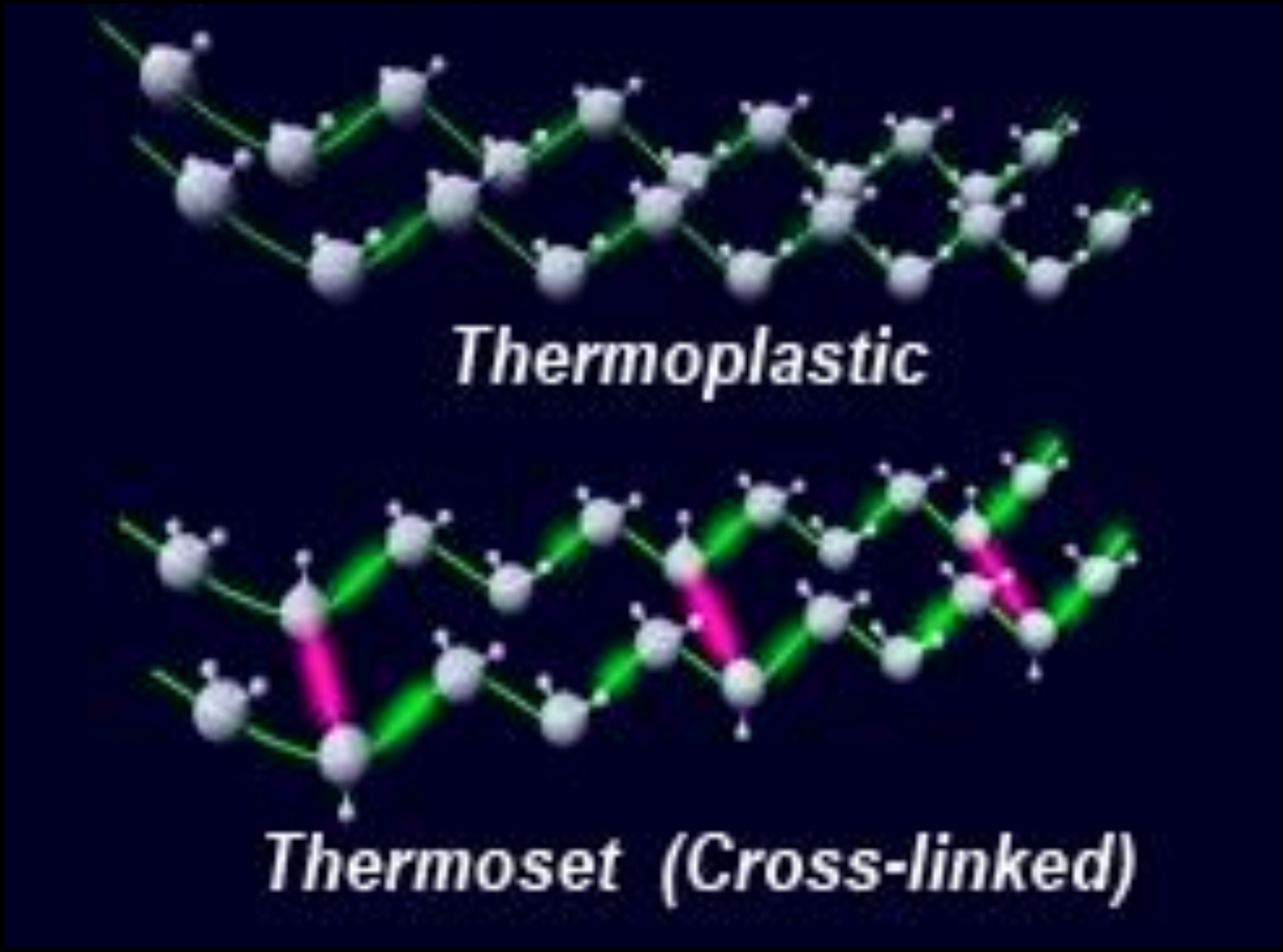


Thermoplastic Polymer

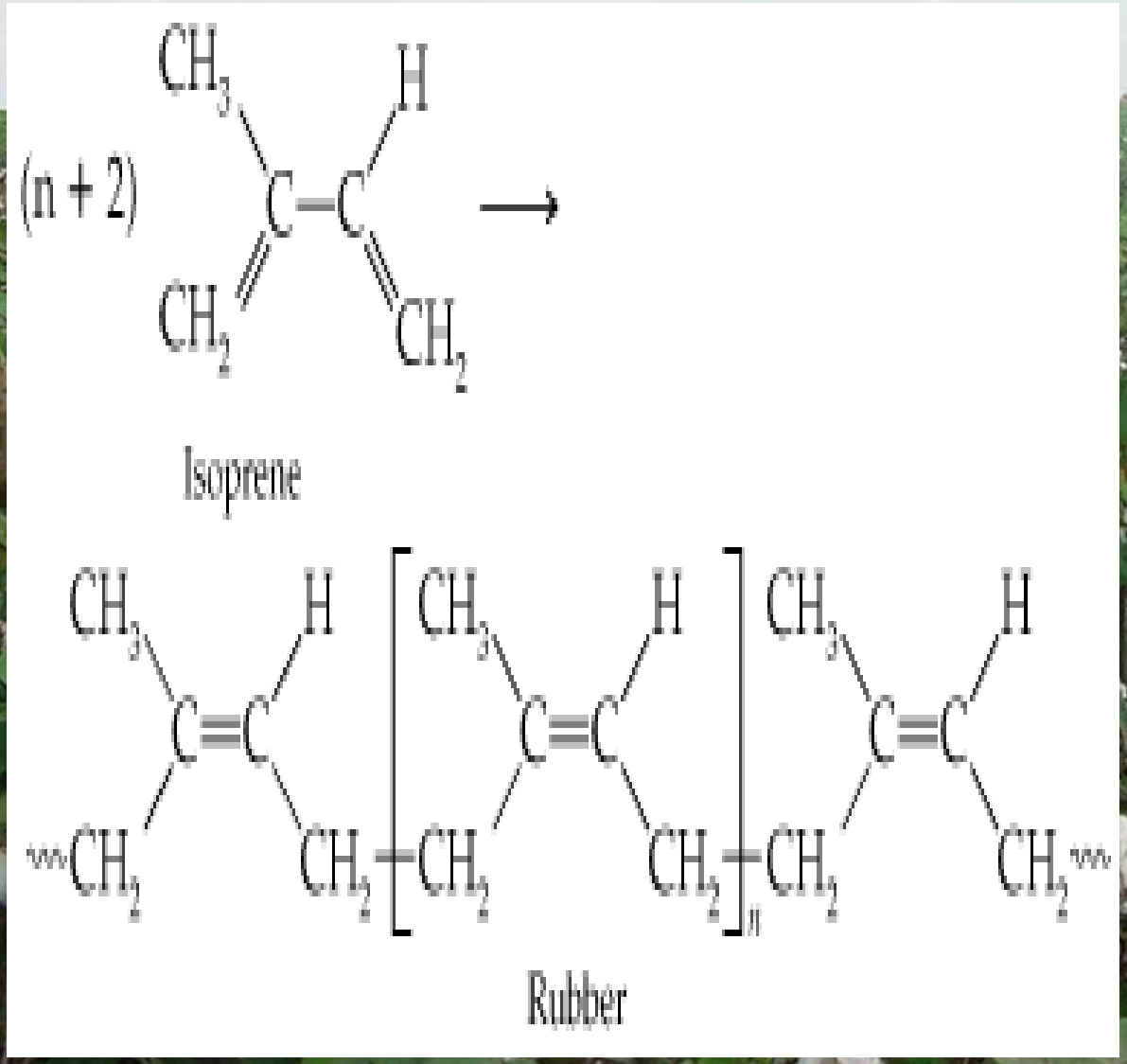
The polymer one which soften on heating and become rigid again on cooling .
Ex.condensation polymer such as nylon ,addition polymer such as polyethylene and
Polystyrene .

Thermosetting polymer

These are polymer which become hard on heating and which cannot soften by heating.
Ex. Phenolic resine such as backelite


Thermoplastic
Thermoset (Cross-linked)

Cotton: a natural polymer



Thank You!