Susceptibility of wood-polymer composites (WPC) against mould, wood staining fungi and algae

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Motivation

Increasing share of wpc in the European **decking** market:

→ 16 % (2010) ⟶ 22 % (2013)[1]

→ > 60 % share at the total production of wpc[2]

→ Wpc for cladding still on a low level[2]

Decking and cladding ≙ outdoor exposure

→ Risk for microbial infestation

→ High requirements for optical appearance

→ Consideration in wpc-standardization: EN 15534-1

[1)] B+L Marktdaten 2013

[2)] Asta Eder, Composite Consulting 2013

Aims of the work

- Estimation of the infestation risk of wpc by discolouring fungi and algae during outdoor exposure
- Diagnostic of the most commonly species in field
- Recommendation of appropriate test methods in lab to give a real assessment of the susceptibility of wpc-material

Funding of parts:
Federal Ministry of Economics and Technology following a decision of the German Parliament (project-no. MF090191)

Test material: 70 % soft wood, polypropylene

Without biocide

Brushed

Trial product

With biocide

Brushed

Standard brown

Standard carbon

Standard brown, flat

Unbrushed

Trial product

Field test at the area of IHD in Dresden

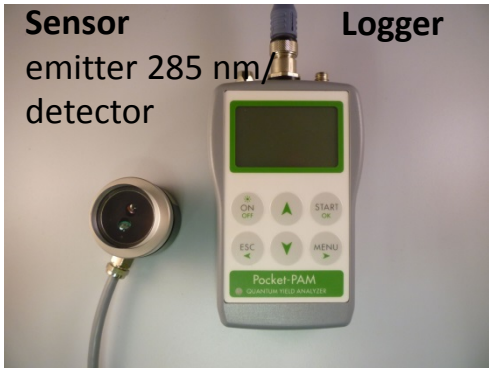
July 2010 – September 2012
(continuance of some materials up to 2014)
45° disposition, exposed to the north

Field test at the area of IHD in Dresden

Periodical evaluation:

- Surface structure changes, discolorations by grey scale, slip resistance
- Colonization with fungi and algae:
  - Visual assessment: rating according to DIN EN ISO 4628-1

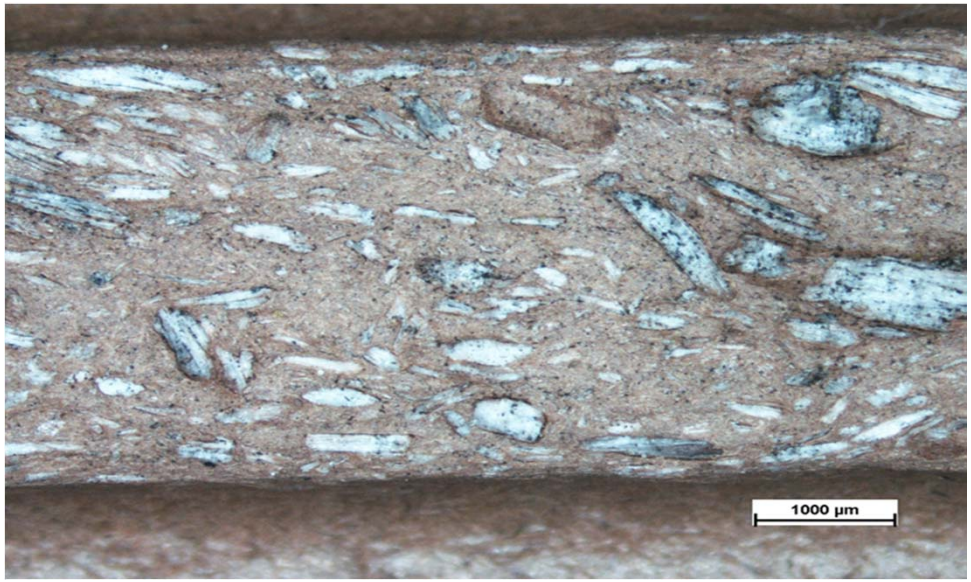
    (number – size – intensity, 0 … 5)
  - Pulse amplitude modulated (PAM) fluorometry: photosynthesis activity



Pocket-PAM
(Gademann Instruments Germany)

Fungi colonization in field weathering

- Initial colonization after 6 months
- After 2 years:
  - Heavy disfigurement on all corrugated materials
  - Slighter disfigurement at the flat and carbon (dark) surface
- Typical appearance:
  black staining of the wood particles

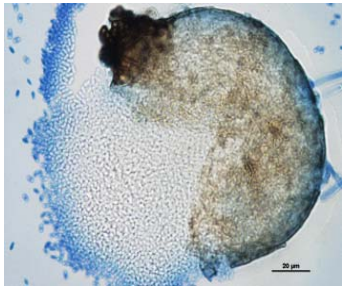


Standard brown with biocide
after 18 month (10-fold)

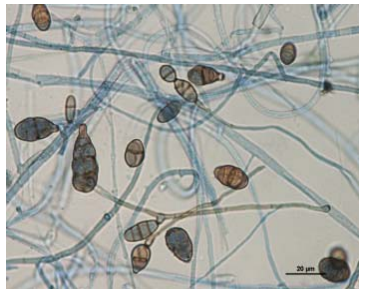
Diagnostic of the fungus species (ascomycetes)

Aureobasidium pullulans

Epicoccum nigrum

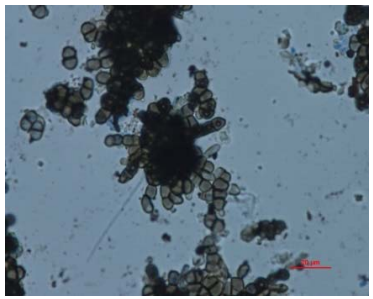


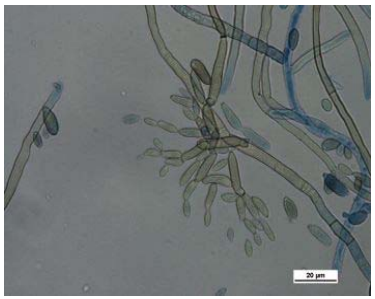
Phoma glomerata



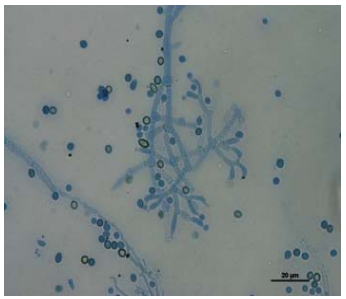
Ulocladium-species

Alternaria-species





Cladosporium-species



Trichoderma-species

Algae colonization in field weathering

- Initial colonization not before after 18 months
- Slightest infestation at the carbon-coloured (dark) surfaces
- No clear advantage of the biocide after 2 but after 3 years

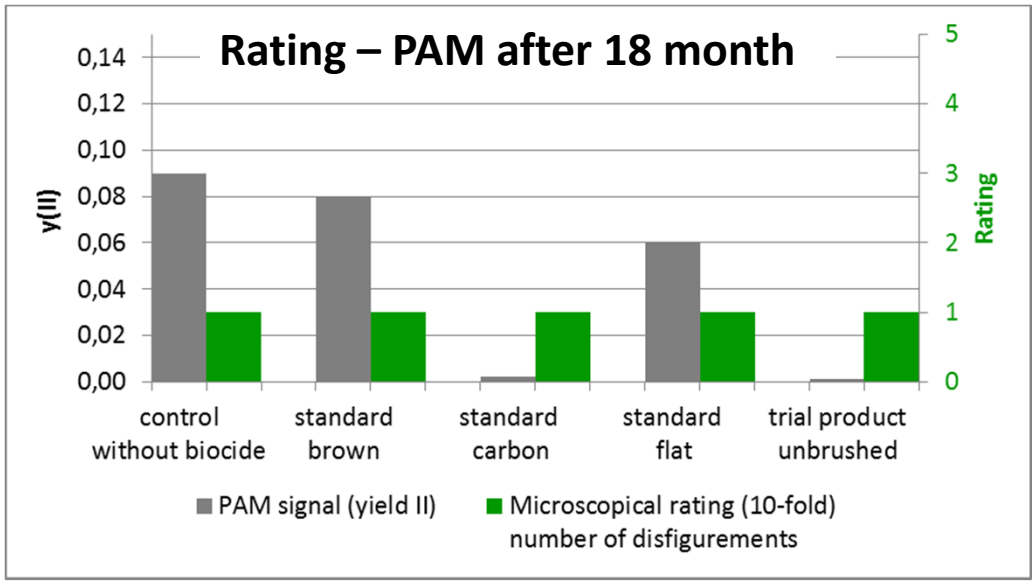
clear advantage of the biocide-containing material after 3 years:

without biocide

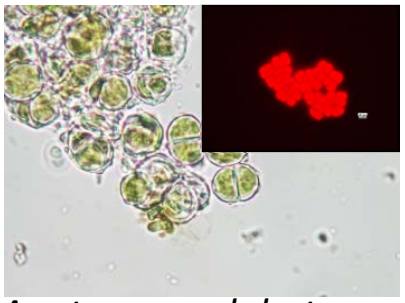
with biocide

Application of the PAM-fluorimetry at the field test

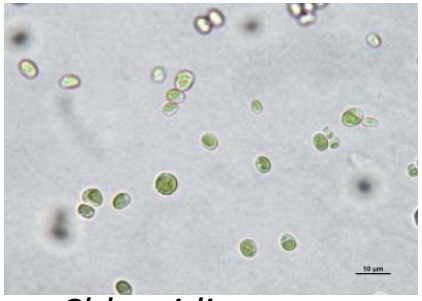
Material		Rating after 24 month
Control biocide-free		3-2-1
Standard brown		3-2-1
Standard carbon		1-1-0
Standard flat		1-4-1
Trial product unbrushed		1-1-1



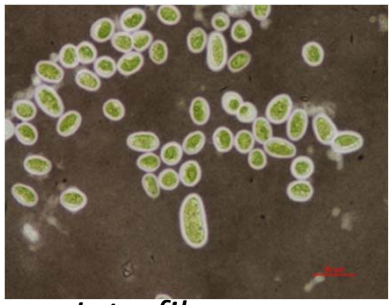
Diagnostic of the algae species



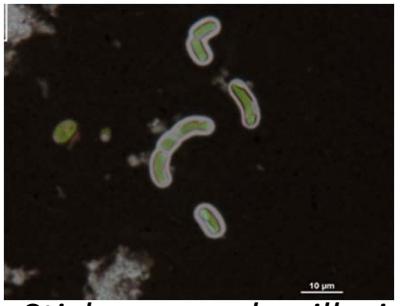
Apatococcus lobatus



Chloroidium sp.

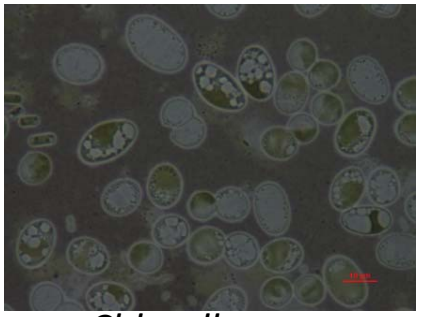


Interfilum sp.

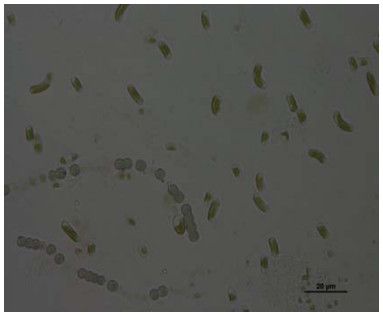


Stichococcus bacillaris

Klebsormidium flaccidum



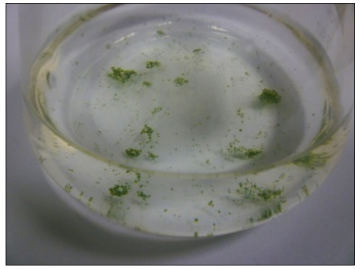
Chlorella sp.



Nostoc commune
Stichococcus sp.

Laboratory tests against algae

- Procedure: EN 15458
- Specimens: (60 × 40 × 5 ... 8) mm³
- Preconditioning: 3 days immersion in water
- Test algae: *Stichococcus bacillaris*, *Nostoc commune*
- Incubation: 21-28 days, 23 °C, 70 % rh
- Light exposure: Periodical (12 h), irrediation intensity: 20 µmol × m^{-2} × s^{-1}
- Evaluation: - Visual rating
  - PAM fluorometry



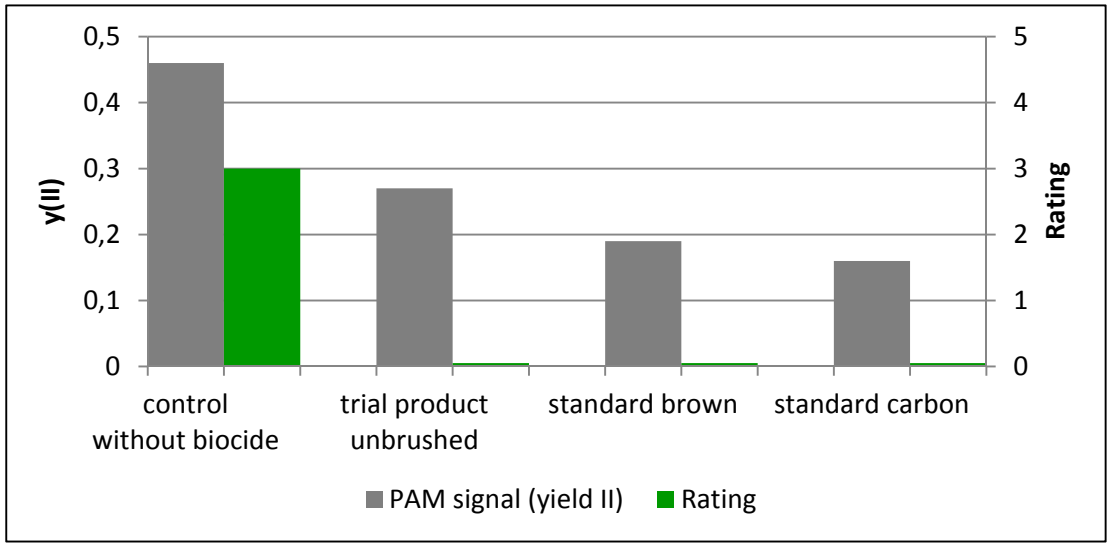
Results:

- Clear advantage of the material with biocide
- PAM as appropriate additional implement

Laboratory tests against algae

Results after 21 days:

- Clear advantage of the material with biocide
- PAM as appropriate additional implement



Appropriate lab tests against mould fungi (DIN EN 15534-1)
Preconditioning: leaching procedure (EN 84)

ISO 16868

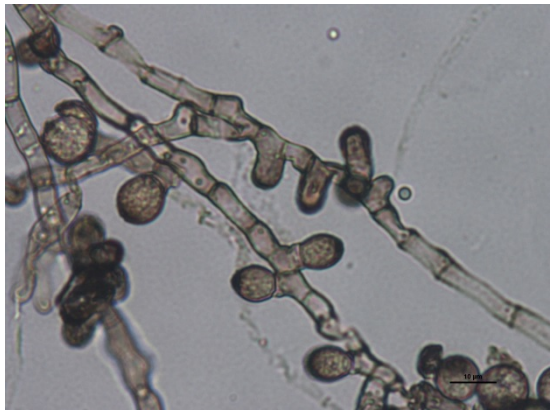
- Specimens on inoculated nutrient-agar (indirect inoculation)
- 21 days incubation
- Evaluation of the relative to reference material

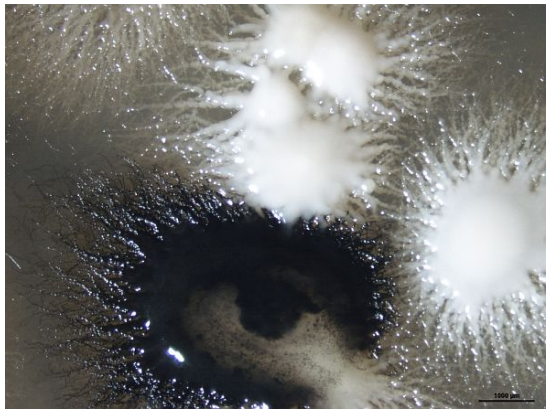
ASTM D3273

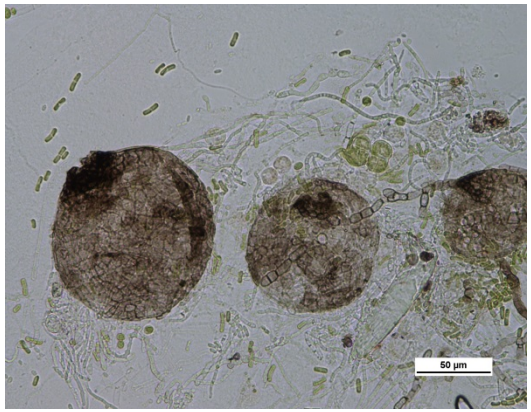
- Specimens hang over an inoculated soil substrate in a moist chamber (rh > 95 %)
- 28 days incubation
- Evaluation of the absolute growth on the material

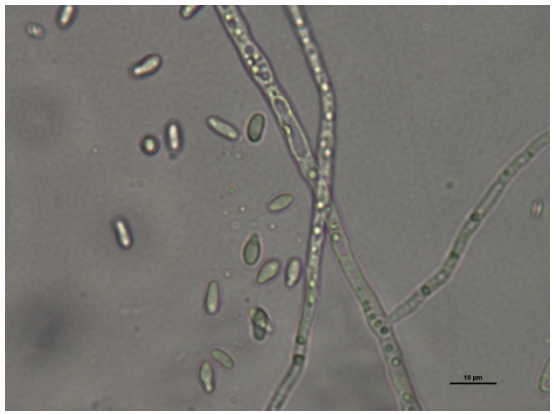
Summary

- Detection of a clear infestation risk at wpc with discolouring fungi and algae with resulting optical disturbance
- Discolouring fungi earlier occur than algae
- No basidiomycetes were found
- No prevention of the infestation by fungi in outdoor exposure by the tested biocide
- Discolouring and infestation of the wood particles by different ascomycetes
- Estimation of the infestation risk with mould fungi and algae possible by the described lab methods
- Need for further investigations with wood staining fungi
- PAM-fluorometry as an additional evaluation instrument in field and lab test against algae









THANK YOU!