UNIVERSITEIT GENT

FACULTY OF BIOSCIENCE ENGINEERING

Moisture dynamics of modified wood

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David Mannes, Eberhard Lehmann and Joris Van Acker

SILEX
LIFE11 ENV/BE/1046
Improving sustainability of construction materials using innovative silicon–based treatment

PAUL SCHERRER INSTITUT PSI

UGCT Centre for X-ray Tomography

PerformWOOD
Performance standards for wood in construction - delivering customer service life needs

ECWM7 – Lisbon – 10-12th of March 2014

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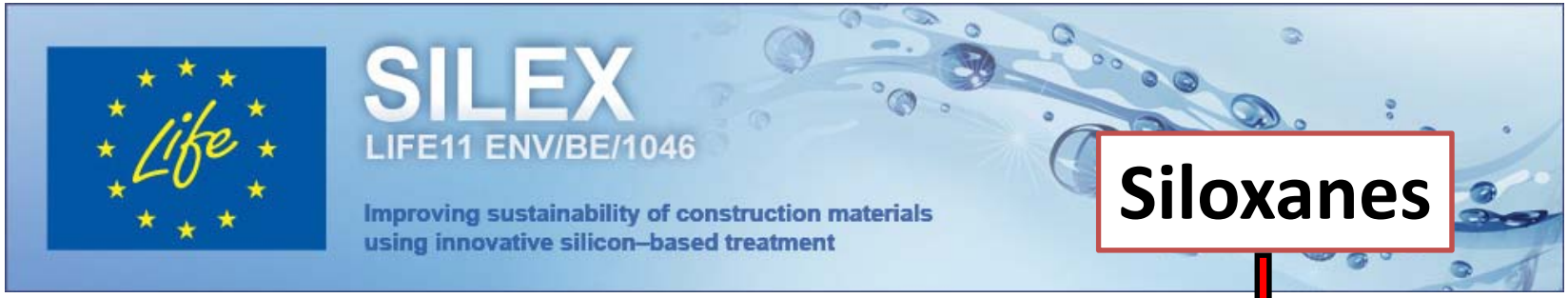
Materials



Beech	A
Oak	B
Scots pine sapwood	C

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Methods: 1

1D+

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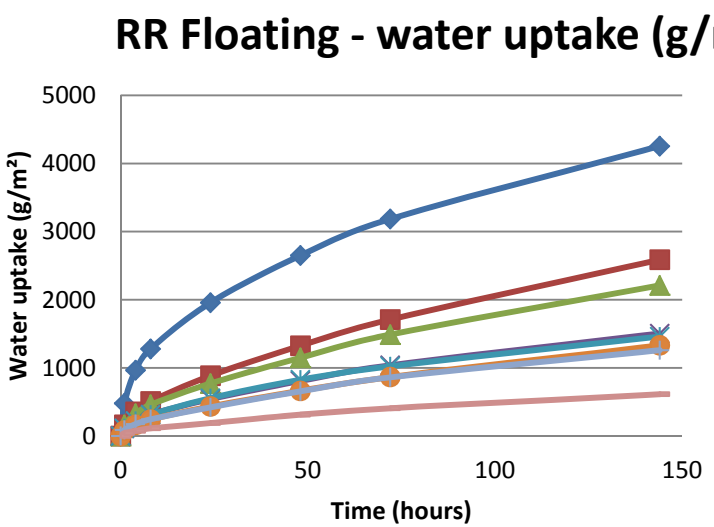
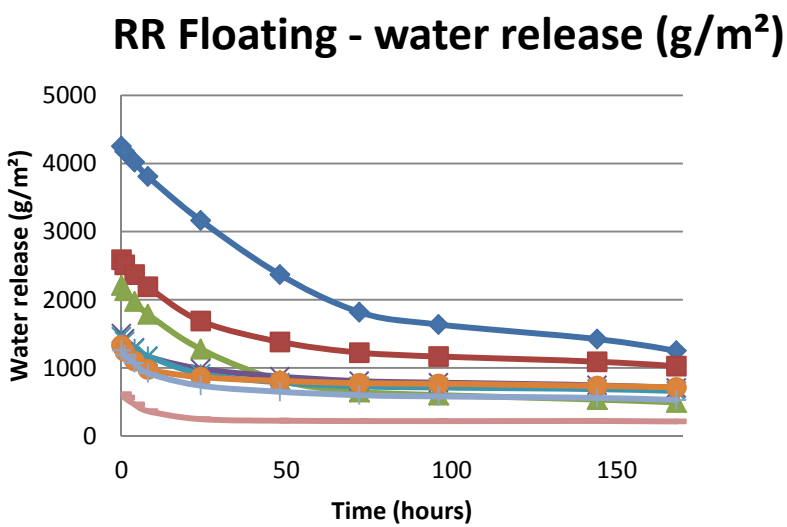
Up-Rel





Methods: 1

1D+

PerformWOOD

Up-Rel

Performance standards for wood in construction - delivering customer service life needs

FDA
PCA

$$y_{ij} = x_i(t_{ij}) + \varepsilon_{ij}$$

a. From discrete to continuous time
b. Smoothing non-parametric basis functions

Methods: 2

2D+

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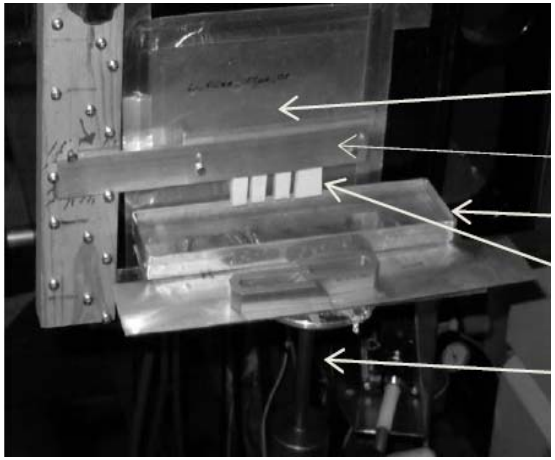
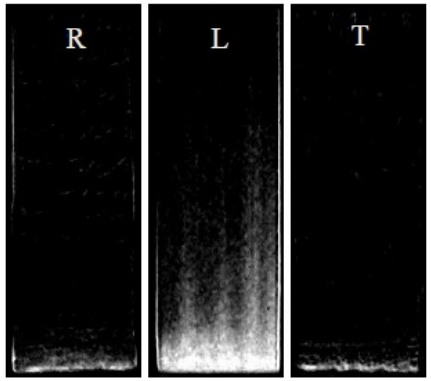
Neutron



$$W_{(t)} = -[\rho_h/(Z_s \times \Sigma_h)] \times \ln[I_{(t)}/I_{(initial)}]$$



10 hours

Oak

Methods: 3

3D

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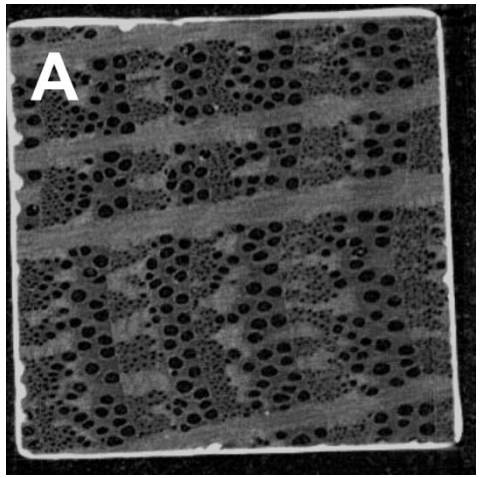
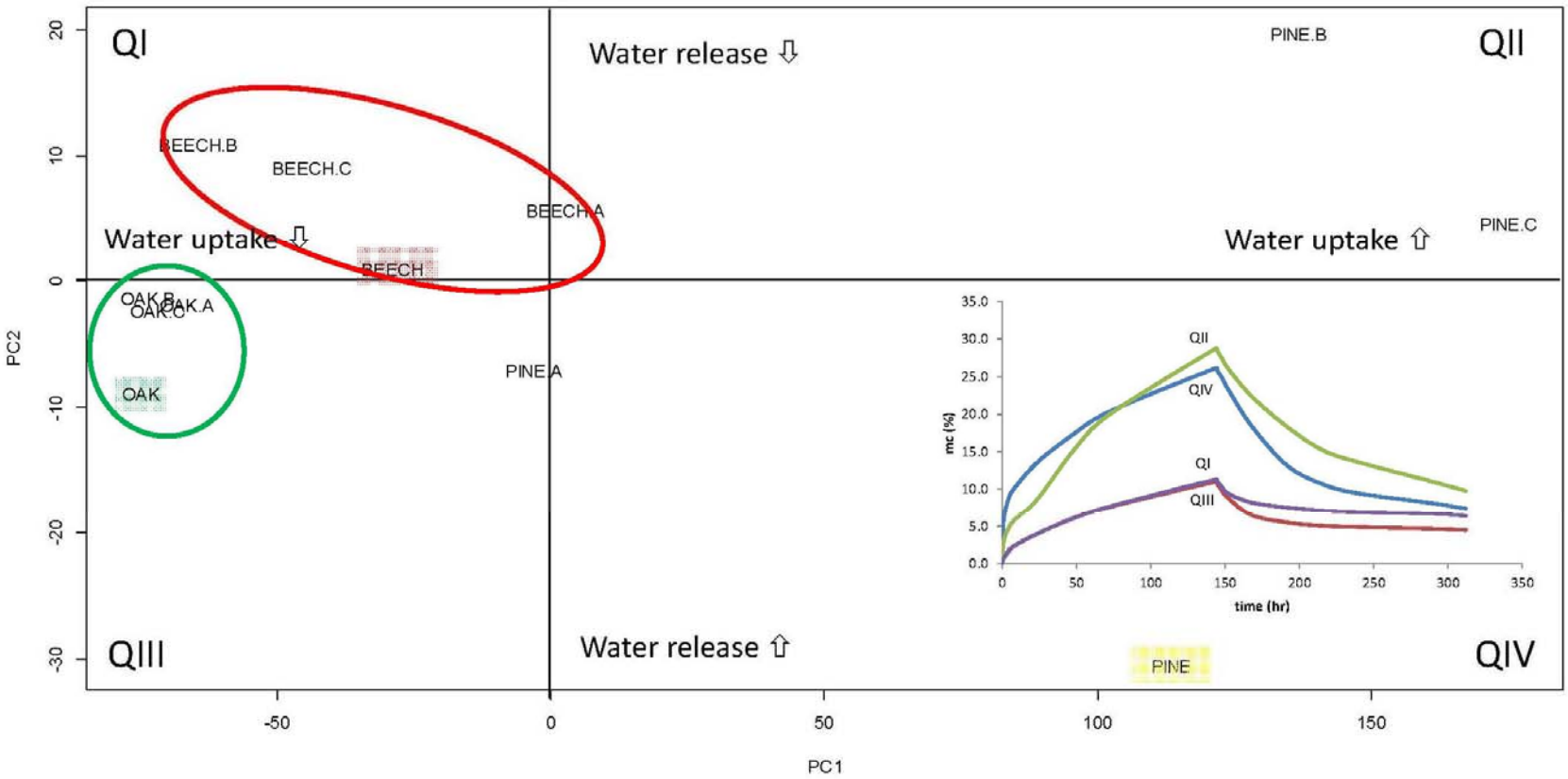
X-ray CT



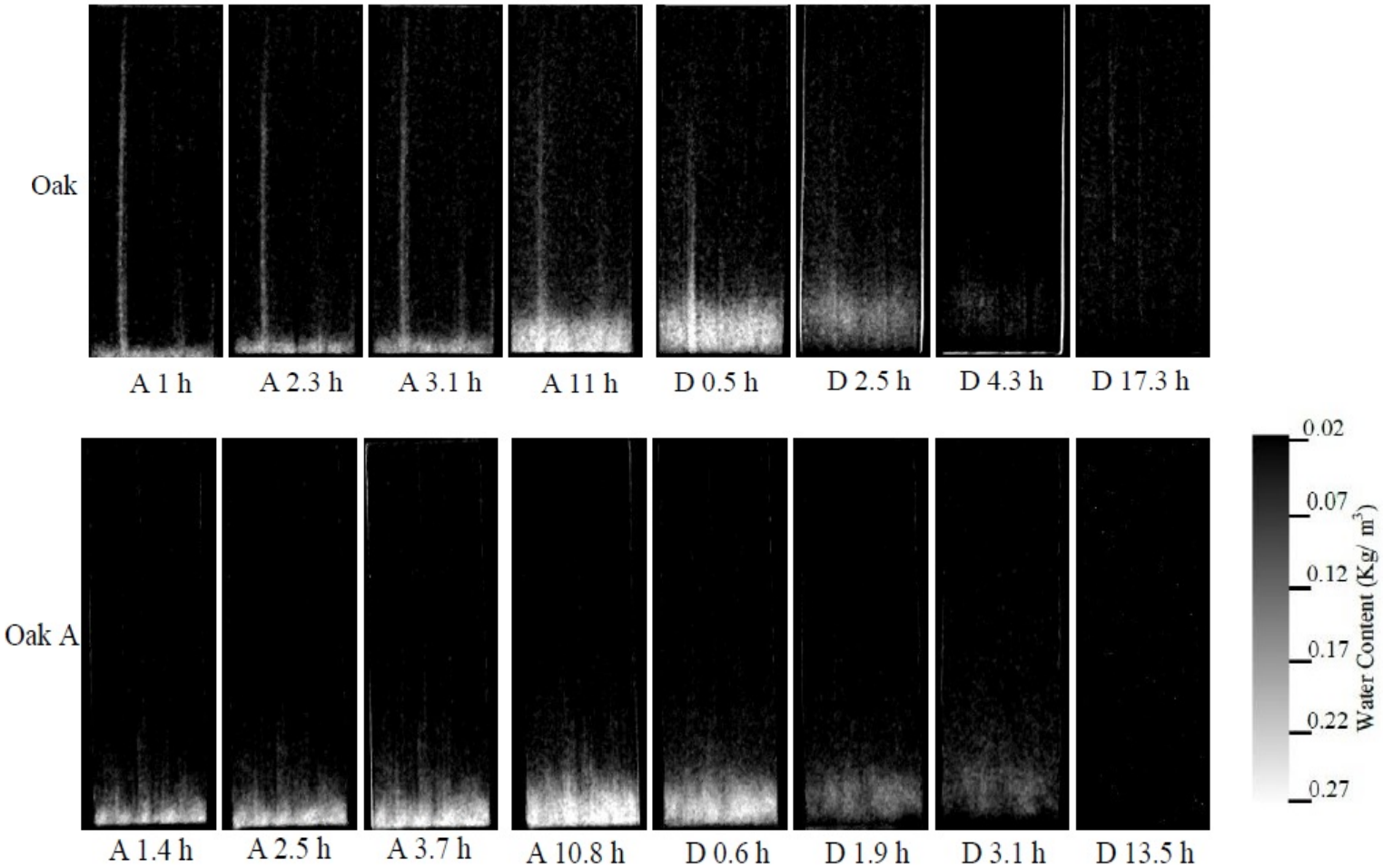
Results

1D+


QI
Water release ⇩
PINE.B
QII
BEECH.B
BEECH.C
BEECH.A
Water uptake ⇩
BEECH
Water uptake ⇧
PINE.C
OAK.B
OAK.C
OAK.A
OAK
PINE.A
QIII
Water release ⇧
PINE
QIV
PC2
PC1
20
10
0
-10
-20
-30
-50
0
50
100
150
mc (%)
time (hr)
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0
50
100
150
200
250
300
350
QII
QIV
QI
QIII

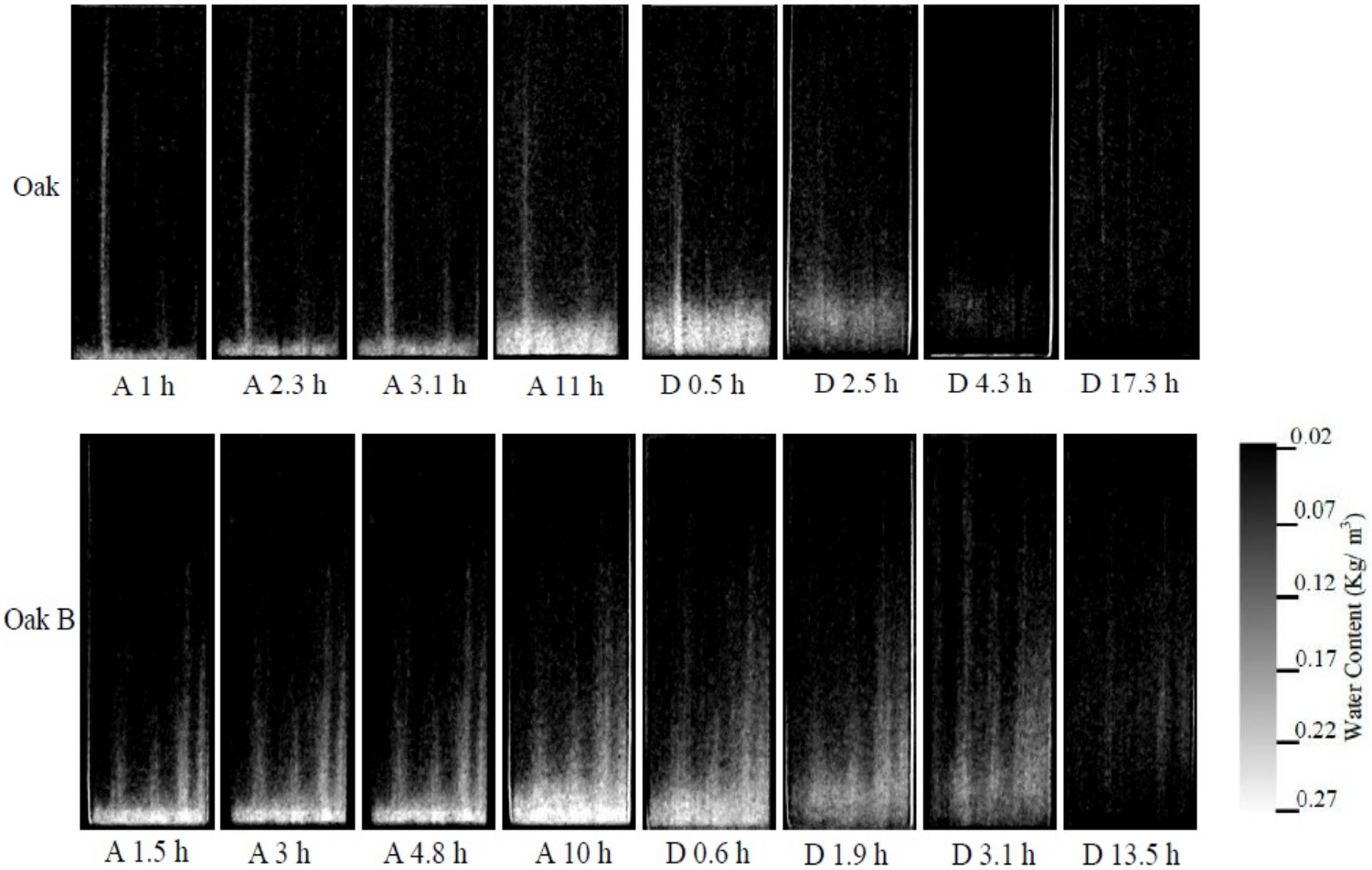
Results

2D+


Oak
A 1 h
A 2.3 h
A 3.1 h
A 11 h
D 0.5 h
D 2.5 h
D 4.3 h
D 17.3 h
Oak A
A 1.4 h
A 2.5 h
A 3.7 h
A 10.8 h
D 0.6 h
D 1.9 h
D 3.1 h
D 13.5 h
0.02
0.07
0.12
0.17
0.22
0.27
Water Content (Kg/ m³)

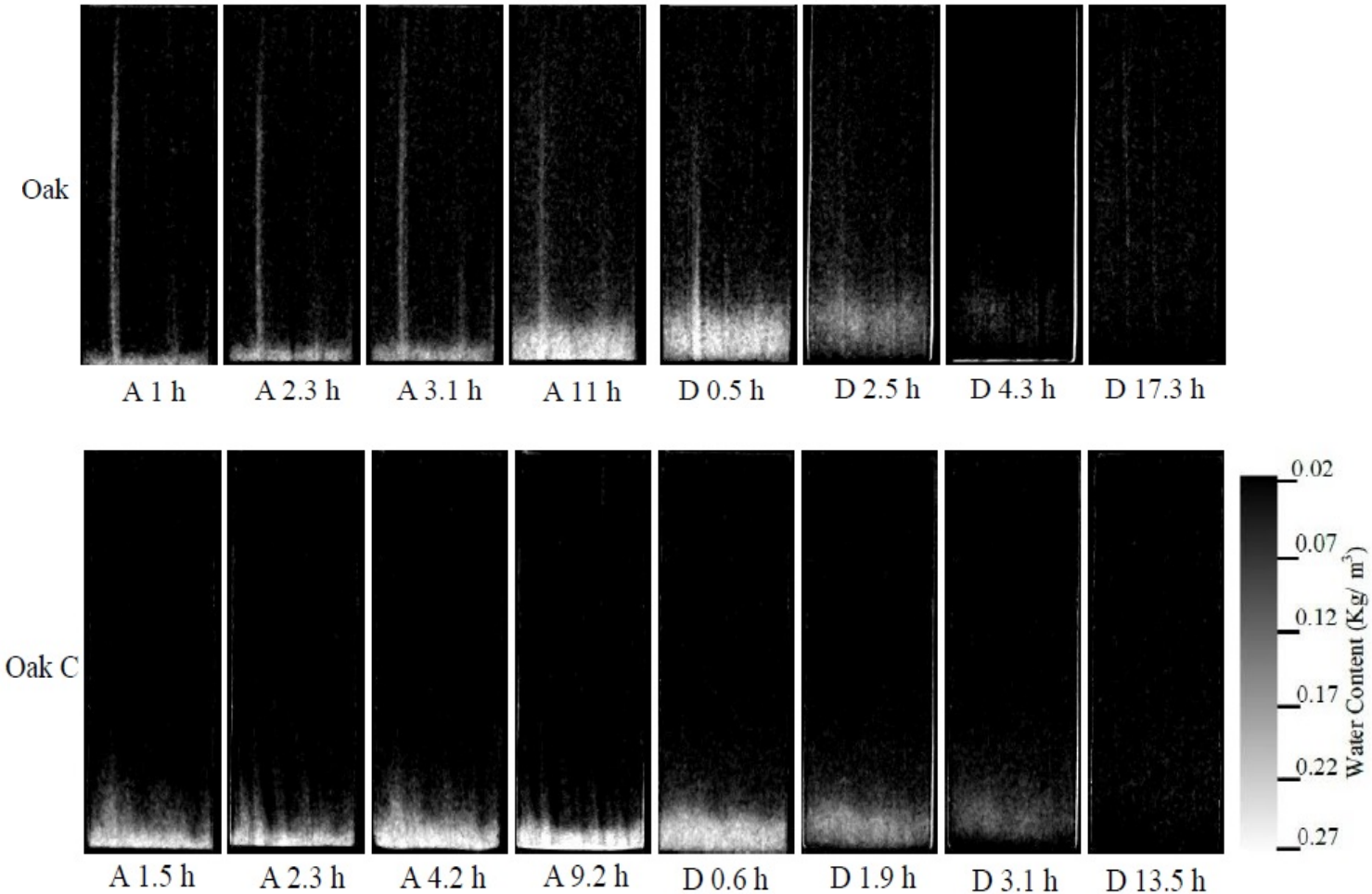
Results

2D+


Oak
A 1 h
A 2.3 h
A 3.1 h
A 11 h
D 0.5 h
D 2.5 h
D 4.3 h
D 17.3 h
Oak B
A 1.5 h
A 3 h
A 4.8 h
A 10 h
D 0.6 h
D 1.9 h
D 3.1 h
D 13.5 h
0.02
0.07
0.12
0.17
0.22
0.27
Water Content (Kg/ m3)

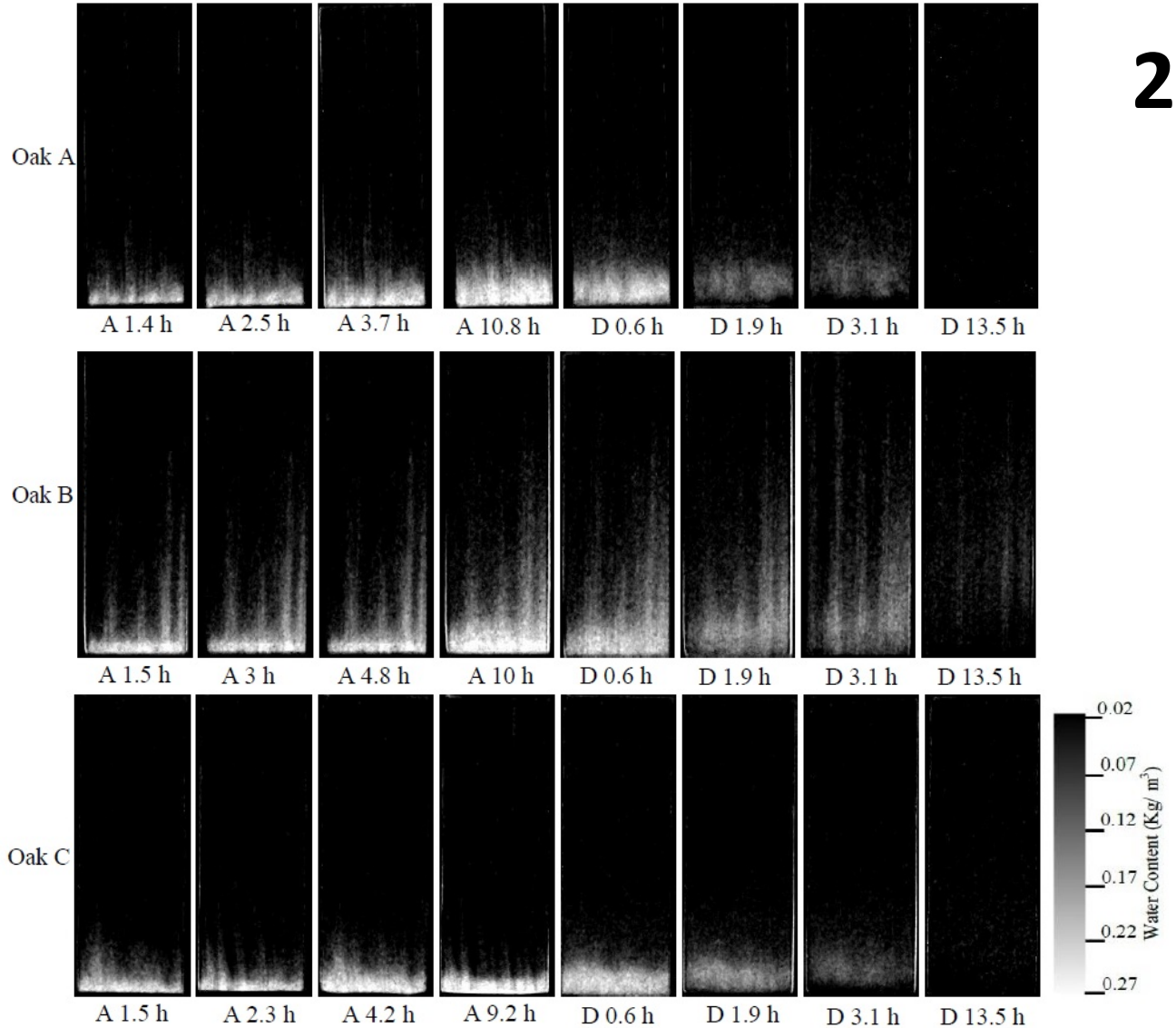
Results

2D+


Oak
A 1 h
A 2.3 h
A 3.1 h
A 11 h
D 0.5 h
D 2.5 h
D 4.3 h
D 17.3 h
Oak C
A 1.5 h
A 2.3 h
A 4.2 h
A 9.2 h
D 0.6 h
D 1.9 h
D 3.1 h
D 13.5 h
0.02
0.07
0.12
0.17
0.22
0.27
Water Content (Kg/ m3)

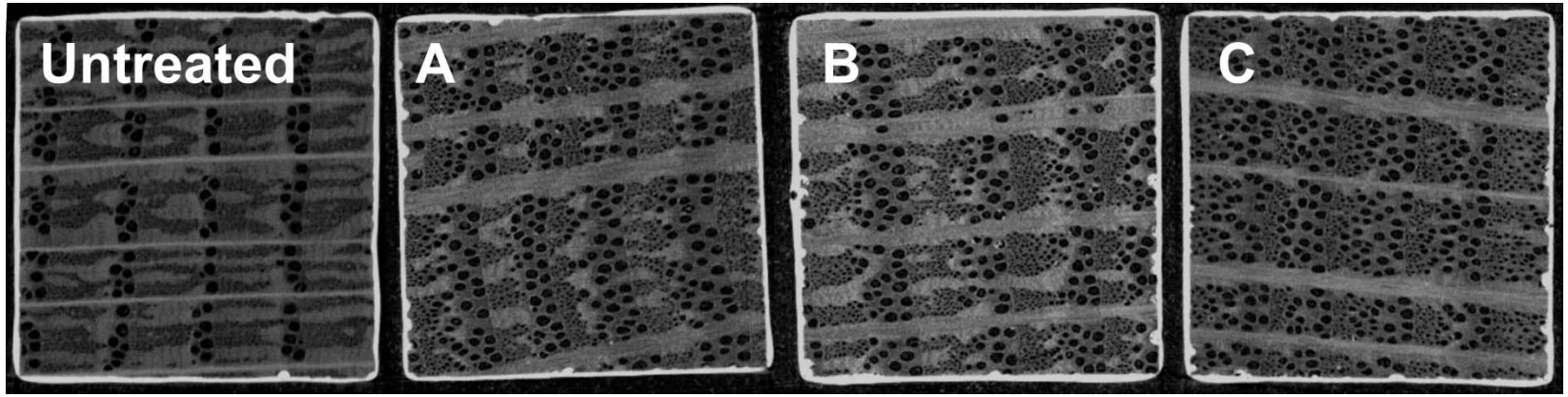
Results

2D+


Oak A
A 1.4 h
A 2.5 h
A 3.7 h
A 10.8 h
D 0.6 h
D 1.9 h
D 3.1 h
D 13.5 h
Oak B
A 1.5 h
A 3 h
A 4.8 h
A 10 h
D 0.6 h
D 1.9 h
D 3.1 h
D 13.5 h
Oak C
A 1.5 h
A 2.3 h
A 4.2 h
A 9.2 h
D 0.6 h
D 1.9 h
D 3.1 h
D 13.5 h
0.02
0.07
0.12
0.17
0.22
0.27
Water Content (Kg/ m3)

Results

3D



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Need for further optimization of siloxanes

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Silanes
Siloxanes

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Up-Rel

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PSI

Neutron

UGCT

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X-ray CT

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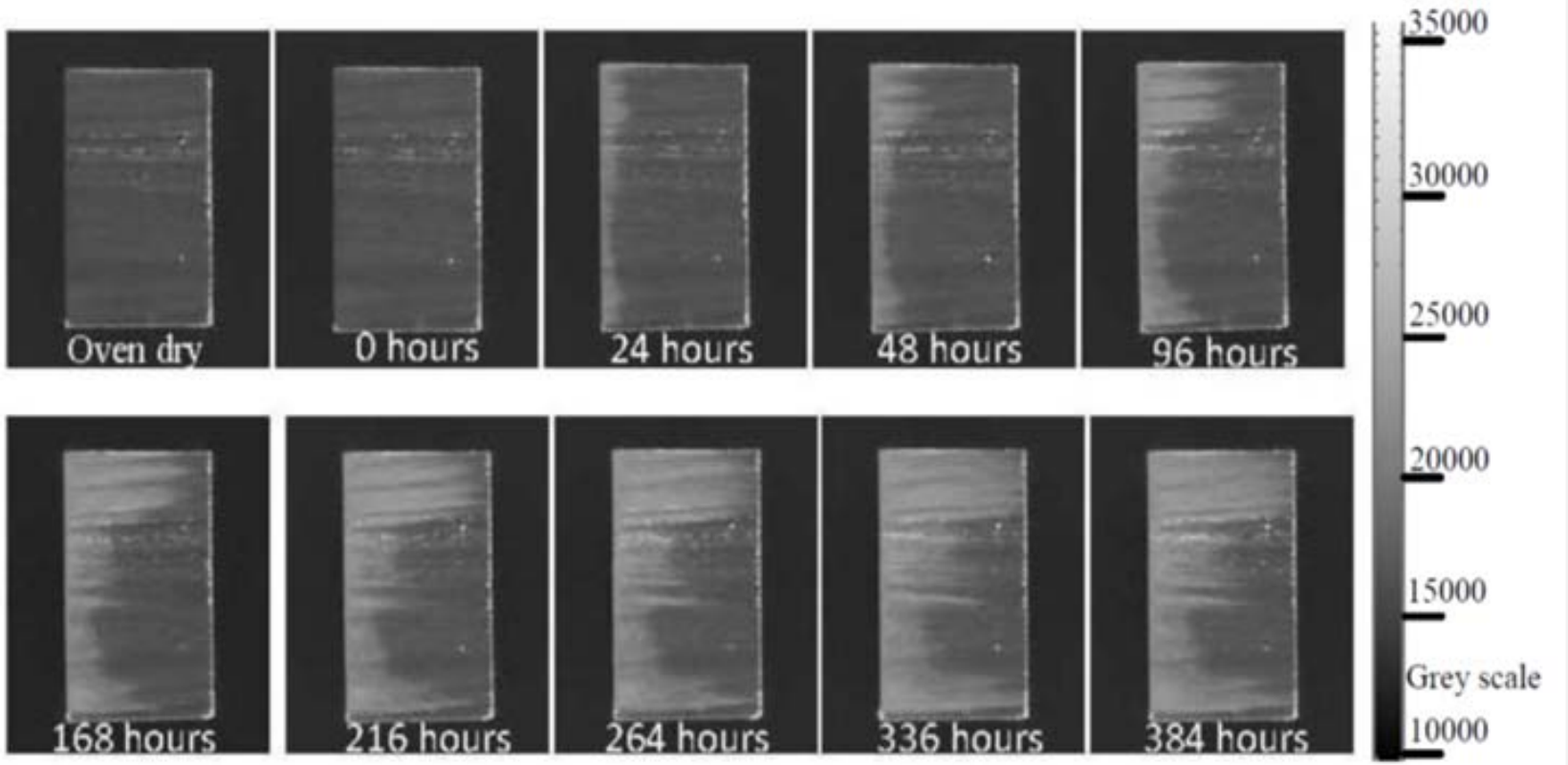
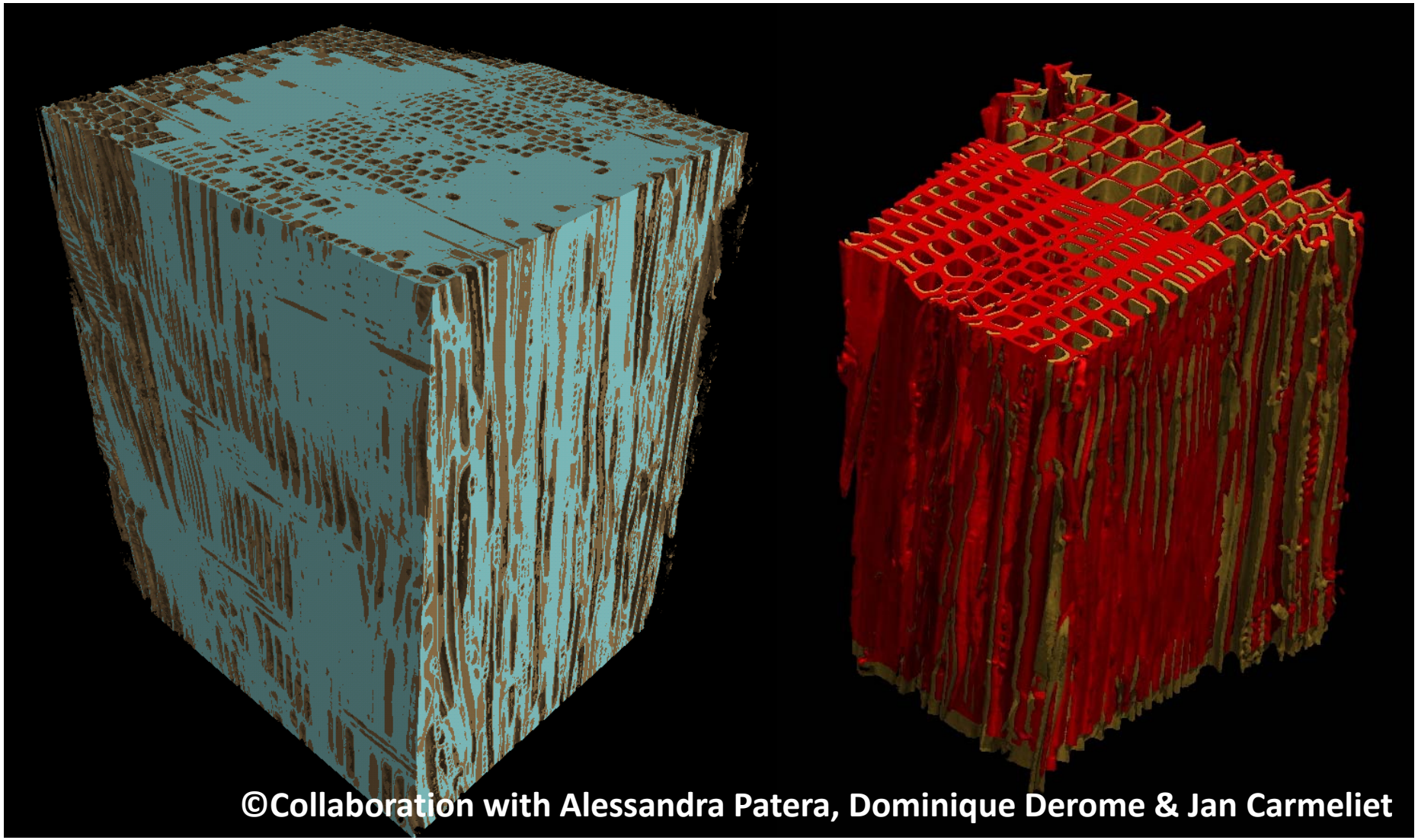
FUTURE

- Abs. coeff. ~ T? **1D+**
- Detailed:
  - Neutron: water **2D+**
  - X-ray CT: structure & water **3D+**


Oven dry
0 hours
24 hours
48 hours
96 hours
168 hours
216 hours
264 hours
336 hours
384 hours
35000
30000
25000
20000
15000
Grey scale
10000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THANK YOU

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