

Discolouration of wood in the living tree and during processing



PD Dr. Gerald Koch



Institute of Wood Technology and Wood Biology (HTB)
Federal Research Institute for Rural Areas, Forestry and Fisheries (VTI)

Content

1. Introduction
2. Occurrence of discolouration in wood
 - ➔ Discolouration in the living tree
 - ➔ Discolouration during storage
 - ➔ Discolouration during steaming and drying
3. Classification of reaction types responsible for discolouration
4. Summary and Conclusions



Occurrence of discolouration

- ➔ Discolouration in the **living tree** (red heart and wounding)
- ➔ Discolouration in **felled and logged wood** before steaming and kiln-drying
- ➔ Discolourations during **steaming and drying processes**
- ➔ Discolourations in kiln-dried wood after **renewed humidification**



Examples of discolouration in hardwoods



Gums in Black cherry
(Discolouration in the living tree)



Staining of Hard maple
(Discolouration during storage)



Oxidative staining of Framiré
(Discolouration during kiln-drying)



Iron-tannin stain of Oak
(Chemical reaction)

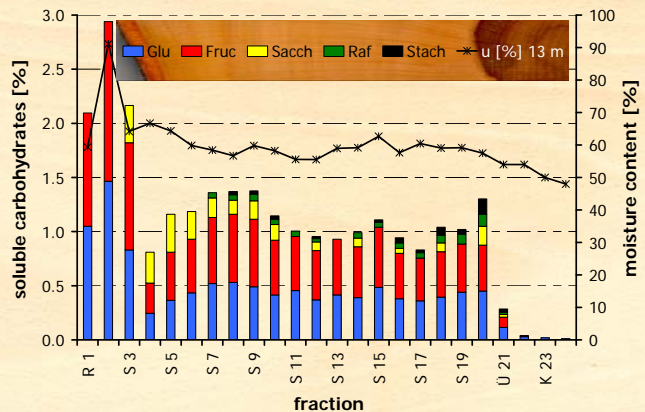
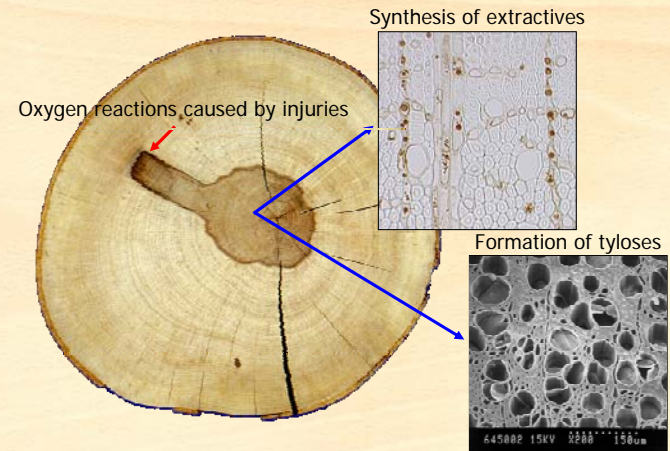


Classification of discolouration on the basis of the different types of reactions [According to Bauch 1984]

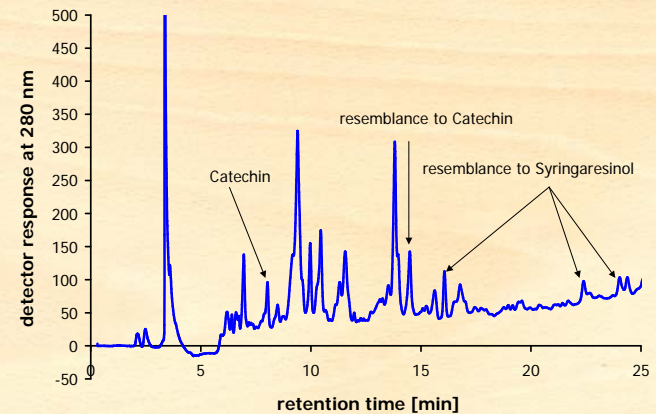
Cause	Example and Description
(1) Fungi	Blue-stain as in sapwood of <i>Pinus</i> due to the chromophoric pigments in the hyphae
(2) Physiological reaction in living cells	Formation of tyloses and accessory compounds as in <i>Fagus</i> due to the reaction of living parenchyma cells
(3) Biochemical reactions	Orange discolouration as in <i>Alnus</i> due to the enzymatic reaction of polyphenoloxidases inducing the production of oregonin
(4) Chemical reactions	Metal-tannin reactions as in <i>Quercus</i>
(5) Combination of reactions	Yellow discolouration of <i>Quercus</i> and <i>Castanea</i> due to a fungal infection and reaction of hydrolysable tannins



Physiological reactions in the living tree

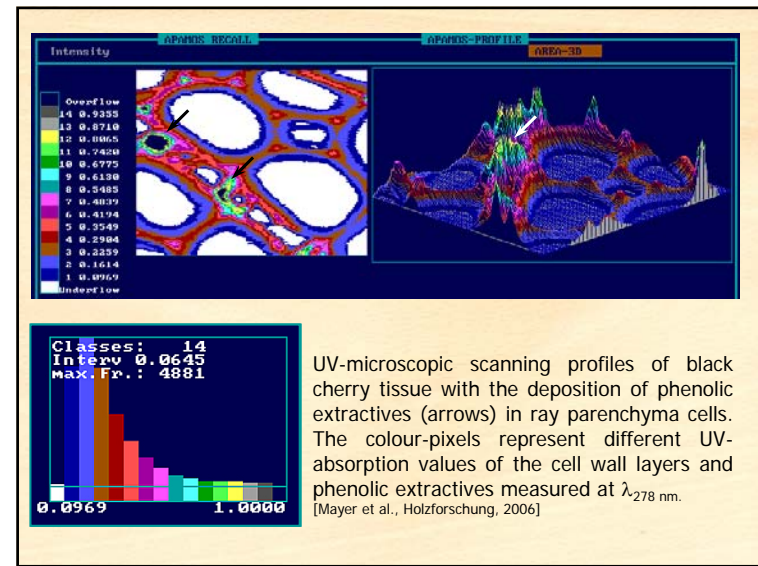
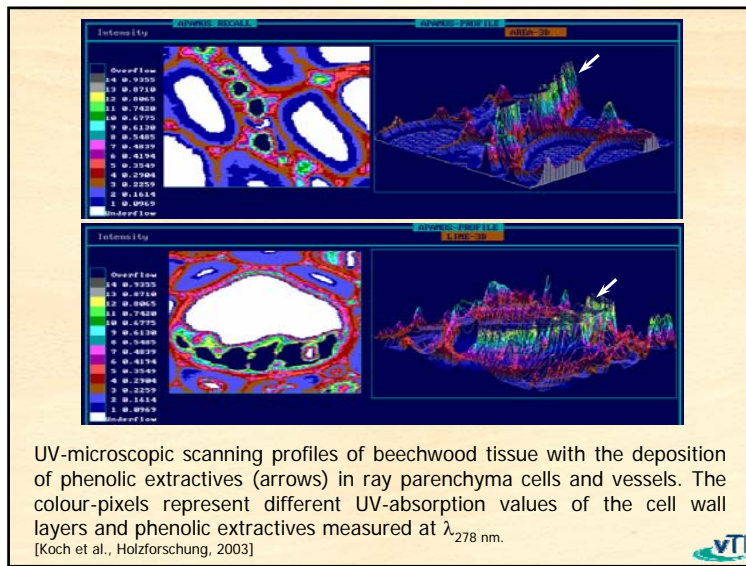
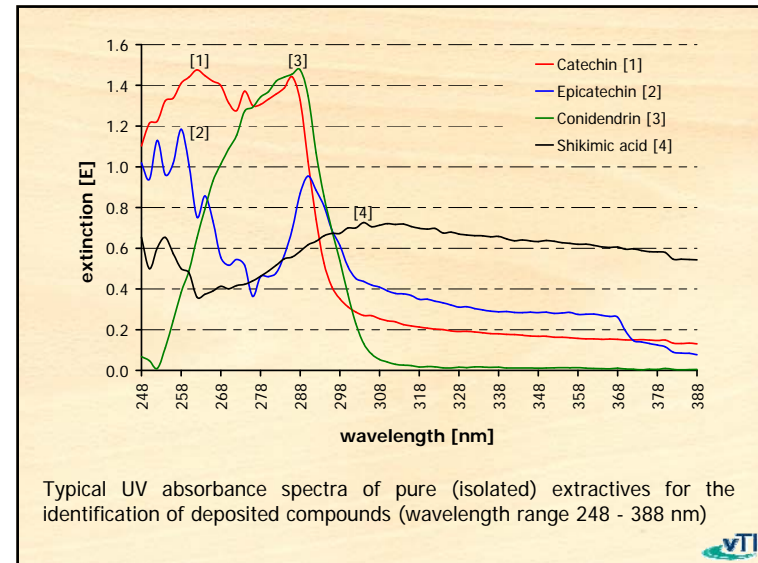
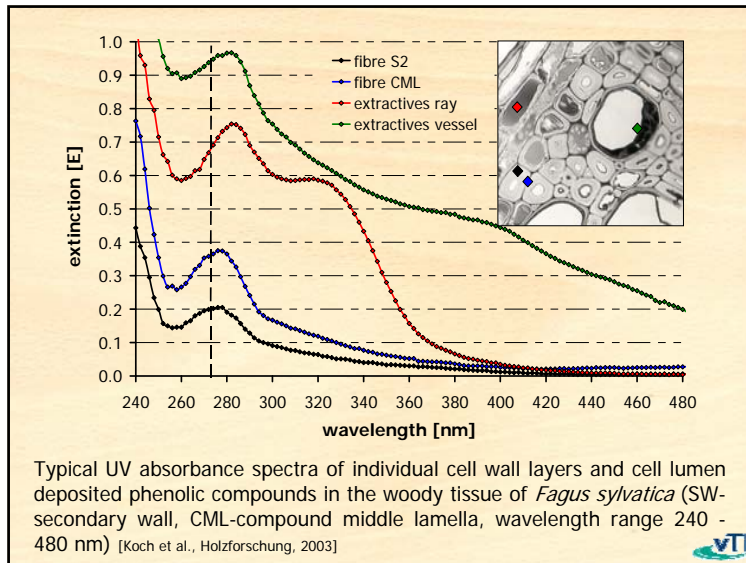


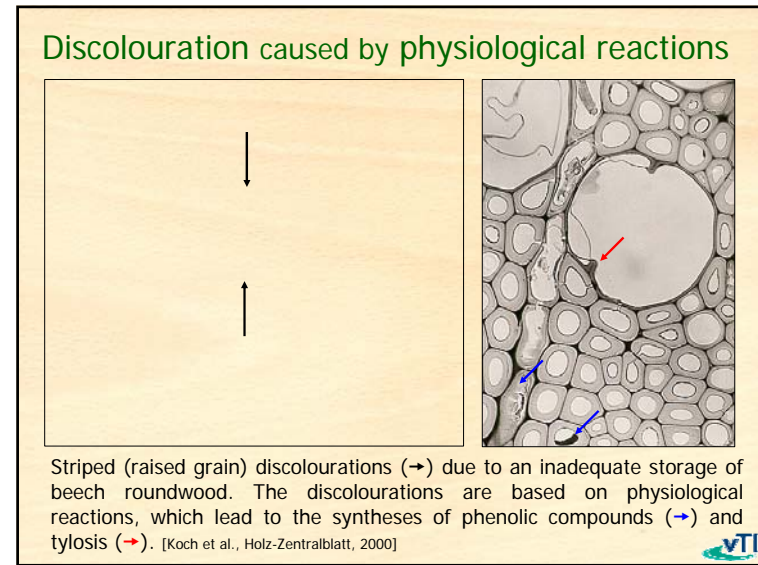
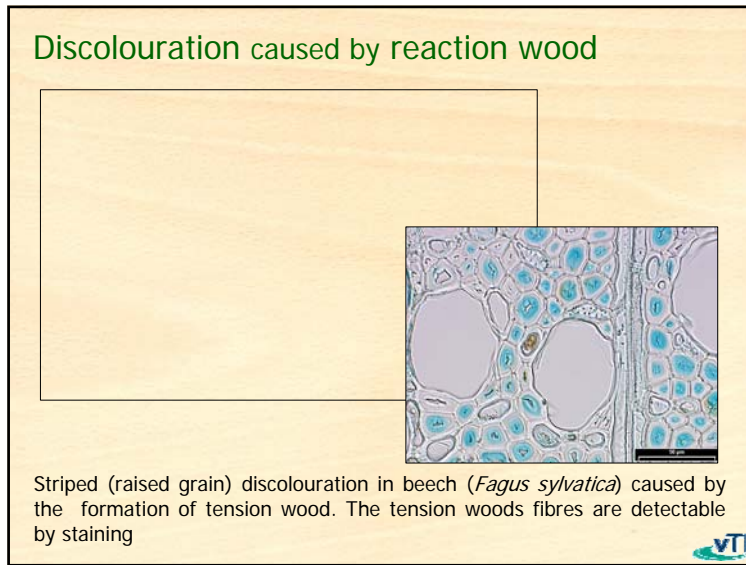
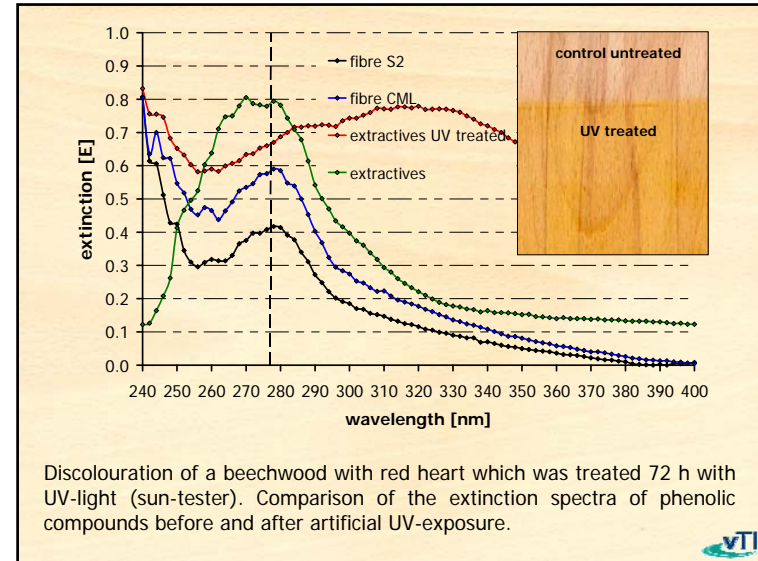
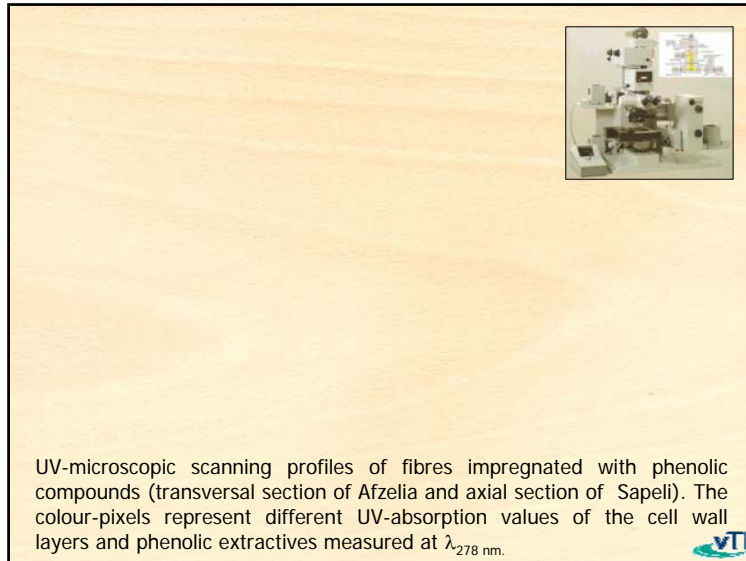
Distribution of soluble carbohydrates and moisture content in a cross section of beechwood with red heart (R-bark, S-sapwood, U-transition zone, K-red heart)



Representative HPLC chromatograms and methanol-water (3:1) extracts of different beechwood fractions (sapwood and red heart)







Discolouration caused by microorganismen

Fungal stain (→) at the wooden surface of steamed and not sufficiently ventilated sawn timber. In the discoloured areas hyphae (→ mycelium filaments) and the decay of the cell content (→) can be observed. [Koch et al., Holz-Zentralblatt, 2000]

Discolouration caused by chemical reactions

Discolouration (→) due to an accumulation of accessory compounds at the wooden surface during the drying process. The chromophoric compounds (→) can be detected in the lumina of the fibres. [Koch et al., Holz-Zentralblatt, 2000]

Discolouration caused by chemical reactions

Contamination with iron

**Detectable with
potassium-thiocyanat**

Discolouration in veneers of birch (*Betula* spp.) caused by a contamination with iron

Discolouration of Siberian larch (*Larix sibirica*) Formation of included sapwood - Methods

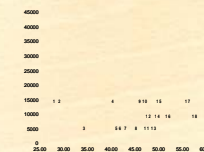


[– 2 cm –]

Microscopy

UV-Spectroscopy
(UMSP)

Chemical analysis
(HPLC)



Discolouration of Siberian larch (*Larix sibirica*) - Topochemical detection of extractives -

UV-microscopic scanning profile of cell wall deposited extractives in tracheids of Siberian larch. The colour-pixels represent different UV-absorption values of the cell wall layers and phenolic extractives measured at $\lambda_{280 \text{ nm}}$.



Summary

- The various kinds of **discolouration** in freshly felled and kiln-dried wood are described and classified according to the different **physiological, biochemical, and chemical reactions** involved.
- In **freshly felled and stored round wood** discolourations are initiated predominantly through **physiological reactions of living parenchyma cells**. Typical reactions are the formation of phenolic compounds and tyloses triggered by oxygen penetrating the tissues. Discolourations can also be caused by **microorganisms**, for instance blue stain fungi, mould fungi, and bacteria which affect the wood surface of inadequately stored and kiln-dried wood.
- The **discolouration during kiln-drying** and steaming are based mainly on **chemical reactions of the accessory compounds** and cell wall components in the woody tissue. The reaction mechanisms are dependent on the process parameters and chemical composition of the wood which have to be determined in individual cases

