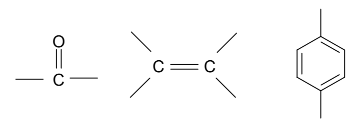
Chromophores in wood and kraft pulp

Lecture 9

Chromophores

- Greek *chroma; 'colour'* and *phoros; 'bearing'*
- Chromophore is an organic structure which gives rise to colour
- Some chromophores:



Auxochrome

(Greek *auxanein, "to increase"*)

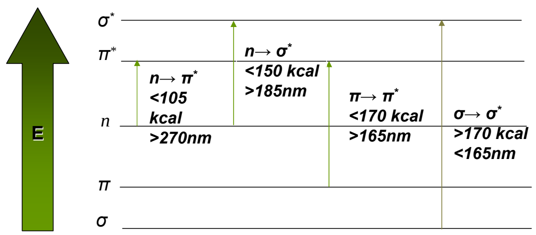
- Auxochromes are groups that can intensify the colour
- Auxochormes are only able to undergo $n \rightarrow \pi^*$ transition
- Some auxochromes:

-OH -OR $-NH_2$ etc.

Electron transitions of chromophores

- Chromophore is an unsaturated group that can undergo $\pi \rightarrow \pi^*$ and $n \rightarrow \pi^*$ transitions
- What does this mean?
  - Light radiation is absorbed by a compound
  - Energy of absorption causes excitation in the compound and leads to transition of electrons to higher energy levels
  - Electron transition gives rise to ultraviolet or visible spectra

Energy requirements for electronic transitions



Chromophores and colour

- Sufficient amount of conjugated double bonds and other chromophoric structures in the compound shift the absorption to wavelengths that reach into the visible region of the spectrum

➡ **Compound will appear coloured**

Colours in the visible spectrum

- Chromophores usually absorb UV (λ=250-400 nm) or visible light (λ=400-750 nm)

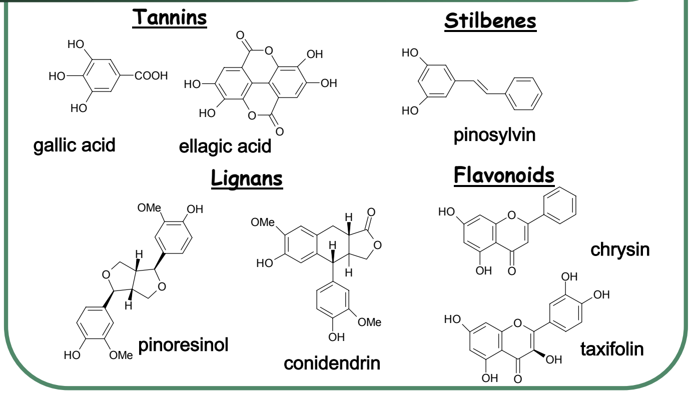
(Fessenden & Fessenden, Organic Chemistry. 5th edition)

Wavelength, nm	Absorbed colour	Apparent colour
400-424	violet	green-yellow
424-491	blue	yellow
491-570	green	red
570-585	yellow	blue
585-647	orange	green-blue
647-700	red	green

Choromophores in native wood

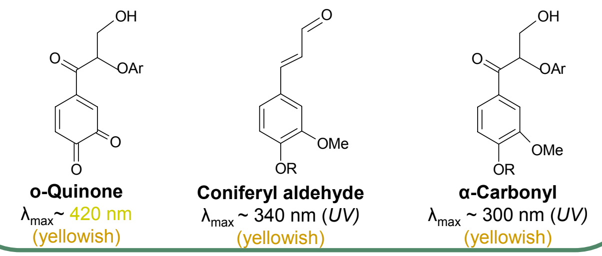
- Chromophore compounds in native wood:
  - light basic colour of wood derives from certain structures of lignin
  - dark colours derive from certain extractives
    - i.e aromatic extractives
    - not all the extractives are coloured, for example fats, waxes, monoterpens, resin acids and sterols are colourless

Aromatic extractive structures



Colour of lignin

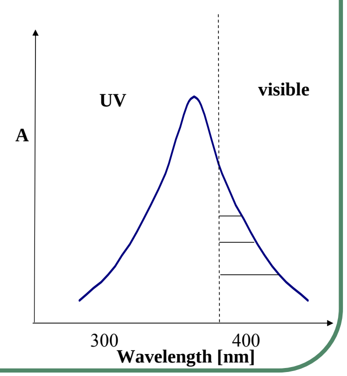
- The colour of lignin originates from oxydized structures
  - quinones, coniferyl aldehydes and α- carbonyl



Absorption of UV radiation

(Fessenden & Fessenden, Organic Chemistry. 5th edition)

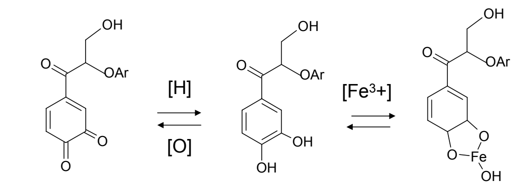
- Some coumpounds may appear yellow although their λ_{max} is in the UV range of the spectrum
- the tail of the absorption band extends into the visible region



Colour of lignin

- Main structures are o-quinones
  - λ_{max}~ 420 nm (yellowish)
- Reduced structures of quinones are catechols
  - λ_{max} ~ 280 nm (colourless)
- However catechols can form complexes with transition metals, like iron (III) ion
  - intensively coloured compounds

Colour of lignin



o-Quinone
λ_{max}~ 420 nm
(yellowish)

Catechol
λ_{max}~ 280 nm
(colourless / UV range)

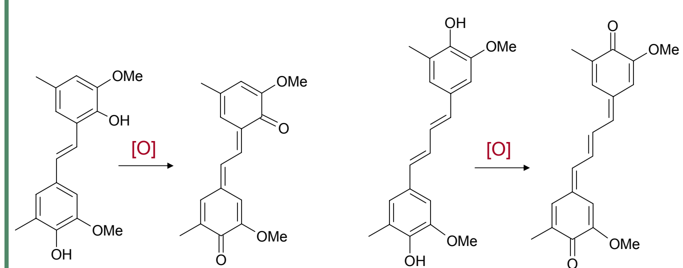
Complex
λ_{max}~ 550 nm
(reddish)

Colour of suphate pulp

Formation of new chromophores during sulphate pulping

- During the alkaline pulping choromophores of native wood will degrade
- Formation of new chromophores, e.g. stilbenes
  - ⇒ The colour of unbleached pulp
- Stilbenes are mainly formed from phenylic structures, such as phenyl coumaran and pinoresinol
- Oxidation of stilbenes
  - ⇒ stilbene quinones – strong colours

Formation of new chromophores during sulphate pulping



Aim of kraft pulp bleaching

- As mentioned before carbohydrate losses increase near the end of kraft cooking
  - Cooking has to be stopped when more than 90 % of the lignin is removed
  - Certain lignin – carbohydrate linkages are alkali stable
  - residual lignin remains in the pulp
- Aim of bleaching is to remove compounds that contribute to pulp colour:
  - chromophores
  - residual lignin
  - HexA