



Colour change monitoring of photodegradation in Scots pine (*Pinus sylvestris*) – a short term focus

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Overview of Presentation

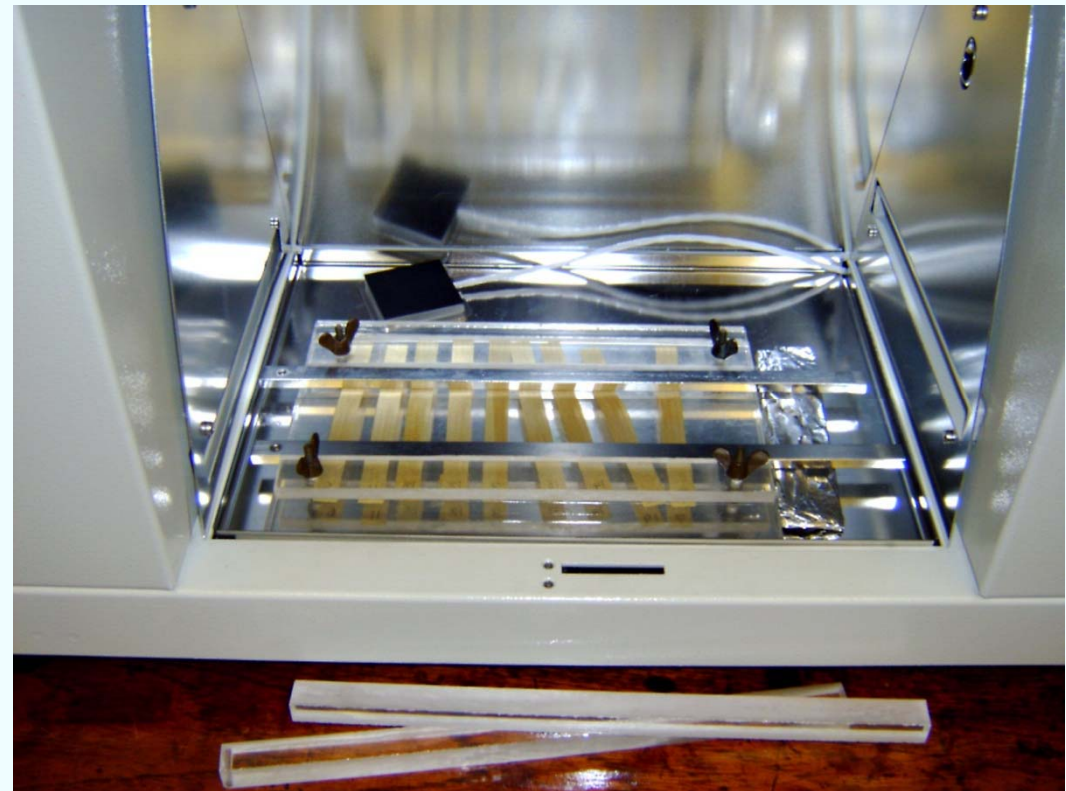
- **Introduction** - different methods which can be used in monitoring photodegradation
- **Comparison** - of the methods for the same sample groups
- **Conclusions** - from the comparison
- **Focus** - on Colour monitoring
- **Summary** - of presentation

Photodegradation

- Irreversible (degradative) changes due to light (UV and visible)
- Affects lignin primarily
- Chromophore formation from photo-oxidation of lignin (stillbenes and quinones)
- Scission of lignin - forms water soluble fragments and gases
- Lignin bonding strength loss
- Loss of cellulose fibrils
- Species variable profile

Exposure details

- 100 μ m microtomed Scots pine strips
- Exposed using Atlas Suntest (Xenon light source 300-800nm)
- Quartz filter mimicking outdoor global solar spectrum
- 500 W/m² at 40 \pm 5 °C (blackbody)
- Control samples in foil

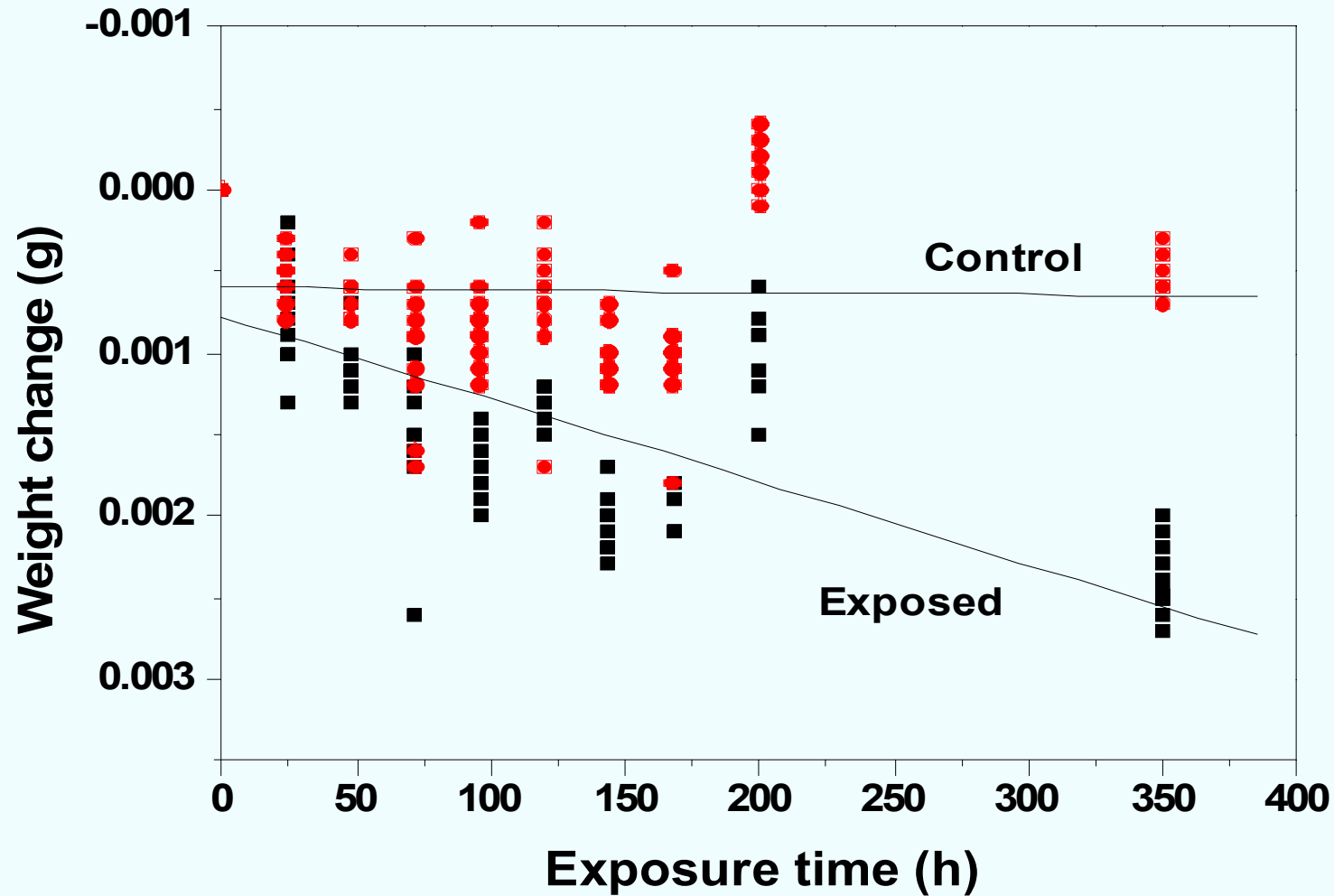


Monitoring methods in Photodegradation studies

- Weight change monitoring
- Micro-tensile change testing
- Colour monitoring

Weight changes

- Samples were Scots pine microtomed strips
- Samples were acclimatised at 20°C, 60% RH for ≥ 3 days
- Samples were weighed prior to exposure (inc. controls)
- After exposure samples were re-acclimatised at 20°C, 60%RH
- Samples were re-weighed to calculate changes due to exposure



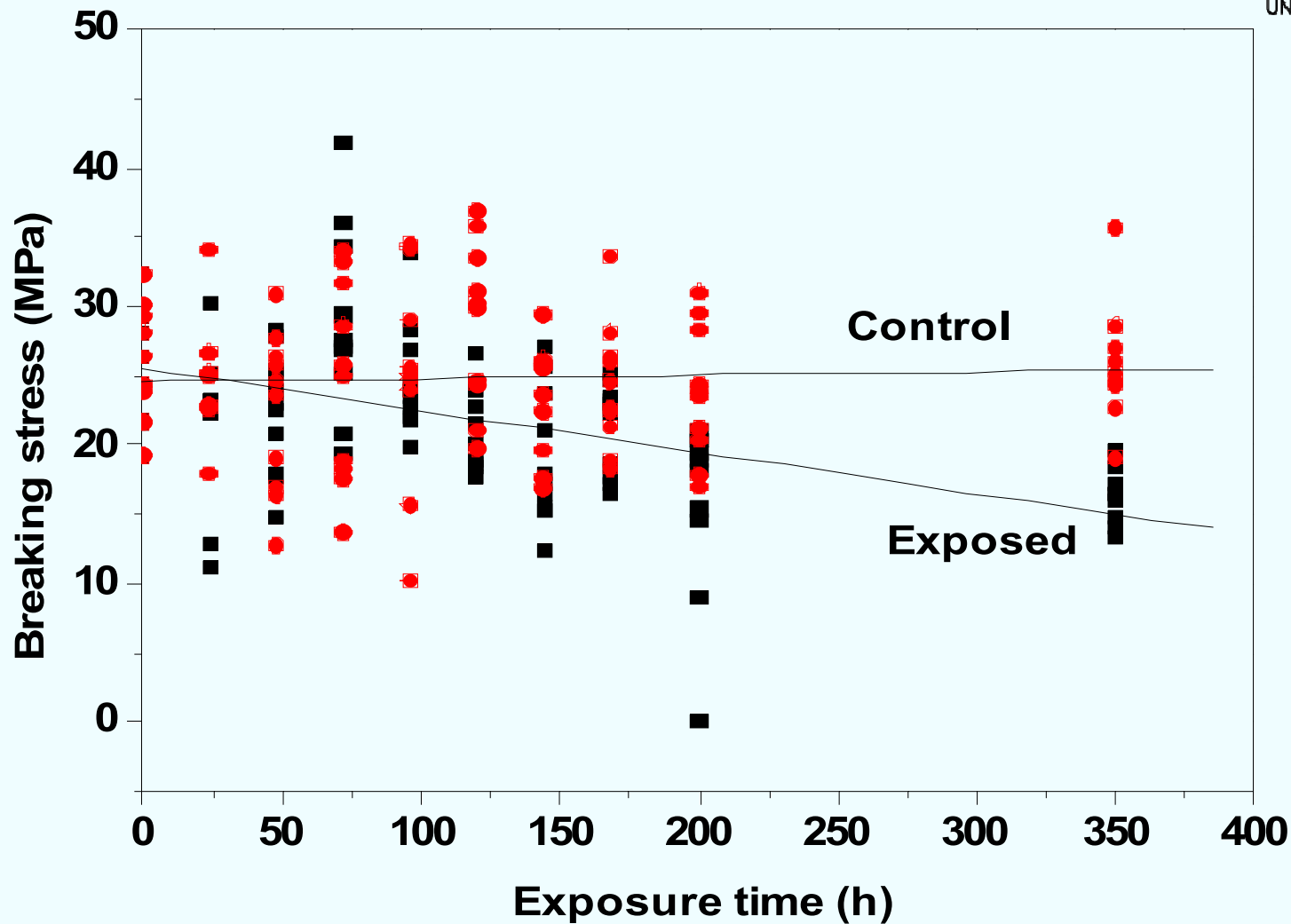
Weight changes occurring due to accelerated sunlight exposure over 350 hours

Microtensile strength tests

- All samples conditioned to at 20°C, 60%RH for ≥ 3 days
- Strips broken on Instron 4301
- Elongation rate 1.2mm/min
- Gauge length 20mm
- Tensile breaking stress calculated

$$\text{MPa} = \text{N} \times \text{m}^2$$



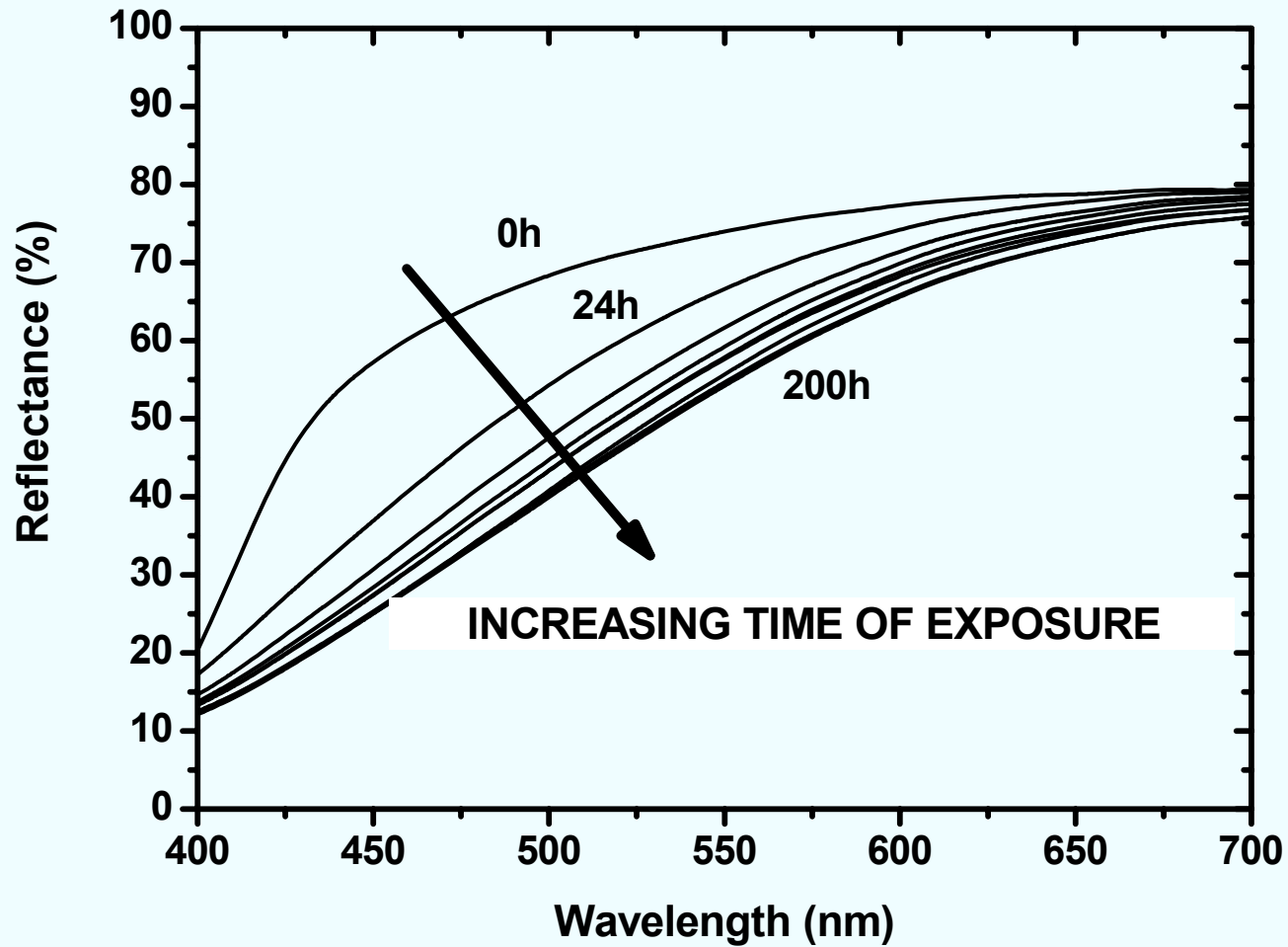


Micro-tensile changes occurring due to accelerated sunlight exposure over 350 hours

Colour monitoring

- Colour measured using Datacolor check system
- Reflectance 400 nm - 700 nm (every 10 nm)
- D65 illumination at 10° standard observation
- Colour of all samples measured prior to and post exposure
- CIE-L*a*b* and ΔE also calculated





Variations in reflectance spectra due to accelerated sunlight exposure within the first 200 hours



Comparison of three methods

- Both weight and micro-tensile changes become significant at 350 hours exposure.
- Colour changes are significant at 24 hours and possibly earlier.
- Colour monitoring is the most sensitive method out of the three covered here.

Focus on colour monitoring

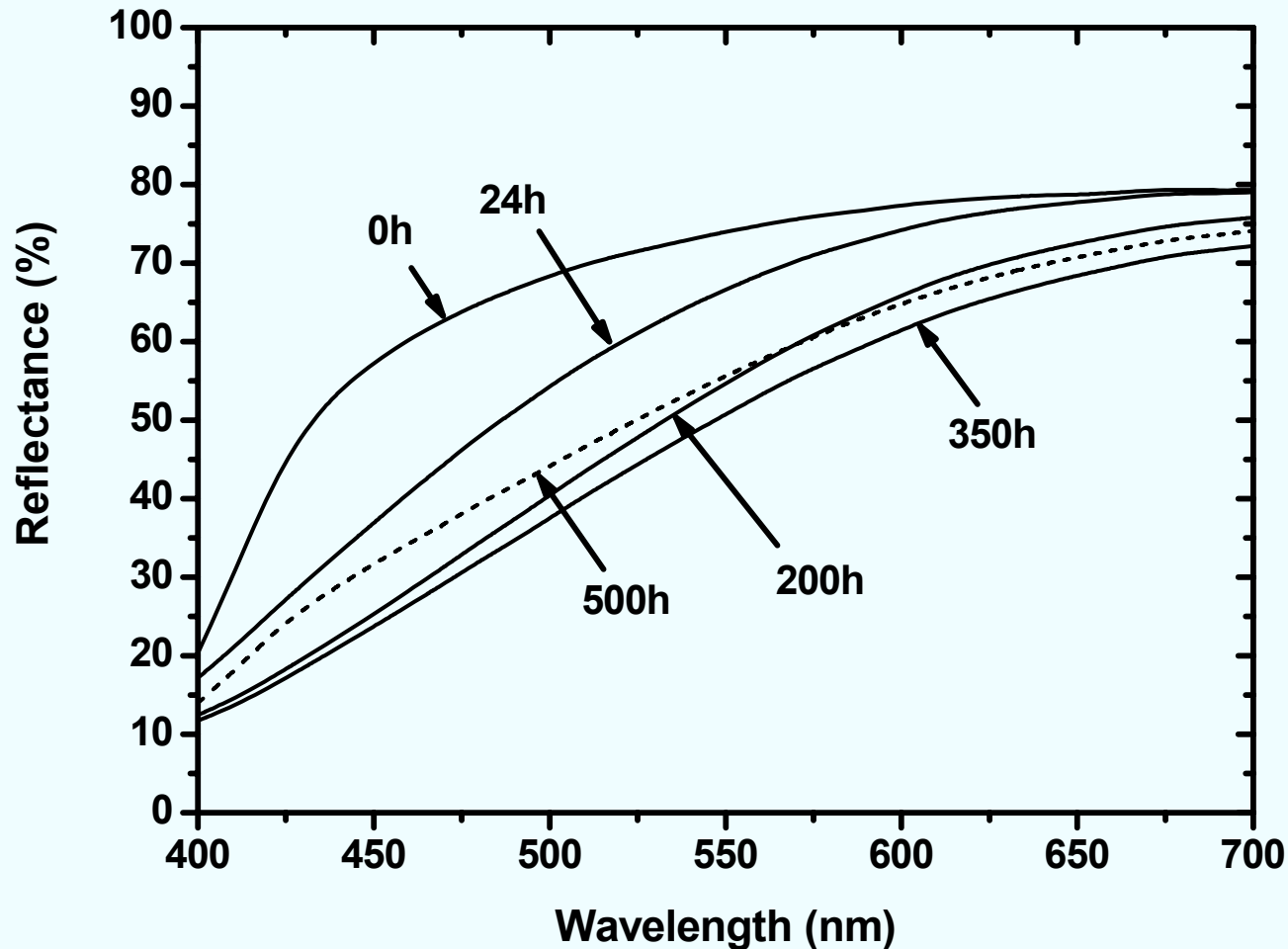
- Can photo-bleaching be picked up quickly?
- Does colour stay stable after a period of exposure?
If not, does it affect colour measurements?
- Does early colour change in Scots pine come from changes in the extractives present?



Focus on colour monitoring

- **Can photo-bleaching be picked up quickly?**
- Does colour stay stable after a period of exposure? If not, does it affect colour measurements?
- Does early colour change in Scots pine come from changes in the extractives present?

Are colour changes uniform, or are there variations?



Reflectance spectra showing an increase at 500h due to photo-bleaching

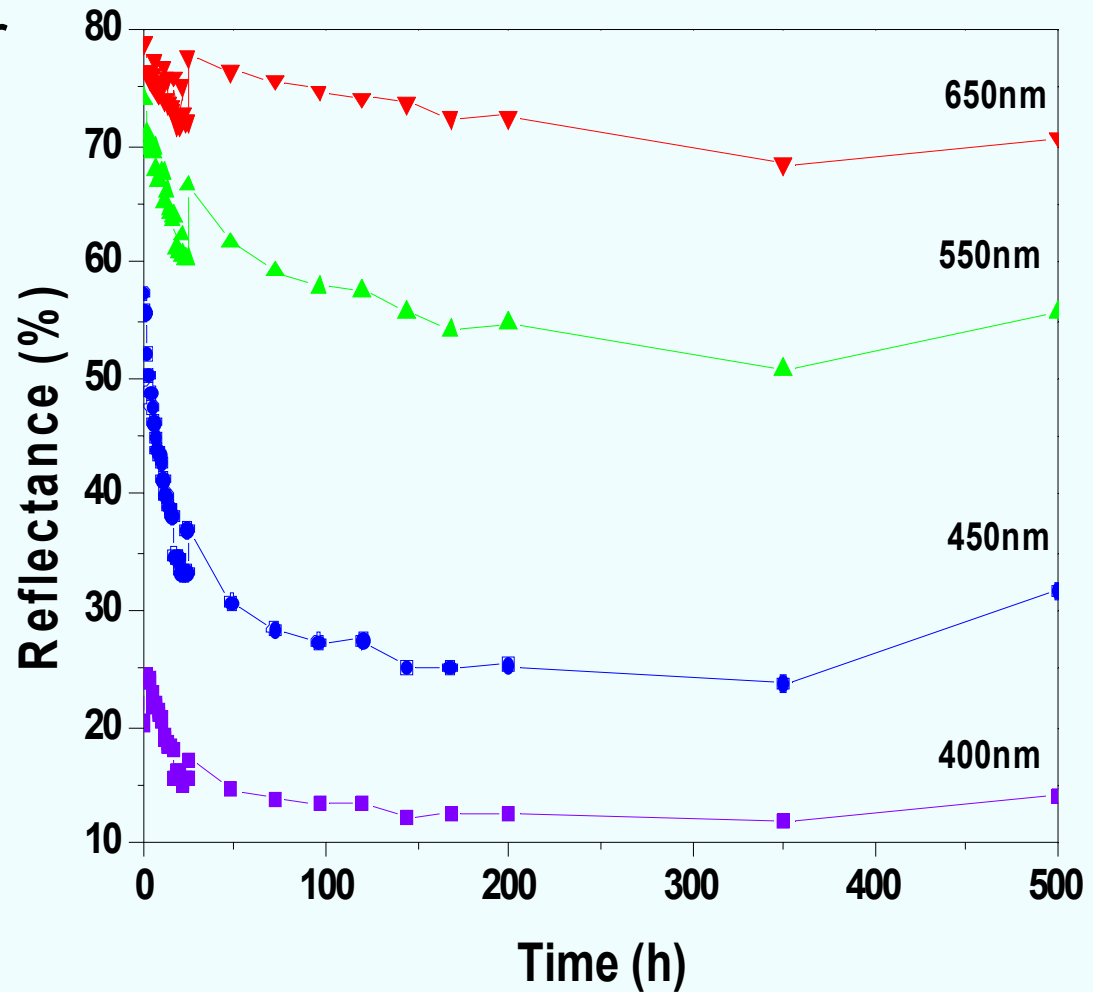


Focus on colour monitoring

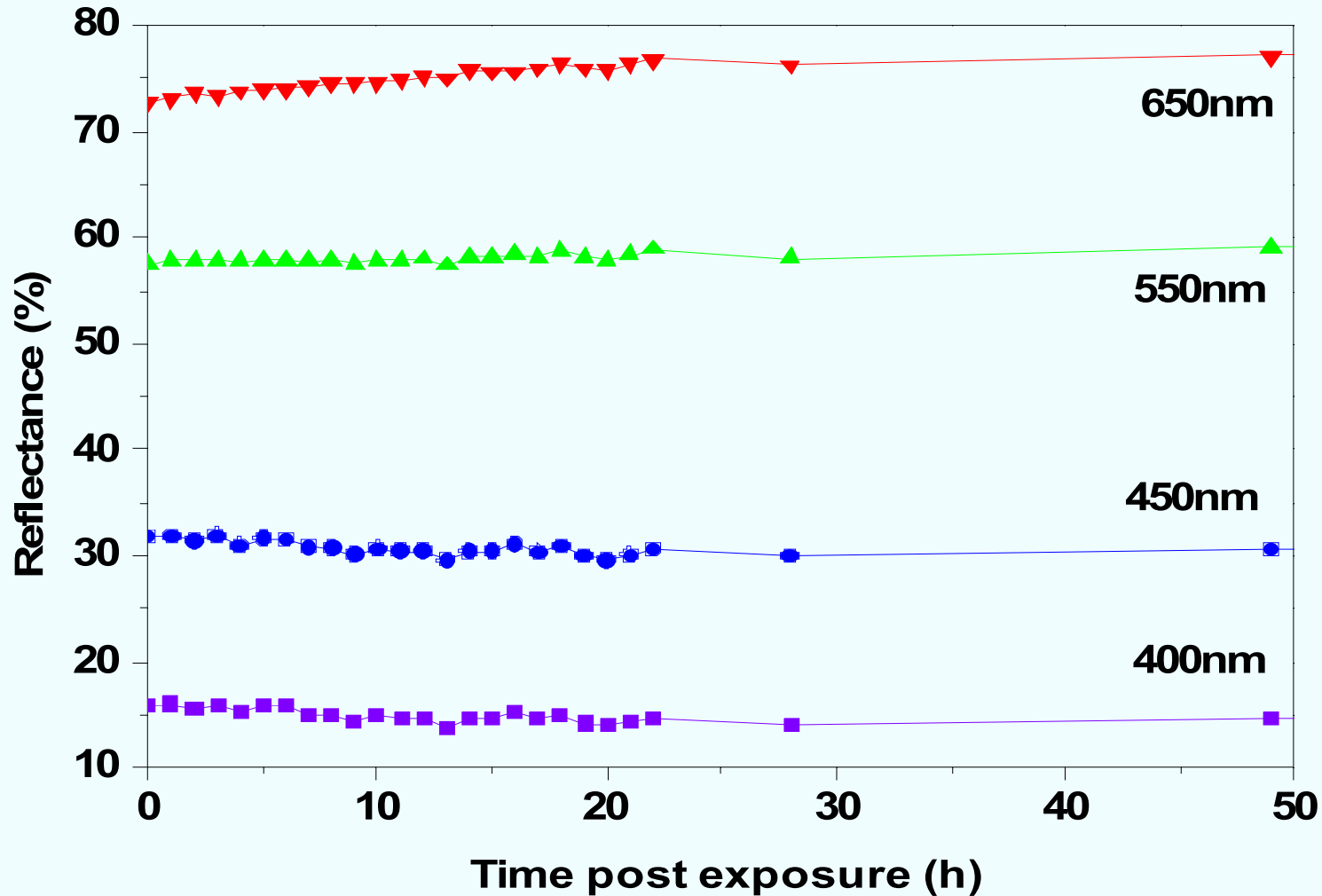
- Can photo-bleaching be picked up quickly?
- **Does colour stay stable after a period of exposure? If not, does it affect colour measurements?**
- Does early colour change in Scots pine come from changes in the extractives present?

Why look at stability?

Variations in 24hour exposed samples depending on single or multiple exposures.

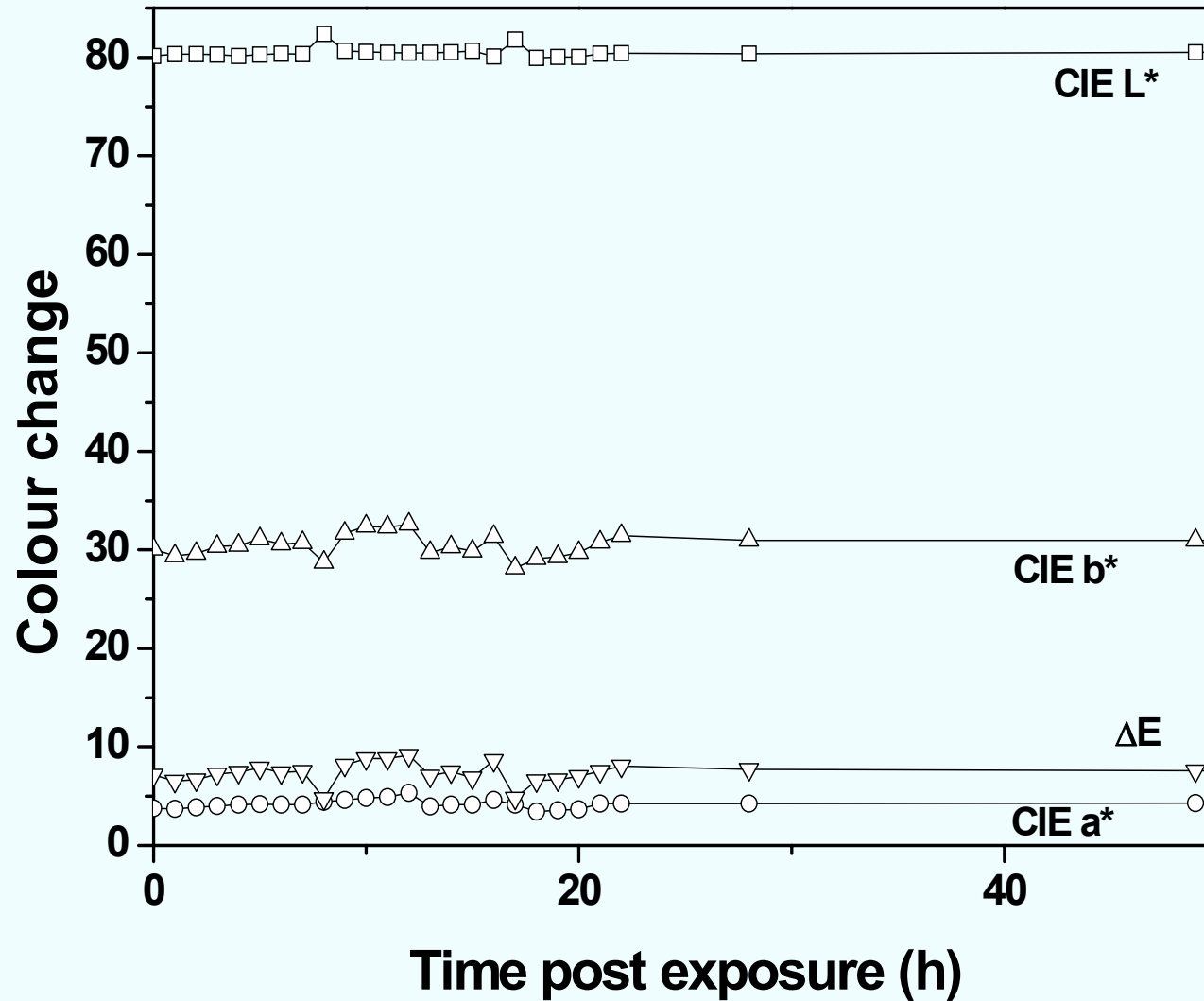


Does colour change stay stable?



Post exposure changes in colour showing greater changes at the redder wavelengths (650nm)

Does it affect colour measurements?



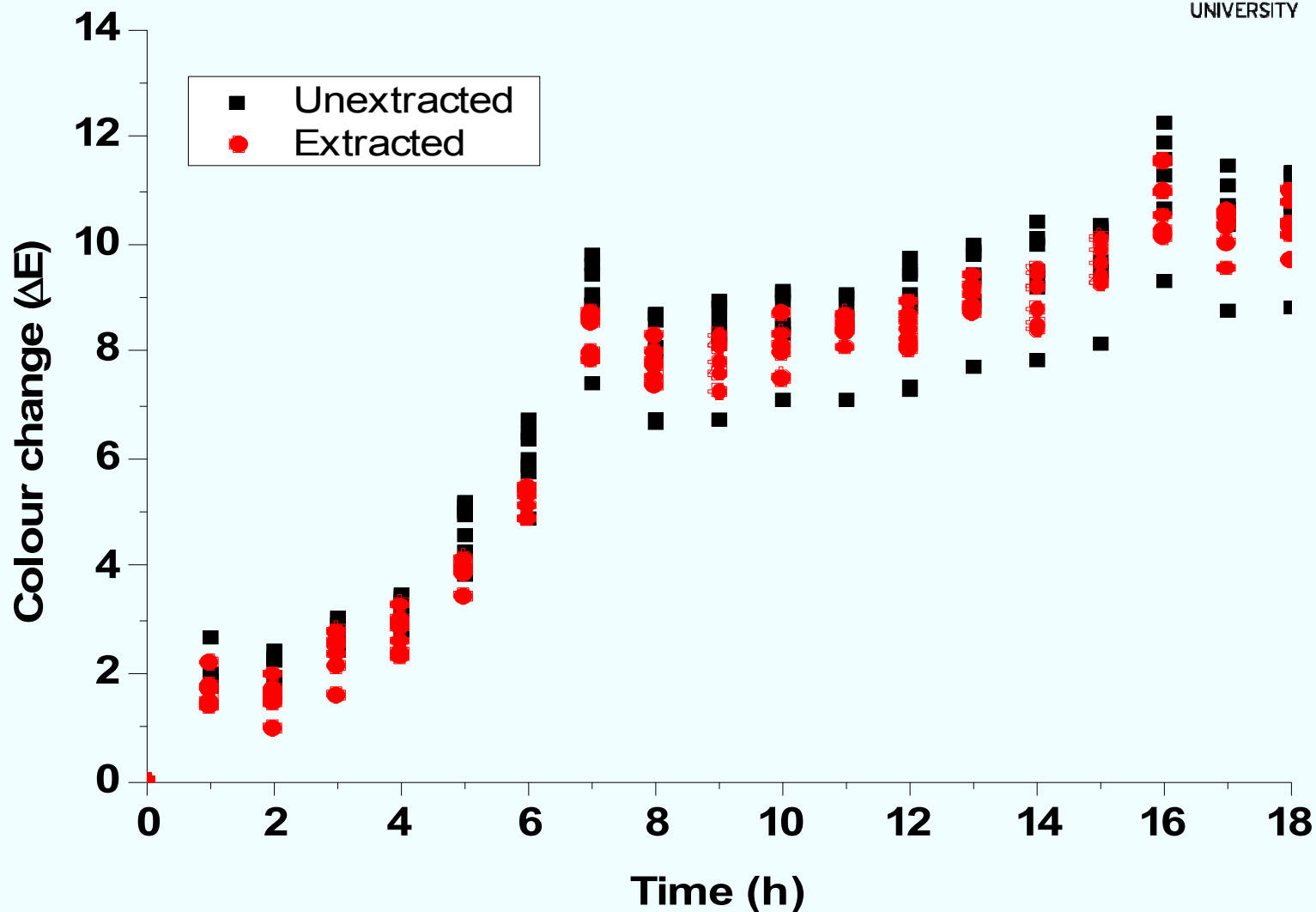
Post exposure changes shown using CIE-L*a*b* system



Focus on colour monitoring

- Can photo-bleaching be picked up quickly?
- Does colour stay stable after a period of exposure? If not, does it affect colour measurements?
- **Does early colour change in Scots pine come from changes in the extractives present?**

Extractive effects?



Colour changes (ΔE) on Extracted and Unextracted Scots pine samples over 18 hours exposure

Summary

- **Different methods** – Weight, tensile and colour change monitoring were used
- **Conclusions** - Colour monitoring **most sensitive** to early changes
- **Focus** – Colour monitoring picks up changes due to photo-bleaching quickly
 - Post exposure changes do happen, but are negligible when using CIE-L*a*b* system
 - Extractives are not responsible for the early colour changes in Scots pine

Thank you.
Any questions?