ORGANIC COATINGS

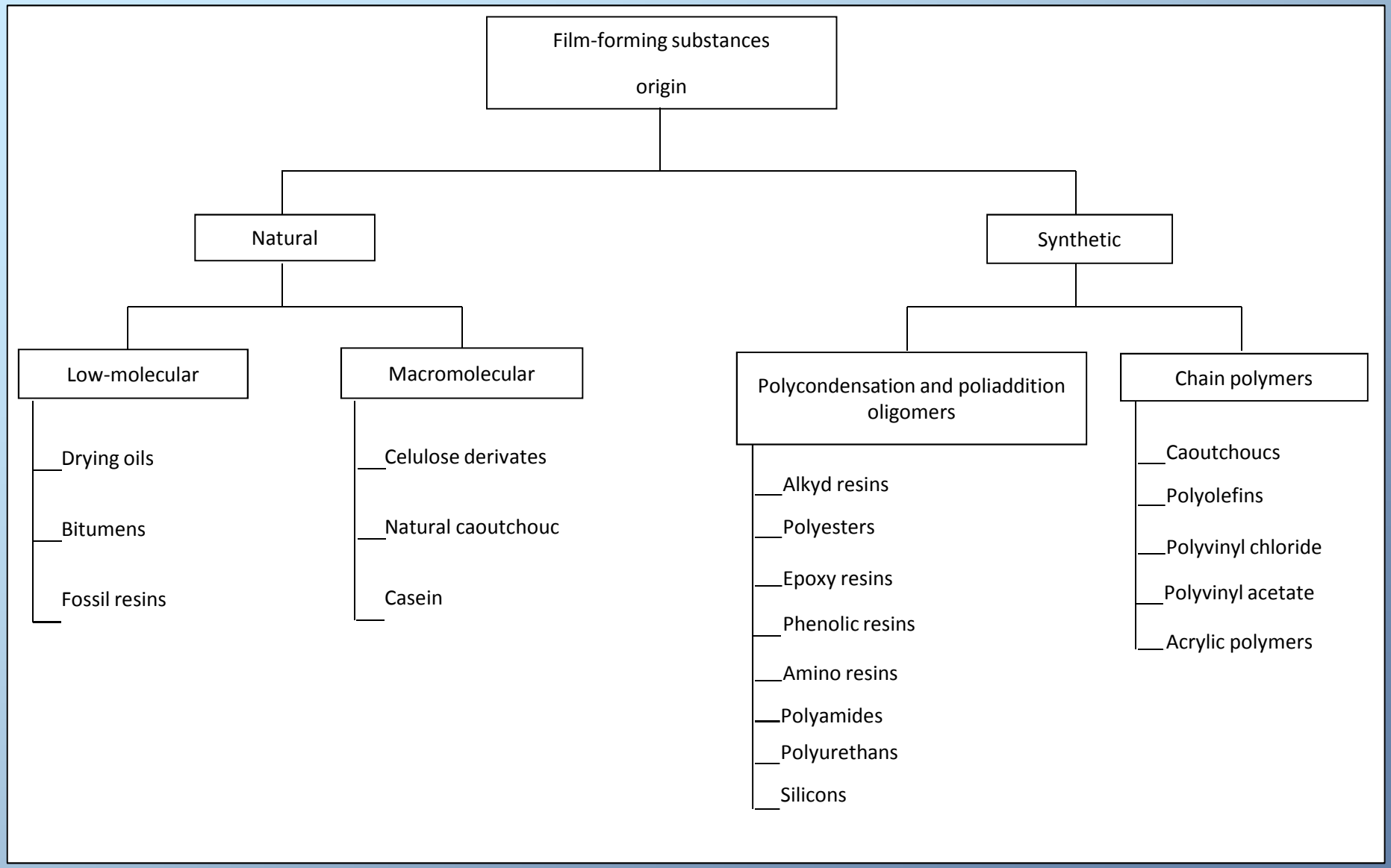
Organic coatings – durable protective coating applied to a substrate for decorative or specific technical properties. The main component responsible for the creation of well-adhering film (membrane) are organic compounds: polymers, oligomers, monomers, or mixtures thereof.

The types of organic coatings:

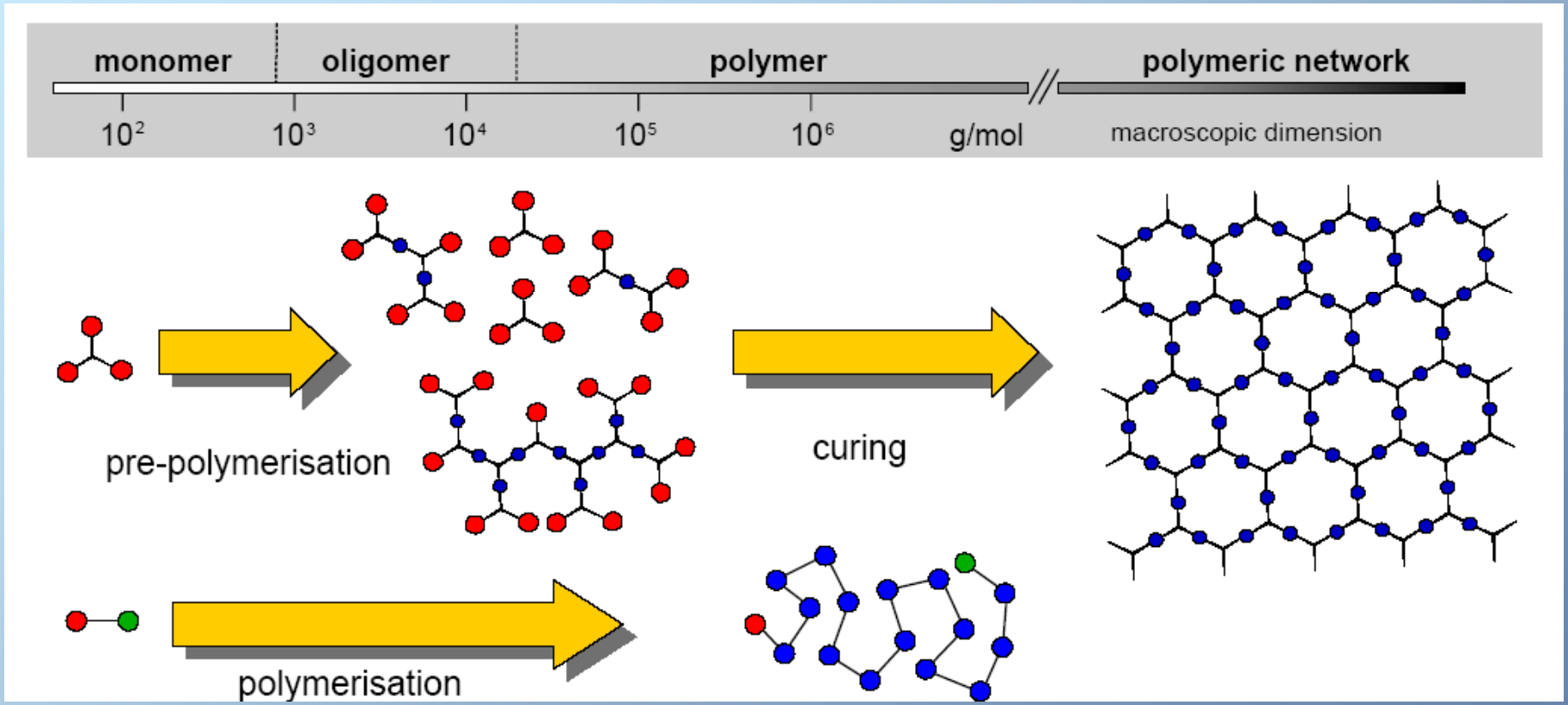
1. Primers - adhesion to the substrate, corrosion protection, paint adhesion,
2. Adhesive cements - materials with a suitable consistency coatings used for surfacing,
3. Topcoats with high resistance to external factors:

- Varnish - solution of film-forming substance in an organic solvent, for example: colorless varnish,
  Enamel - solution of film-forming substance, pigments (colorants), modifiers, additives in an organic solvent
- Paints - solution of film-forming substance, pigments (colorants), modifiers, inorganic anti-corrosion additives in an organic solvent.

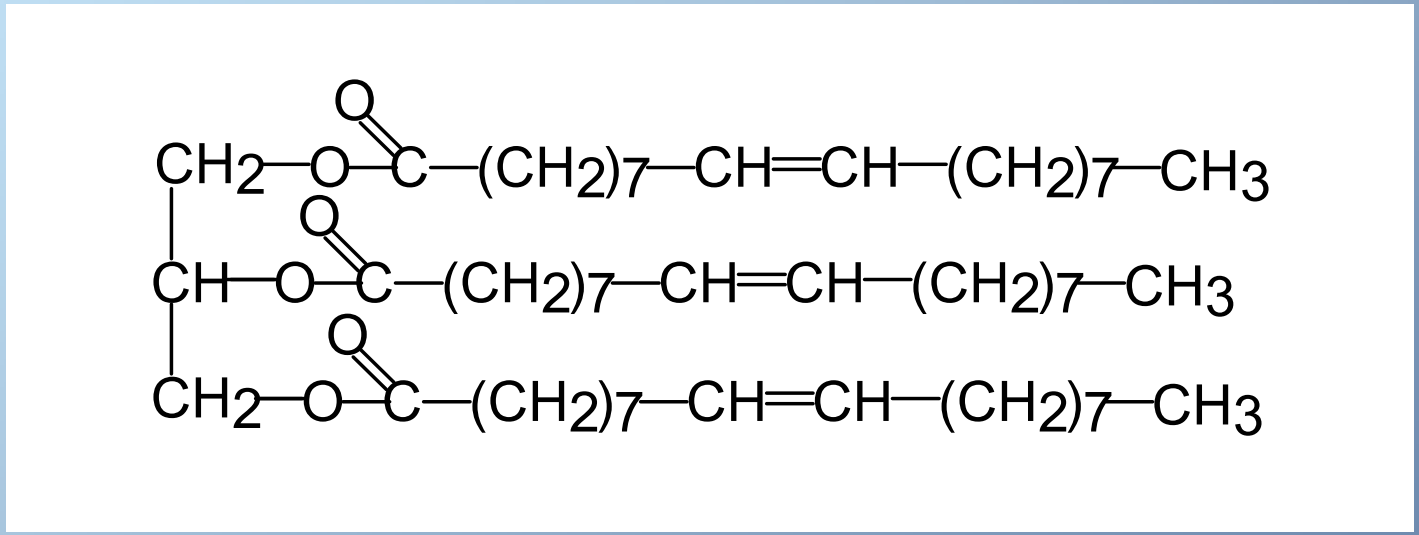
Corrosion and corrosion protection



Scheme of polimerisation process



Drying oils - glycerol esters of fatty acids, mainly unsaturated. Obtained from seeds and fruits (sunflower, cotton, flax, etc.). They have the ability of drying in the air (chemical curing). Currently used as modifiers in synthetic resigns (alkyd, phenolic).



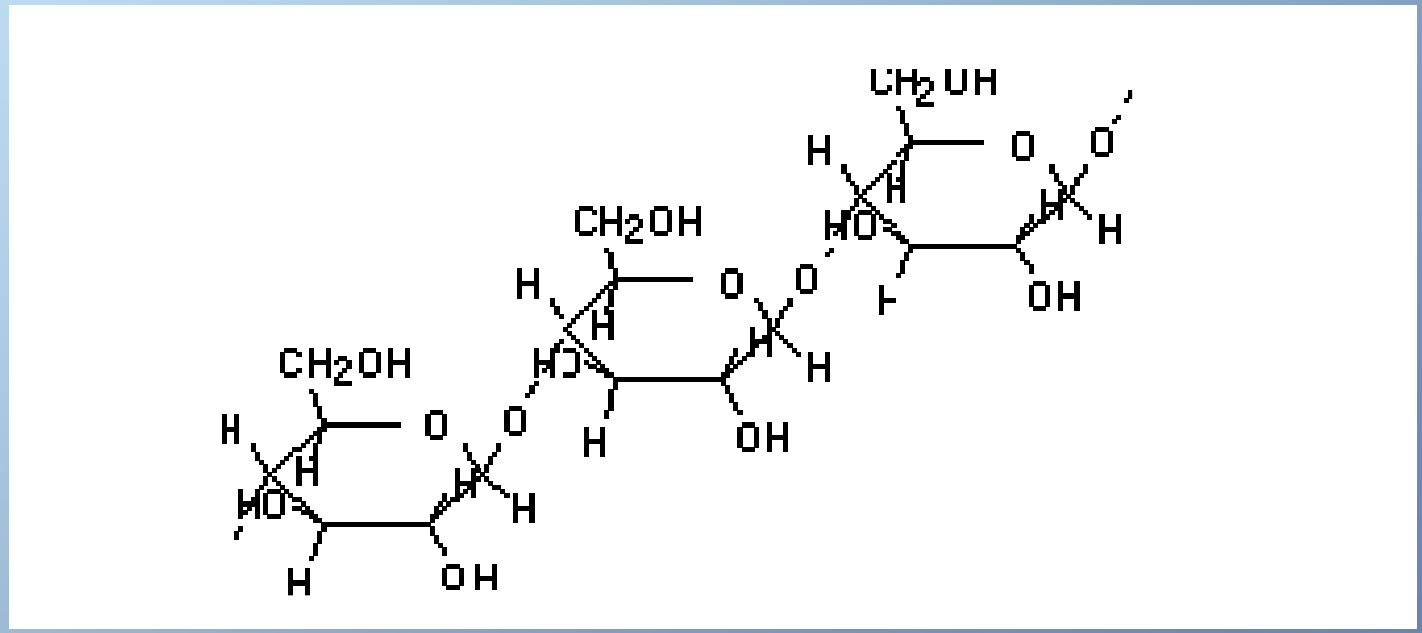
Esther of glycerol and oleic acid

Bitumens - mixtures of hydrocarbons of high molecular weight and the products of its oxidation and polymerization. They are divided into natural and synthetic. The main advantage of bituminous coating is waterproofing, a disadvantage - the ability for the oxidation (aging). Typical composition of bitumen is given in the table below:

	Natural bitumens [% w]	Synthetic bitumens
Mineral oil	47	67
Resins	32	16
Asphaltenes	16	15
Asphalt-forming acids and other	5	2

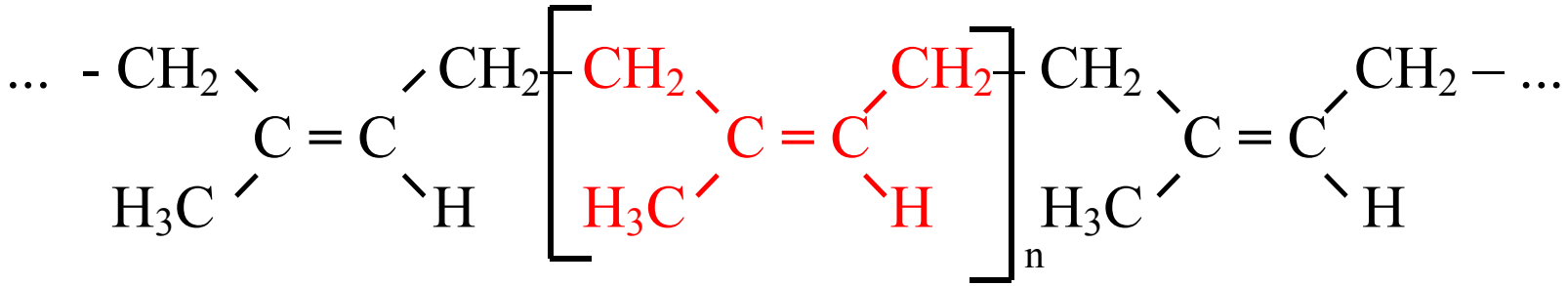
Fossil resins, vegetable resins of high hardness, high melting point (up to 300°C), low solubility. Used to produce high-quality oil paints. Now lost their significance.

Cellulose derivatives - cellulose esters and ethers, the most important: nitrocellulose, methyl and ethyl cellulose. Their advantage is the ease of drying and durability, the disadvantage - low dry matter content in the binder and solvent toxicity.



Cellulose

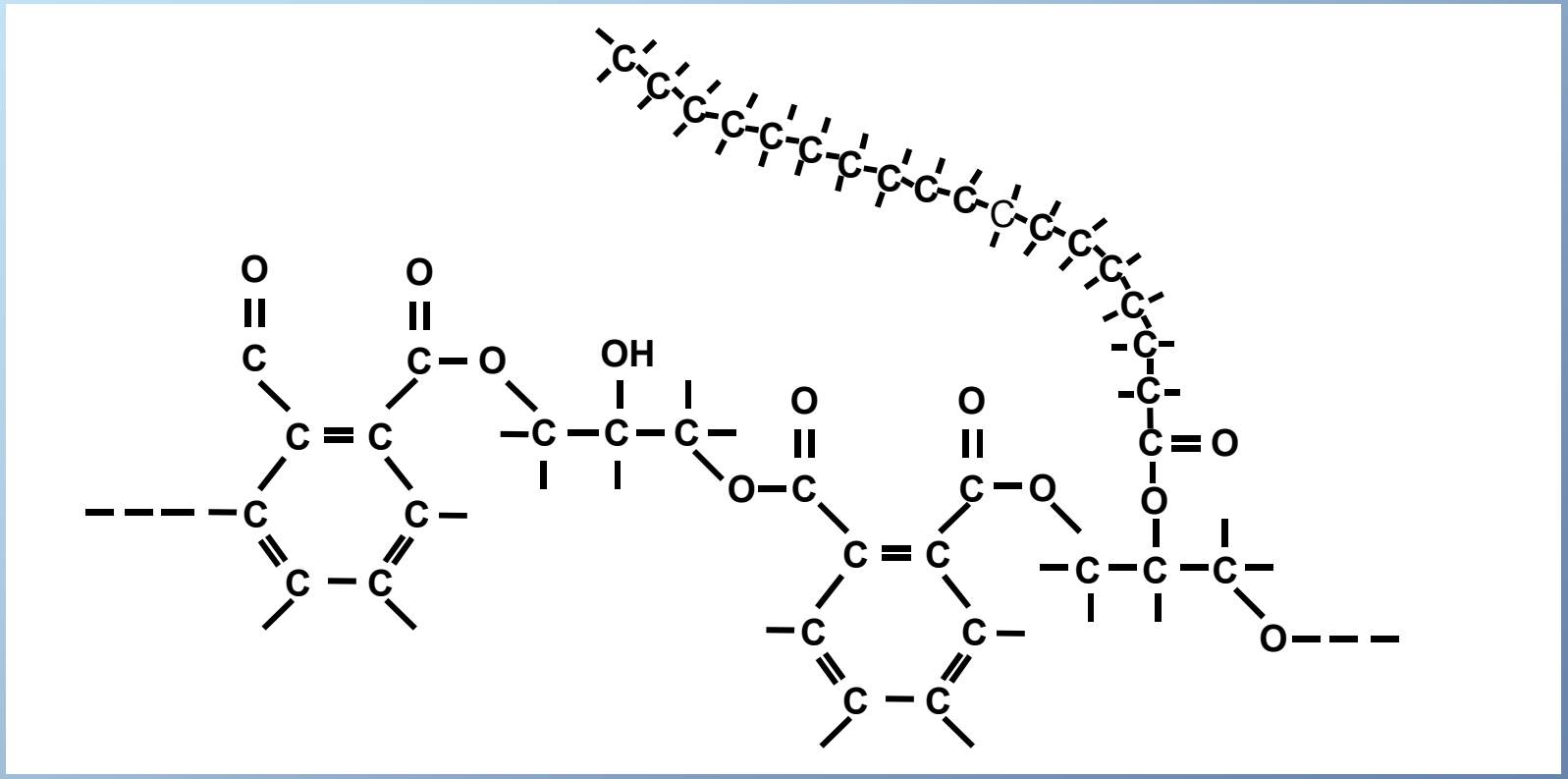
Natural rubber - used in the form of derivatives: chloro-rubber and cyclo-rubber. Protective coatings of derivatives of natural rubber are non-flammable, resistant to acids and alkalis, have high gloss and good adhesion. Chlorinated rubber is widely used in anticorrosive coating products for industrial machinery, shipbuilding and construction. Cyclized rubber is used to produce fast-drying coatings, especially for printing.



Natural caoutchouc (polyizoprene)

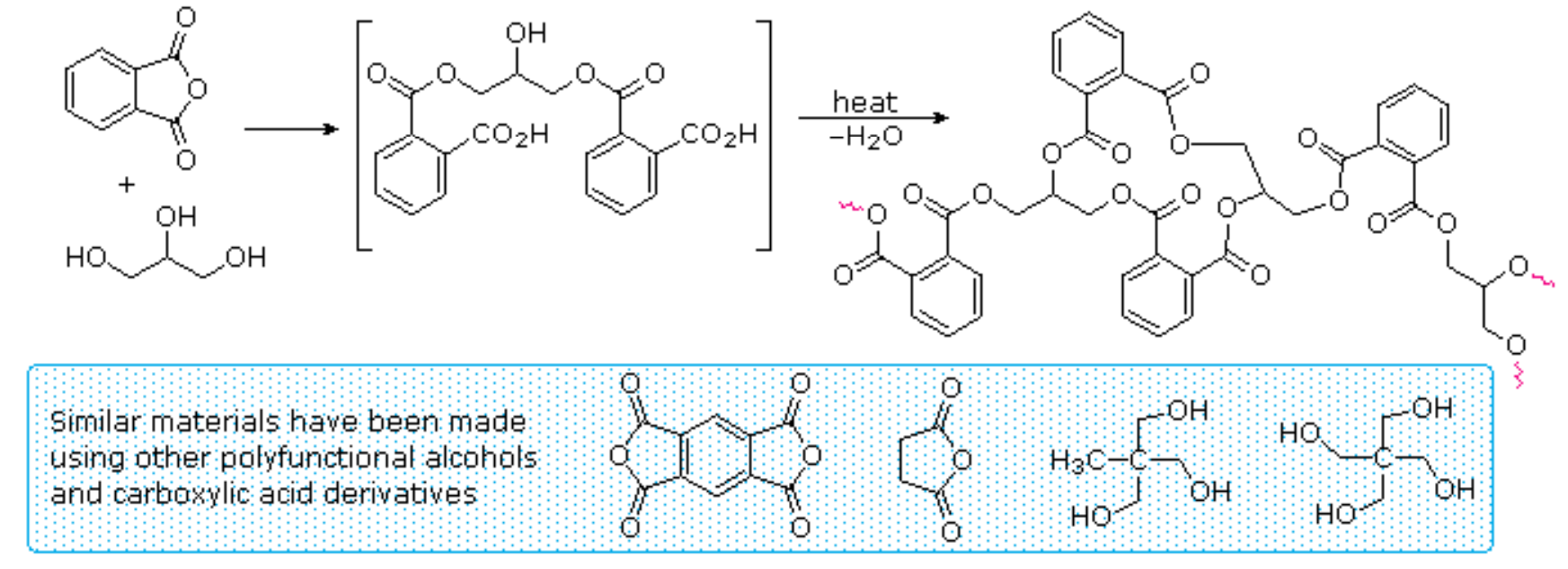
Casein - fosfoproteid - protein containing the amino acid with phosphorus in a molecule. It is derived from cow's milk. Casein paints are mainly used in construction and coloring of the skin.

Alkyd resins – products of polyester resins modification with oils, mostly vegetable



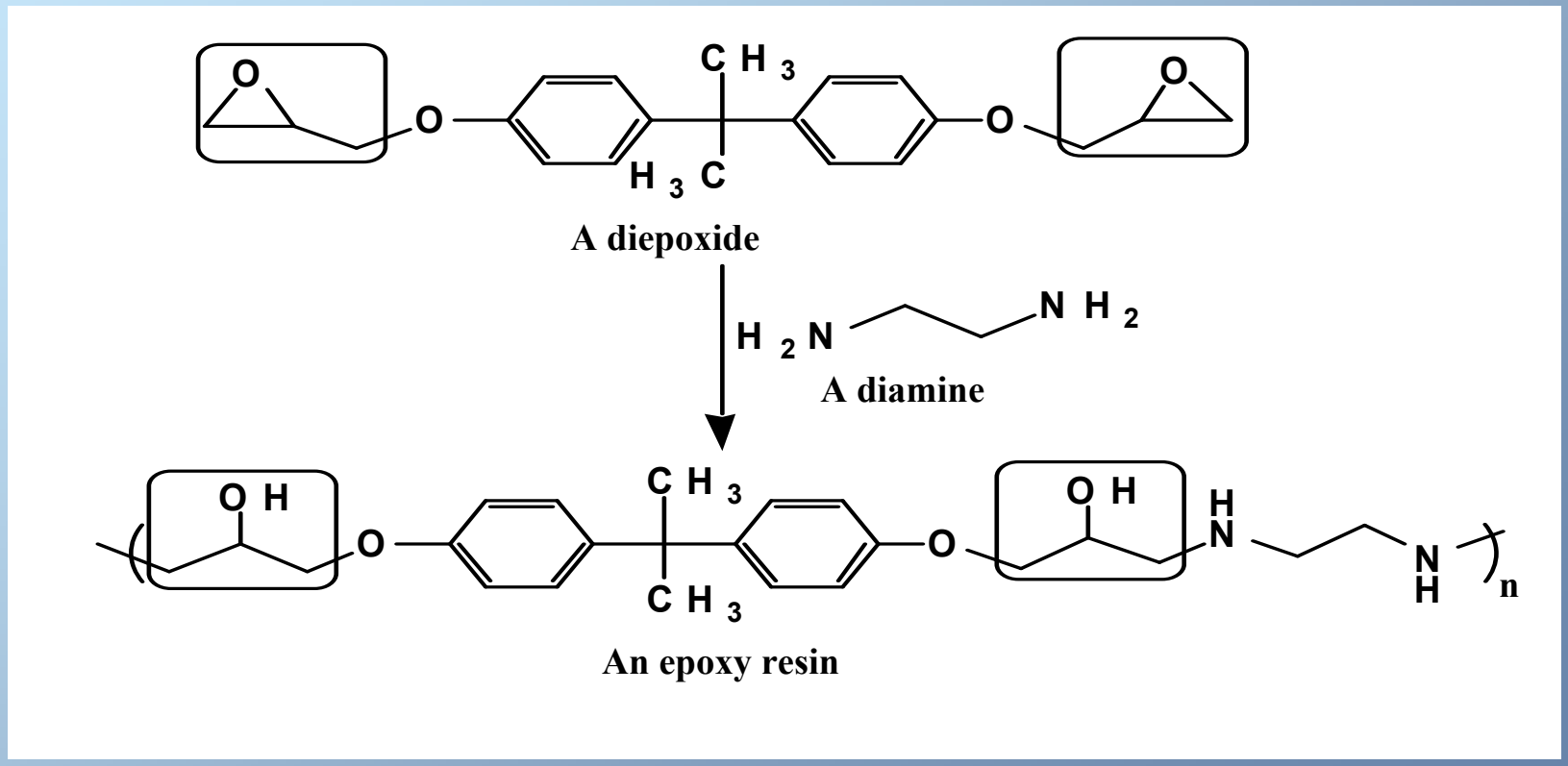
Alkyd resin

Polyesters - polycondensation products of polyhydric alcohols and polycarboxylic acids. The great variety of physical and chemical properties associated with various polyester construction makes them widely used, for example: polyesters formed in the reaction of phthalic anhydride and maleic acid with glycols are widely used in the furniture industry.



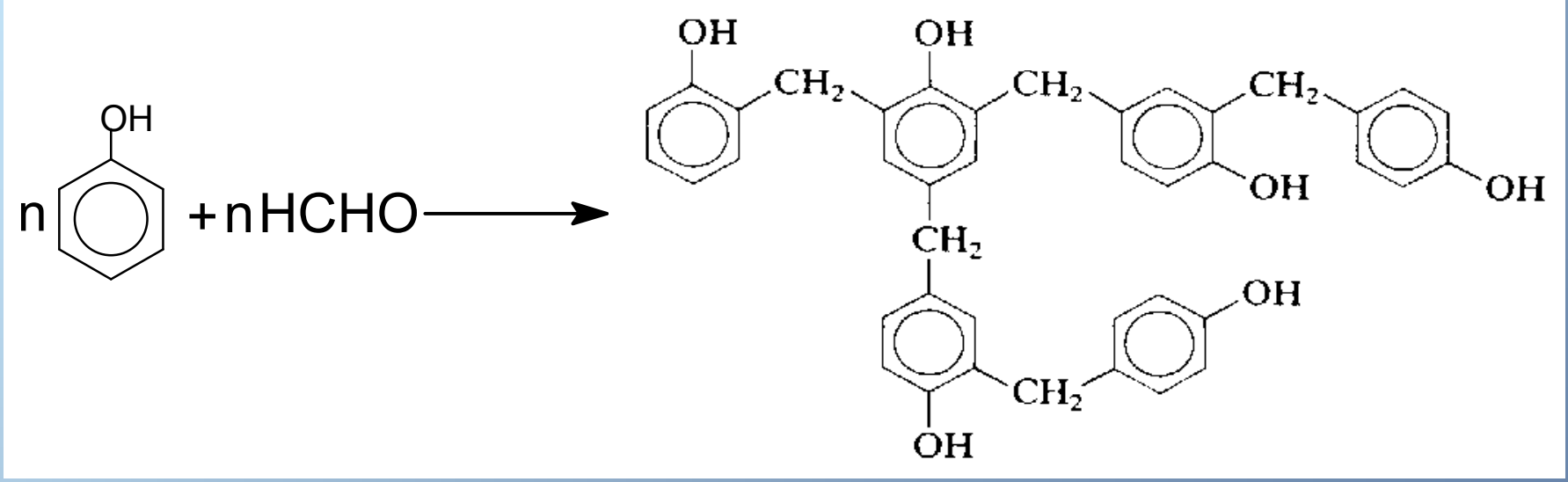
Formation of polyester resin

Epoxy resins - products of polymerization of bisphenol A and epichlorohydrin. The best properties shows coatings of the resins of molecular weight of 800-1000u. Due to the high reactivity at room temperature epoxy paints are used most often in the form of two-component (resin + hardener). Curing agents are polyamines and polyaminoamides.



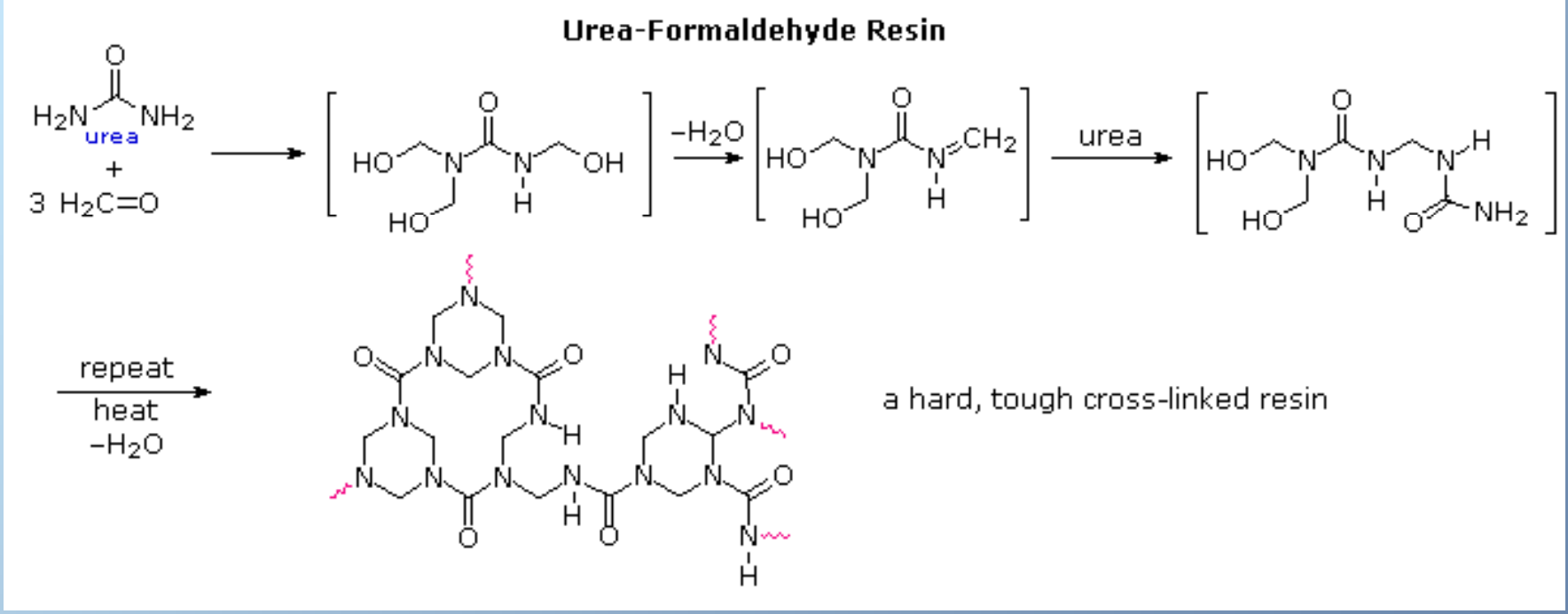
Formation of epoxy resin

Phenolic resins - used alone (resoles) or in modified form. These resins, cured at a temperature of 150°C - 205°C produce coatings resistant to water, acids, organic solvents and inorganic substances besides bases. The modification consists in introducing into the molecule of polyamides the epoxy resins and improves the flexibility of the coating.



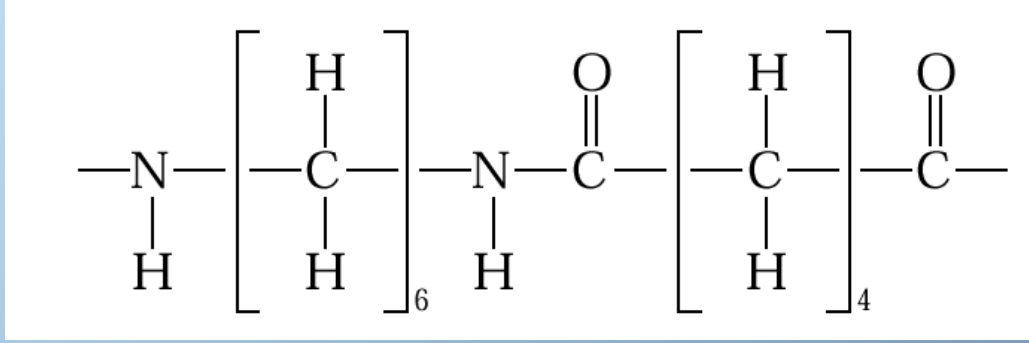
Formation of phenolic-formaldehyde resin

Amino resins - usually urea - formaldehyde or melamine - formaldehyde. Serve as a curing alkyd resins and acrylic polymers recently.



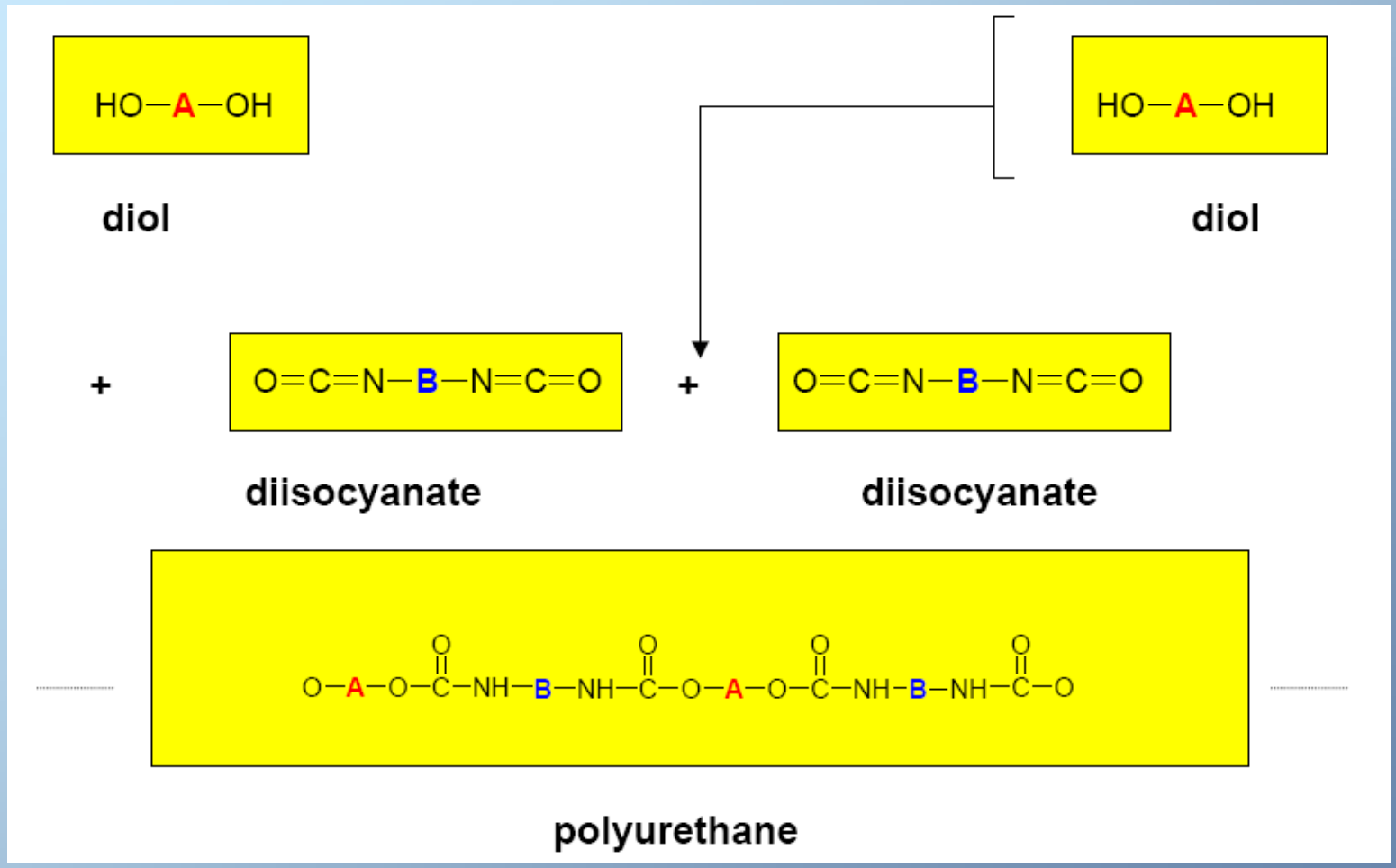
Formation of urea-formaldehyde resin

Polyamides - products of condensation of long chain fatty acids with polyamines of molecular weight of 2000 – 5000u. They are also used as a modified with rosin esters and alkydes.



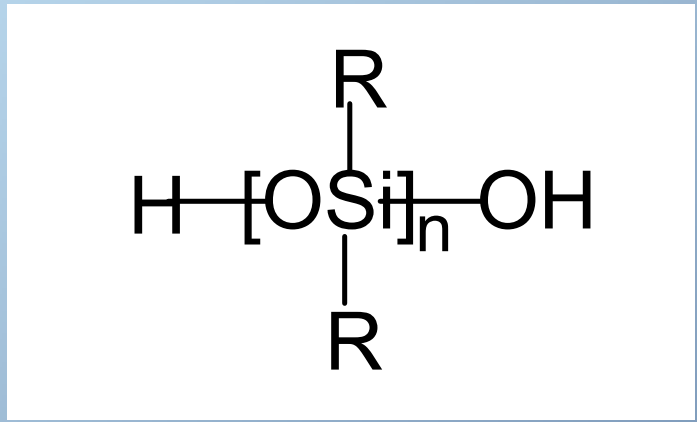
Polyamide chain (nylon)

Polyurethanes - derived from diisocyanates and oligomers with-OH groups.



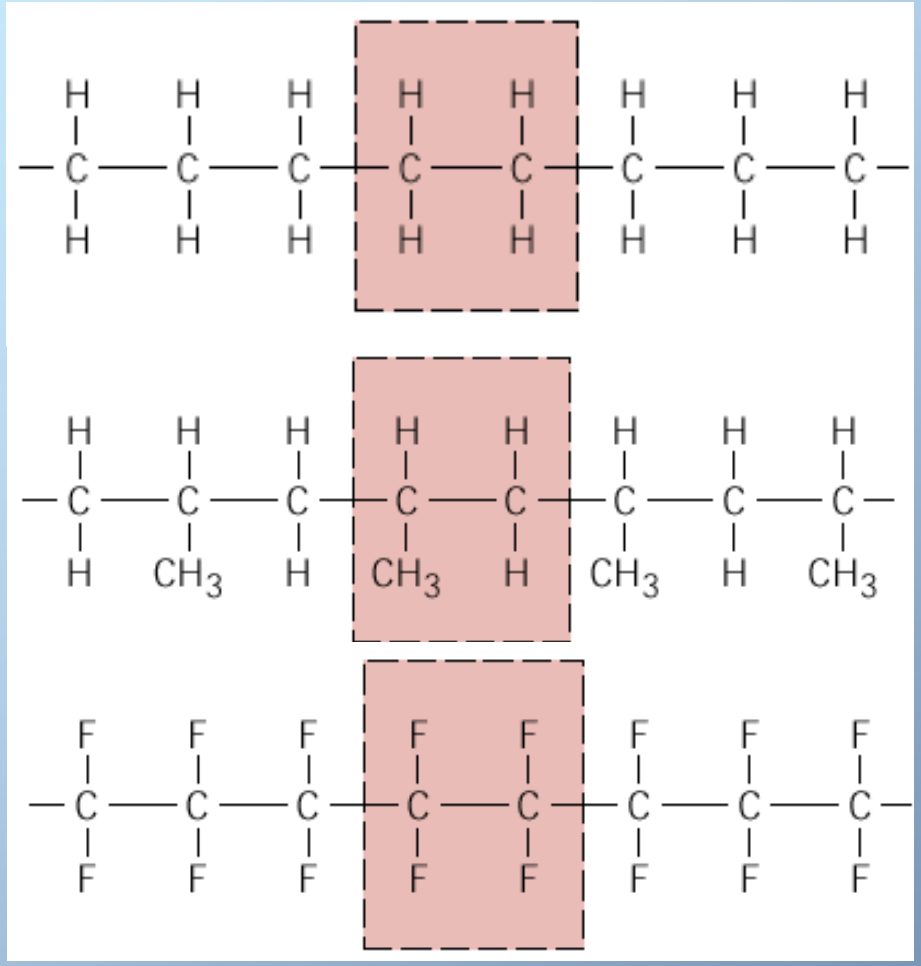
Formation of polyurethane

Silicones - organosilicon resins containing siloxane bond. High temperature resistant (250° - 300°C) and with the use of metal filler (aluminum) - even up to 650°C.



Silicon

Polyolefins - addition polymers used in the manufacture of powder coatings. The most common are polyethylene, polypropylene, Teflon



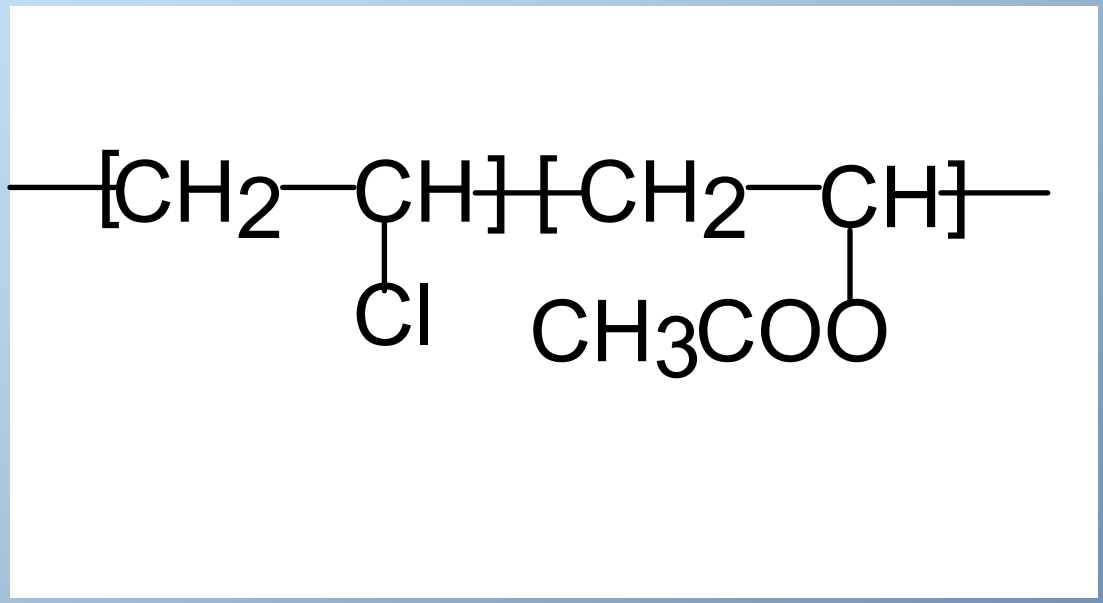
poliethylene (PE)

polipropylene (PP)

poli(tetrafluoroetlylene)

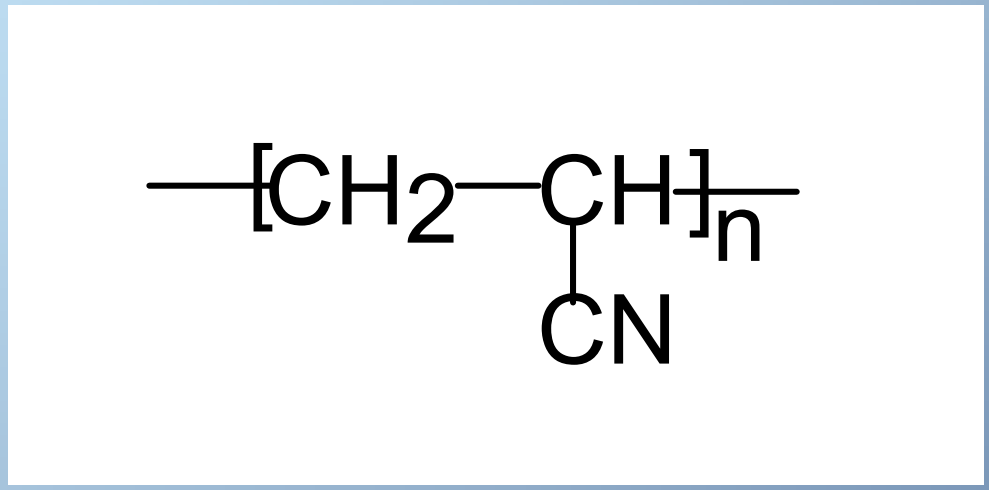
Teflon (PTFE)

Vinyl chloride and vinyl acetate polymers – copolymers, applied ussualy as water emulsion as paints.



Chain of vinyl chloride and vinyl acetate copolymer

Acrylic polymers - polymers and copolymers of acrylic and metacrylic acid and their derivatives (esters, nitriles, amides). Exhibit excellent resistance to corrosion and hydrolysis both in acid and alkaline. Is a key base coatings for the automotive industry.



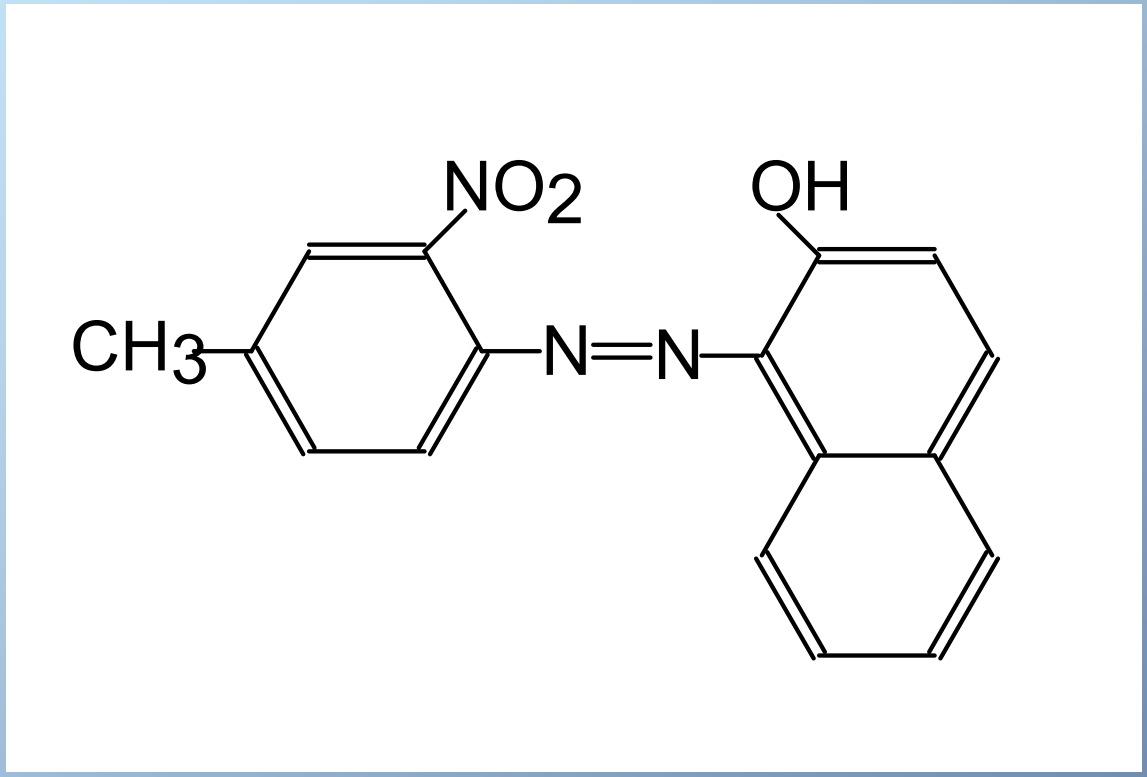
Polyacryllic nitride

Pigments - insoluble white or colored body fit and color of the product, together with fillers that provide coverage of the protected surface coating. Represent the largest cost of paints and varnishes. There are both inorganic pigments and organic.

Inorganic pigments:

- red lead Pb_3O_4,
- titanium dioxide TiO_2,
- iron oxides such as iron glance - hematite, Fe_2O_3,
- chrome green Cr_2O_3,
- zinc oxide ZnO,
- zinc sulfide and barium sulfate (lithopone) $ZnS/BaSO_4$,
- ultramarine ($Na_2Al_6Si_5O_{24}S_2$),
- soot C,
- zinc phosphate $Zn_3(PO_4)_2$,
- triphosphates of aluminum,
- borates $X_3^{n+}(BO_3)_n$,
- ferrite pigments $MeO{\bullet}Fe_2O_3$ (Me = Mg, Ca, Sr, Ba, Fe, Zn, Mn),
- zinc dust

Organic pigments - usually azo-compounds.



Lithol scarlet

Fillers - powdered minerals added to the paint, partially replacing expensive pigments.

The most commonly used fillers:

- calcite $CaCO_3$,
- talc $3MgO \cdot 4SiO_2 \cdot H_2O$,
- barite $BaSO_4$,
- kaolin $Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$,
- silica SiO_2,
- mica $K_2O \cdot 3Al_2O_3 \cdot 6SiO_2 \cdot H_2O$

Solvents: liquids, usually organic, which are soluble binder, without changing the chemical properties.

The main criteria for selection of solvents:

- dissolving ability
- volatility,
- smell,
- ignition temperature,
- toxicity,
- price.

The most commonly used solvents:

- aliphatic - hydrocarbons with a chain structure obtained during the distillation of crude oil, such as white spirit, light, etc.,
- alcohols - ethanol, propanol, butanol, glycols,
- esters - propyl acetate, butyl acetate,
- ketones - acetone,
- aromatics - benzene homologues of benzene, toluene, xylenes - the most toxic (carcinogenic)

The most important physical and mechanical properties and protective coatings:

- adhesion,
- flexibility,
- abrasion,
- hardness,
- water resistance (porosity, swelling, permeability),
- resistance to chemicals, light, temperature change.

The aging of organic coatings

Aging - changes in the structure of the shell due to external influences resulting in the loss of protective properties of the coating.

The processes of aging are caused by:

- oxidizing agents (oxygen, ozone),
- high temperature,
- light (UV factor),
- aggressive chemicals.

Ageing under the influence of oxygen from the air occurs by a free radical mechanism:

induction phase - formation of free radicals under the influence of oxygen

$$RH \xrightarrow{+O_2} R^{\bullet} + HO_2^{\bullet}$$

- chain growth

$$R^{\bullet} \xrightarrow{+O_2} RO_2^{\bullet} \xrightarrow{+RH} ROOH + R^{\bullet}$$

$$R^{\bullet} \xrightarrow{+O_2} RO_2^{\bullet}$$

- ending of the chain

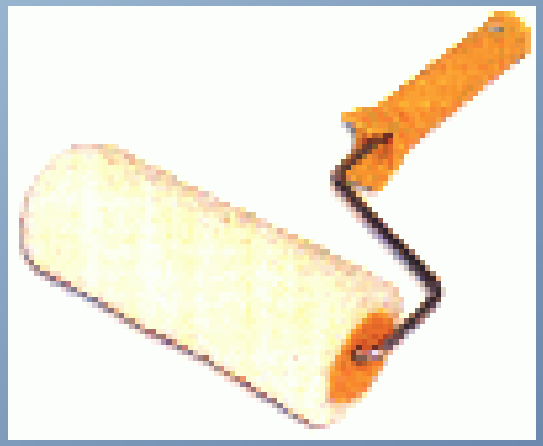
$$2R^{\bullet} \longrightarrow R\text{-}R$$

$$RO_2^{\bullet} + R^{\bullet} \longrightarrow ROOR$$

$$RO_2^{\bullet} \longrightarrow ROOR + O_2$$

Deposition of coatings:

- hand painting:
  - brushing,
  - paint roller,



Spray painting:

- air spray,
- airless spray,
- electrostatic spraying,

Dip painting,

- painting curtain
- electrophoretic painting,
- fluidization,
- roller coating and laminating.