Performance of a water-borne stain on beech, spruce, MDF and OSB improved by plasma pre-treatment

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AGENDA

- **Motivation**
- **Experimental**
- **Results**
  - Artificial accelerated weathering
  - Water uptake
  - Adhesion strength
- **Conclusions**

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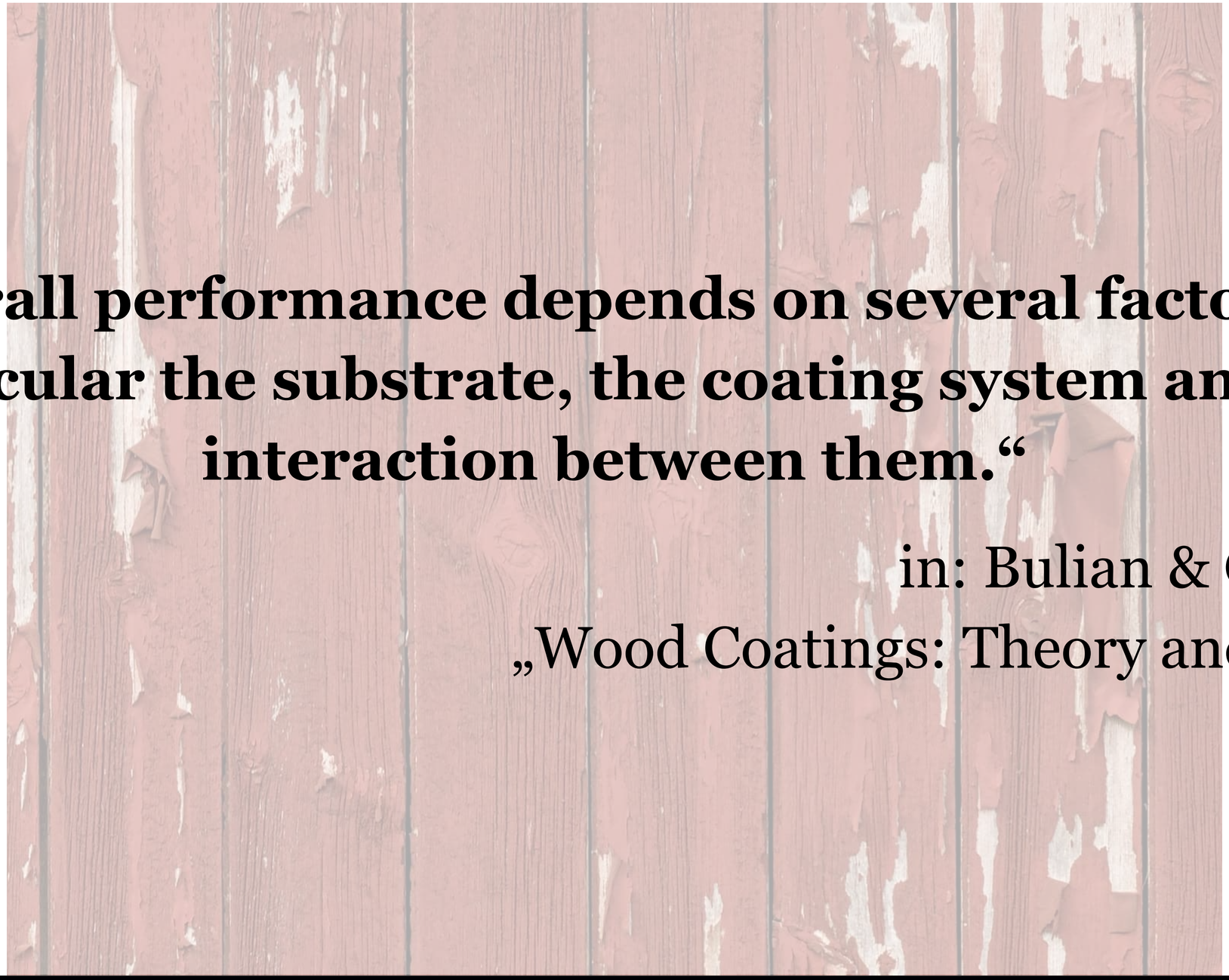
Motivation



„Overall performance depends on several factors, in particular the substrate, the coating system and the interaction between them.“

in: Bulian & Graystone,
„Wood Coatings: Theory and Practice“

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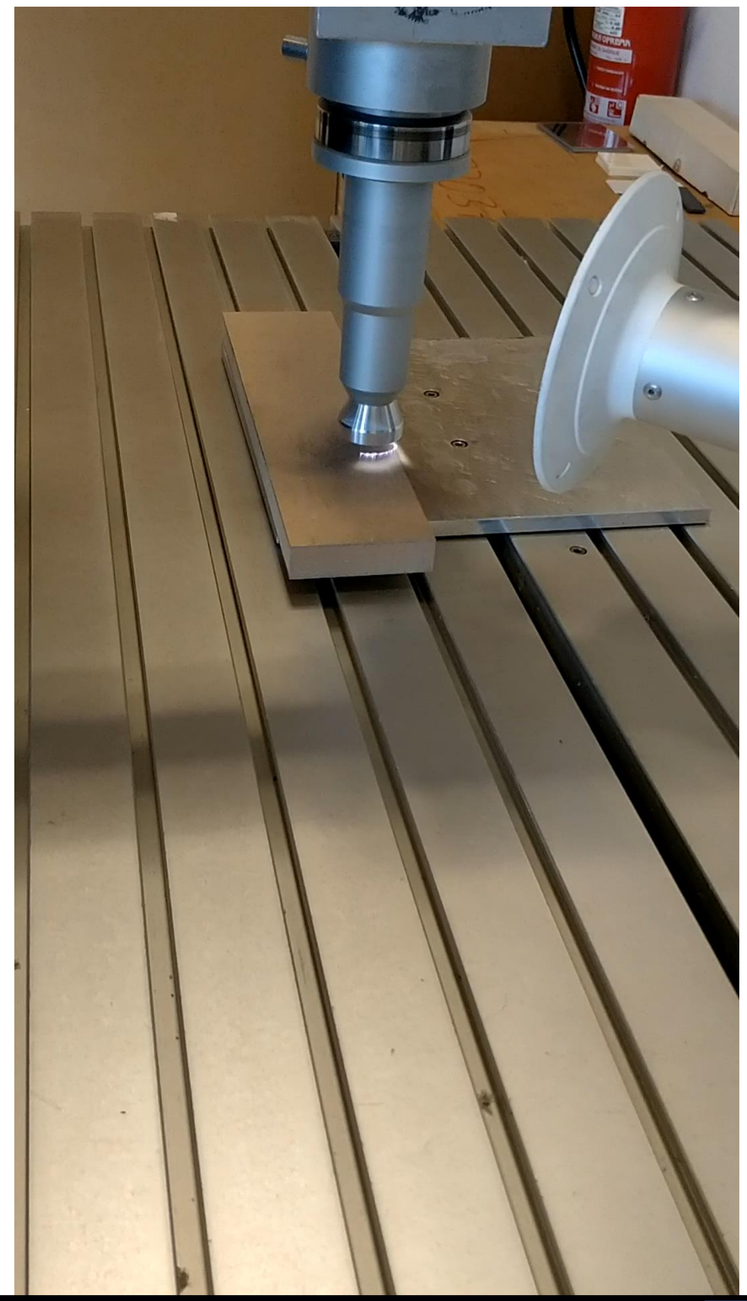
Experimental: Plasma

PlasmaTreat Openair® unit

RD1004 head @ 2800 min^{-1}

280 V, 15.6 A, 21.0 kHz, 100%,
4 bar pressurized air.



PT optimized for each substrate

incl. nozzle, distance, speed

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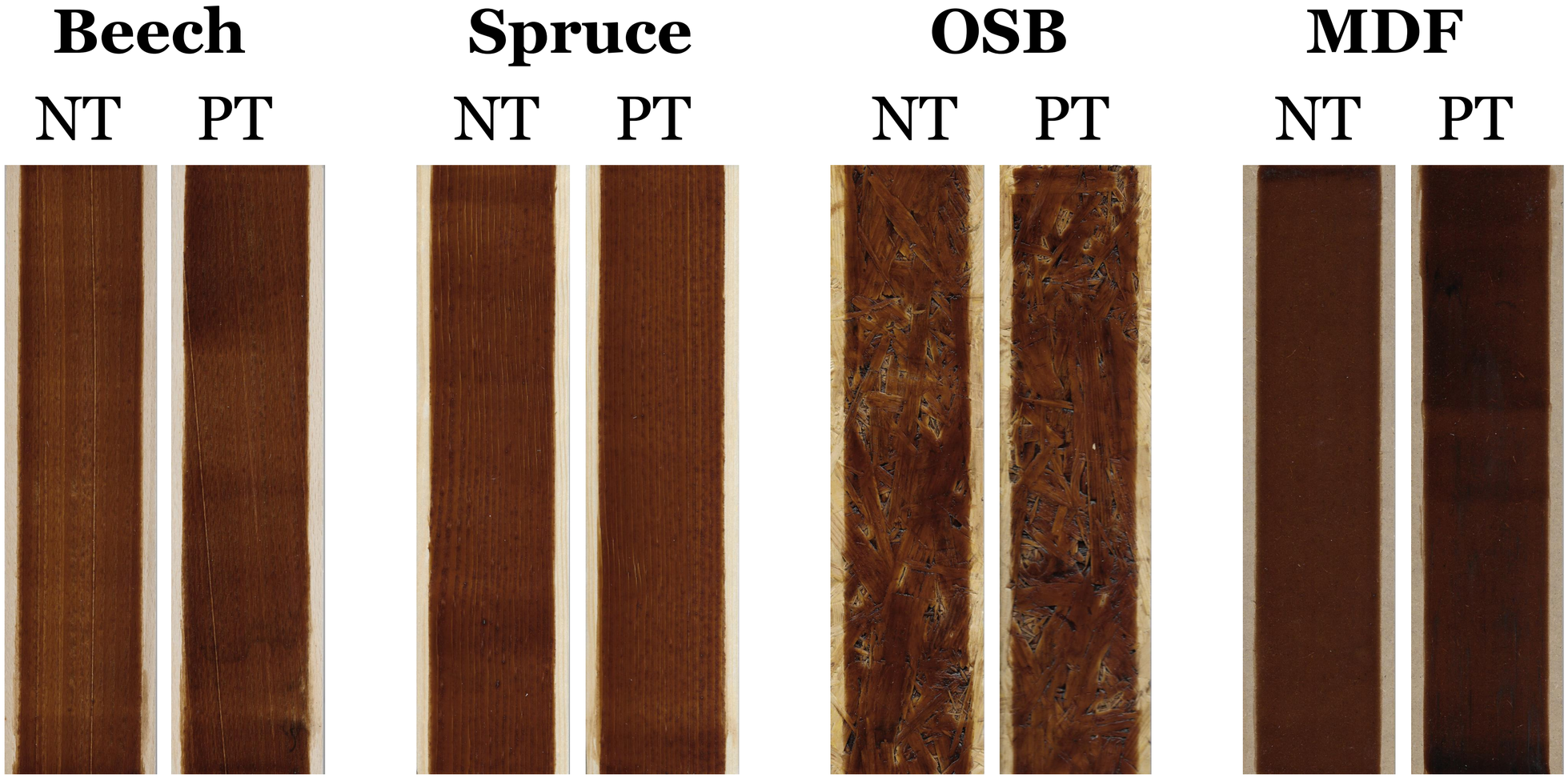
Experimental: Substrates and coating



300 mm × 75 mm × 19 mm
Conditioned at 20°C, RH 65%

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RESULTS

Artificial accelerated weathering

Water uptake

Adhesion strength

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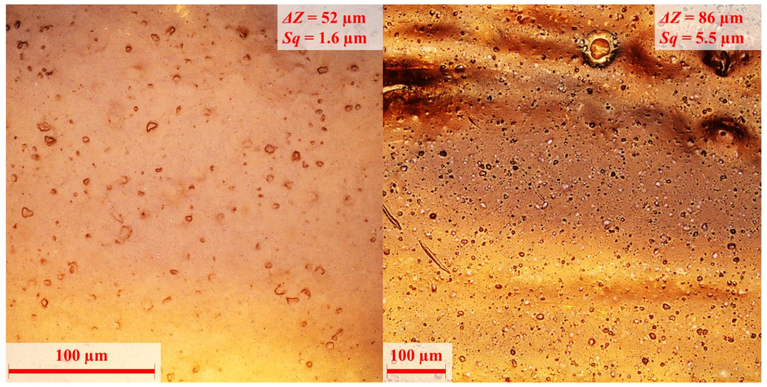
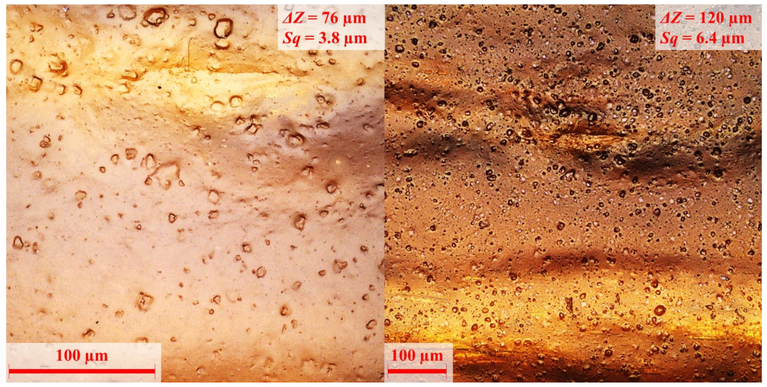
Weathering of Beech

CLSM

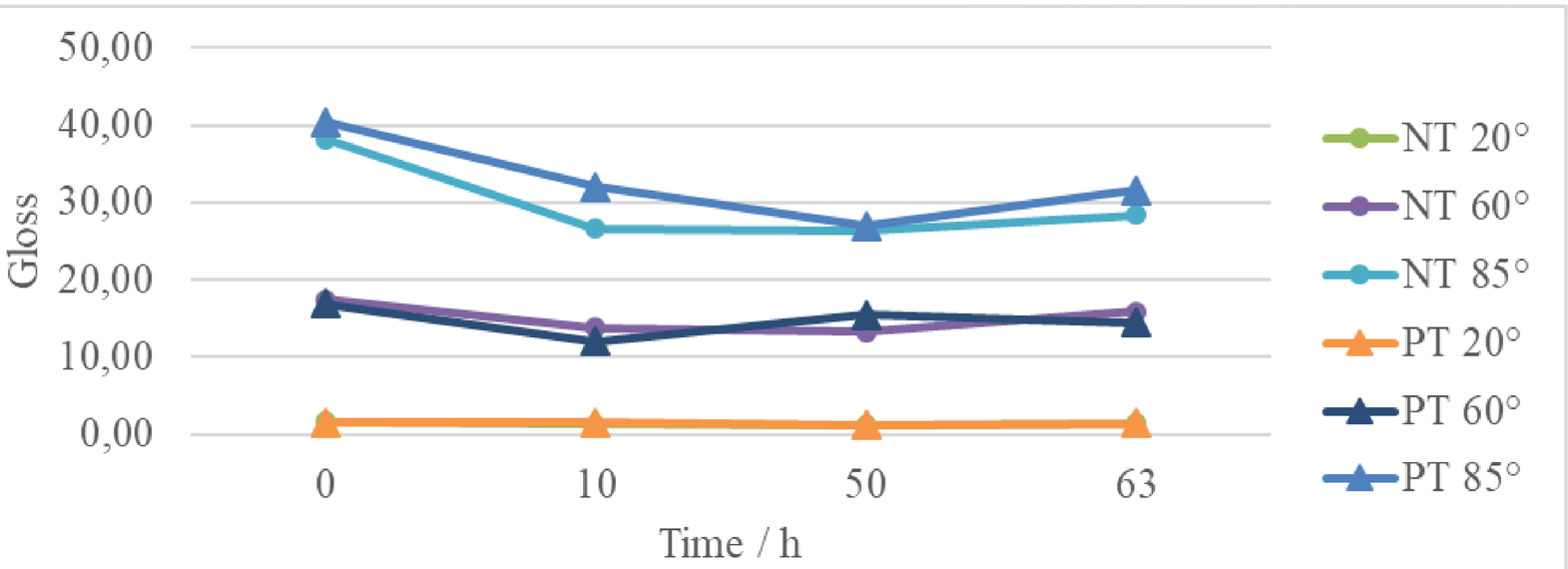
63 h AAW NT



63h AAW PT



GLOSS



CIELAB

Weathering Time / h	NT				PTC			
	ΔE	ΔL*	Δa*	Δb*	ΔE	ΔL*	Δa*	Δb*
10	0,69	-0,75	-0,12	-0,44	2,03	-1,92	-1,07	-2,16
50	3,61	-3,11	-1,73	-4,43	3,80	-3,26	-2,14	-4,35
63	2,69	-2,31	-1,31	-3,32	4,03	-3,18	-2,51	-4,80

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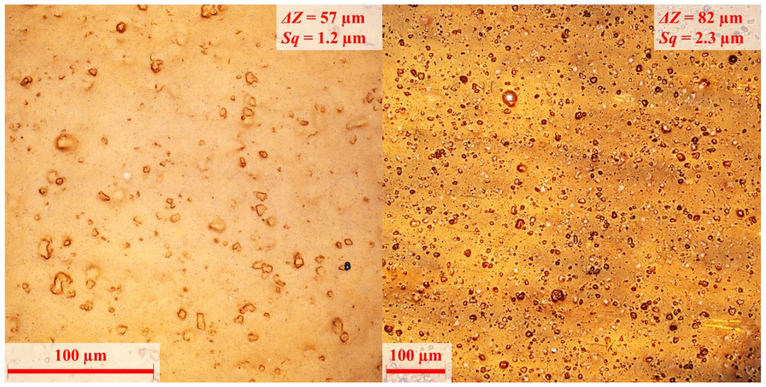
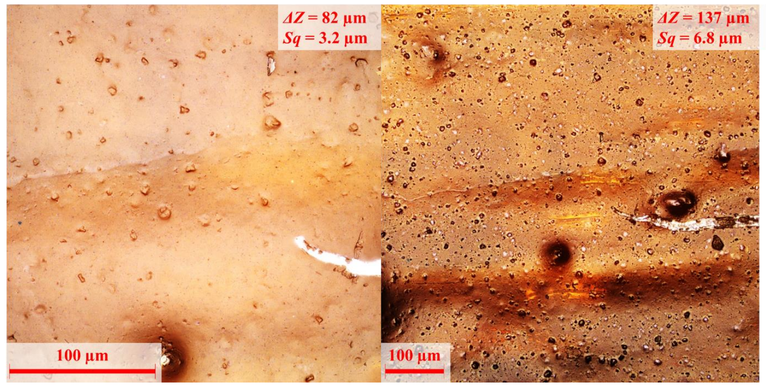
Weathering of Spruce

CLSM

63 h AAW NT



63h AAW PT



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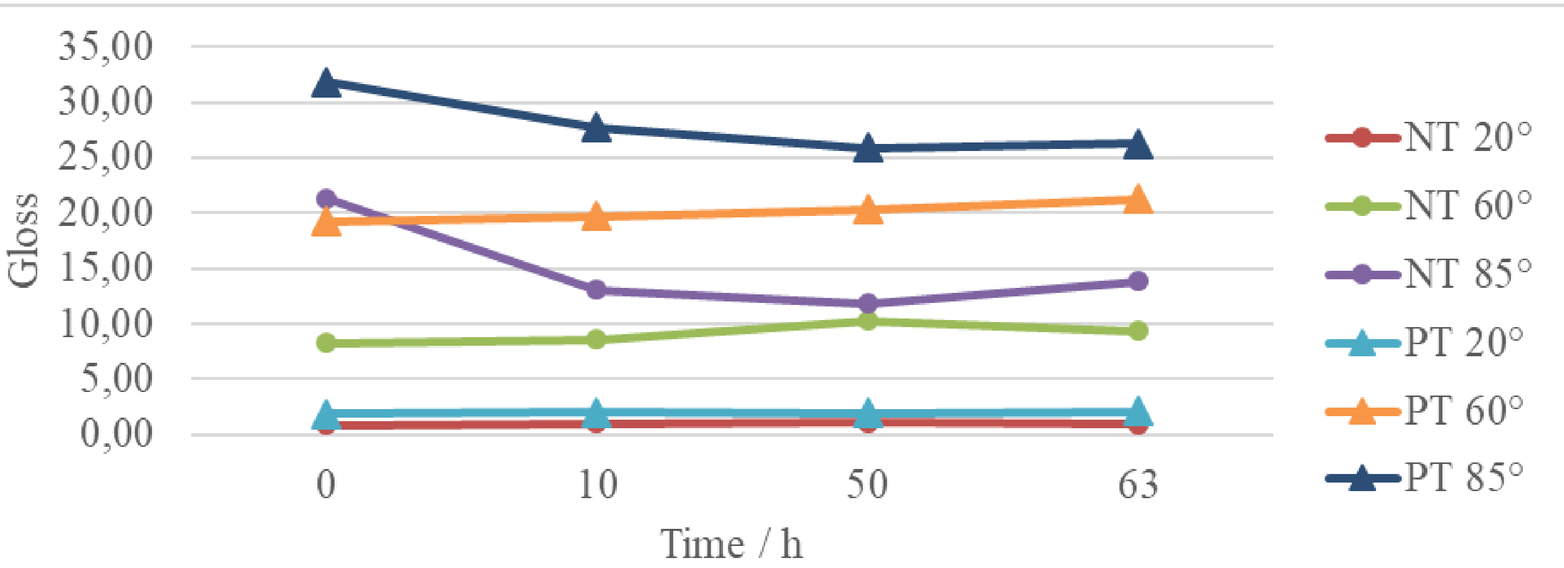

CIELAB

Weathering Time / h	NT				PTC			
	ΔE	ΔL*	Δa*	Δb*	ΔE	ΔL*	Δa*	Δb*
10	1.55	-1.65	-0.51	-1.16	1.28	-1.01	-0.99	-1.69
50	1.81	-1.88	-0.43	-1.50	1.69	-1.38	-1.25	-2.16
63	2.07	-2.19	-0.72	-1.70	1.66	-1.44	-1.25	-1.95

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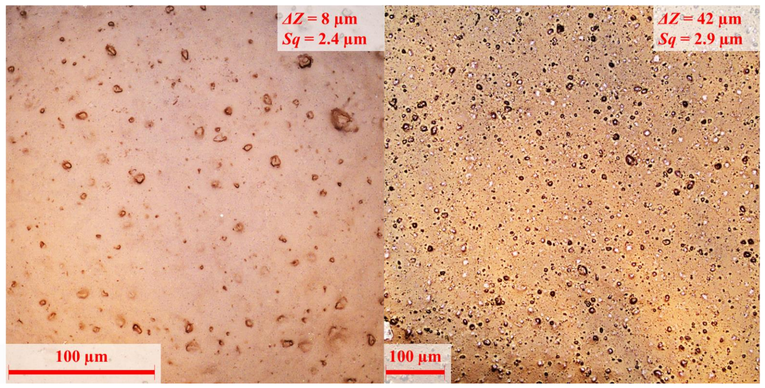
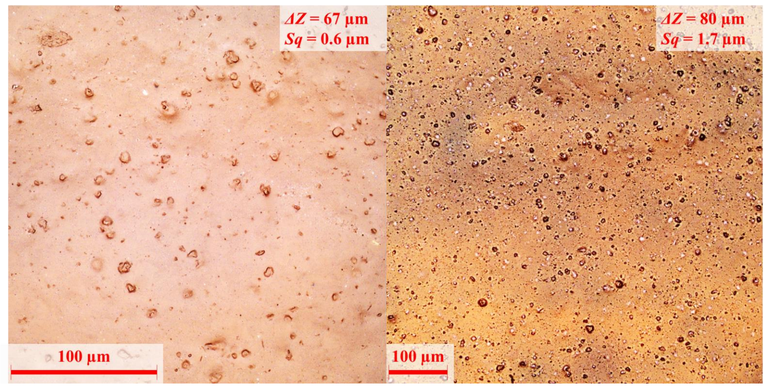
Weathering of OSB

CLSM

63 h AAW NT



63h AAW PT



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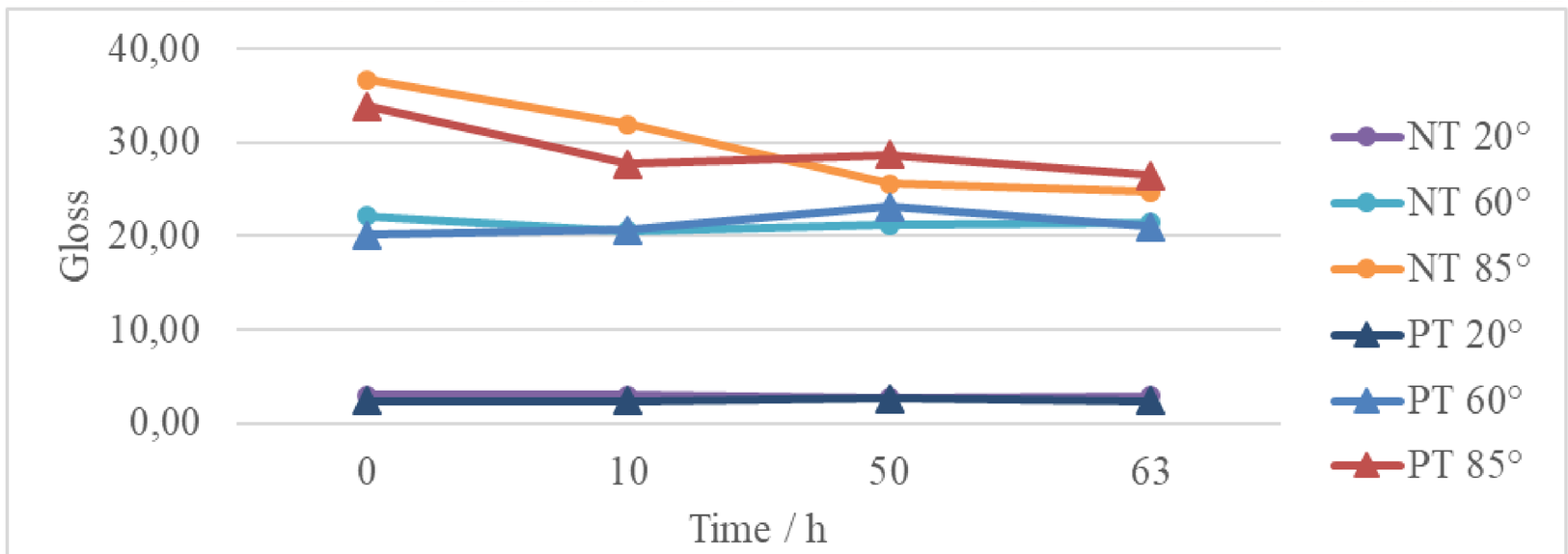

CIELAB

Weathering Time / h	NT				PTE			
	ΔE	ΔL*	Δa*	Δb*	ΔE	ΔL*	Δa*	Δb*
10	1.11	0.22	-0.02	0.24	0.37	-0.29	-0.29	-0.24
50	0.52	-0.33	-0.26	-0.30	0.52	-0.30	-0.41	-0.60
63	0.84	-0.66	-0.49	-0.92	0.53	-0.40	-0.29	-0.40

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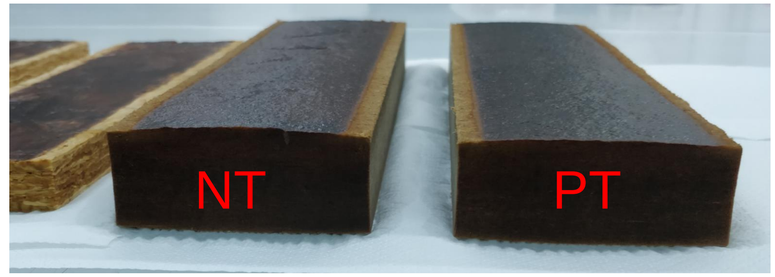
Weathering of MDF

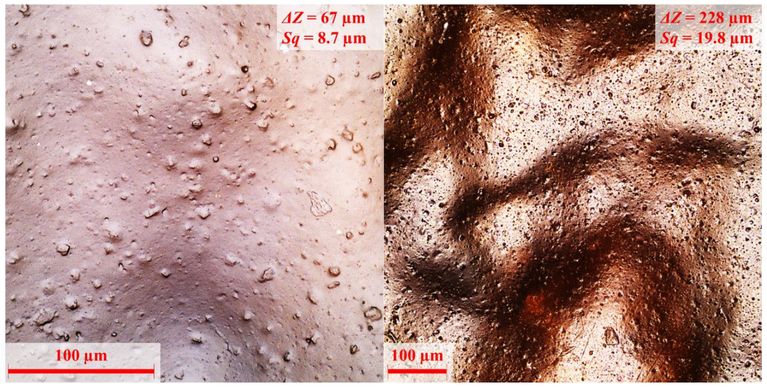
31.5 mm
+66%



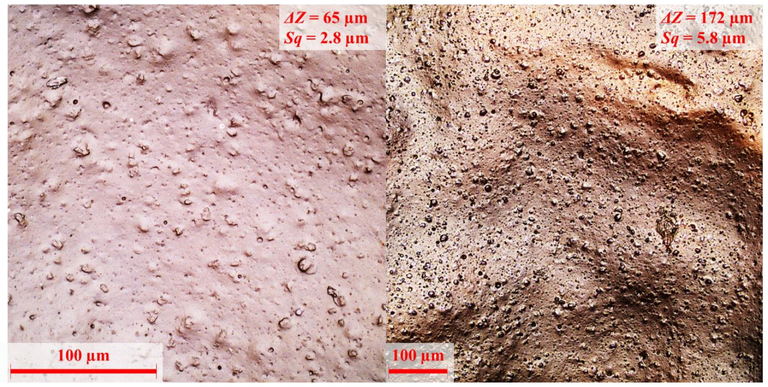
30.1 mm
+58.4%

CLSM

63 h AAW NT

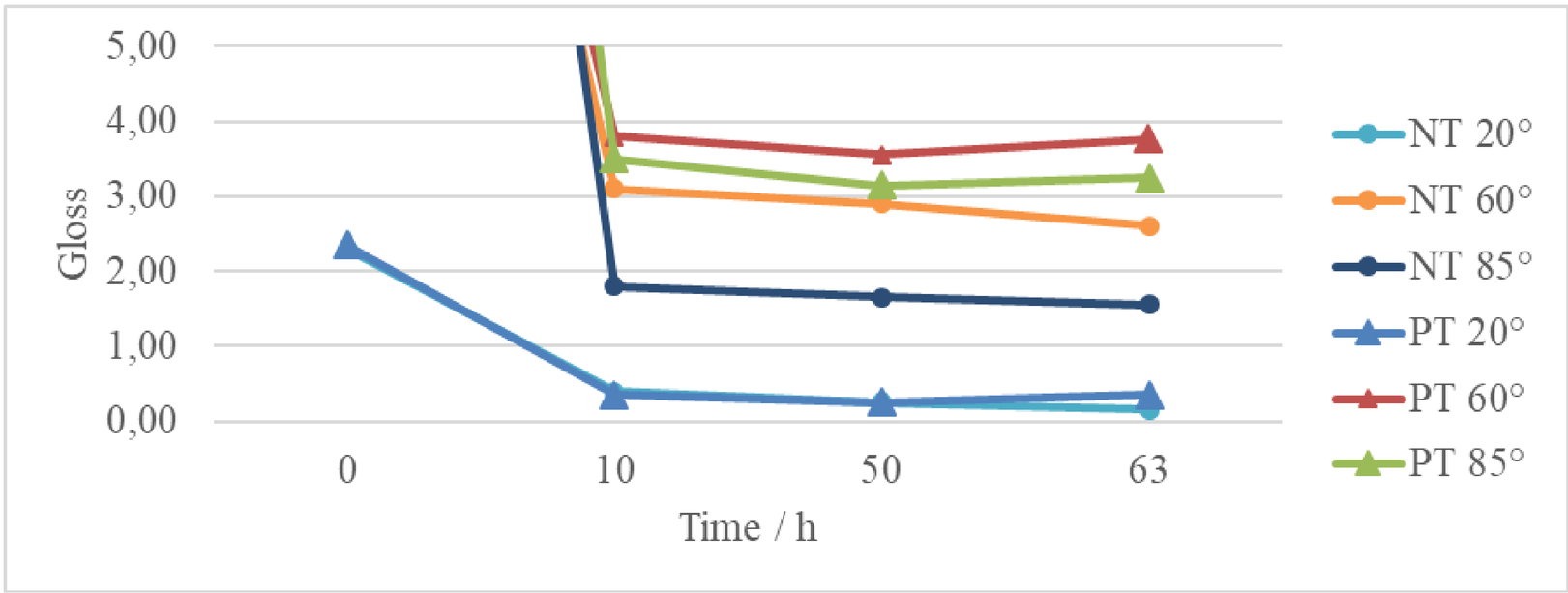


63h AAW PT



50h AAW

GLOSS



CIELAB

Weathering Time / h	NT				PTA			
	ΔE	ΔL*	Δa*	Δb*	ΔE	ΔL*	Δa*	Δb*
10	3.36	-2.04	-2.39	-3.60	1.84	-0.42	-1.42	-1.79
50	7.69	-4.22	-6.01	-6.91	5.00	-1.62	-4.06	-3.65
63	6.68	-3.73	-5.14	-6.32	4.29	-1.32	-3.46	-3.34

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Weathering - Summary

Beech – stronger discoloration with PT

Spruce – higher gloss with PT due to less number of pores,
color and gloss better preserved during weathering

OSB – no significant differences with PT

MDF – decreased swelling and higher gloss with PT

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RESULTS

Artificial accelerated weathering

Water uptake

Adhesion strength

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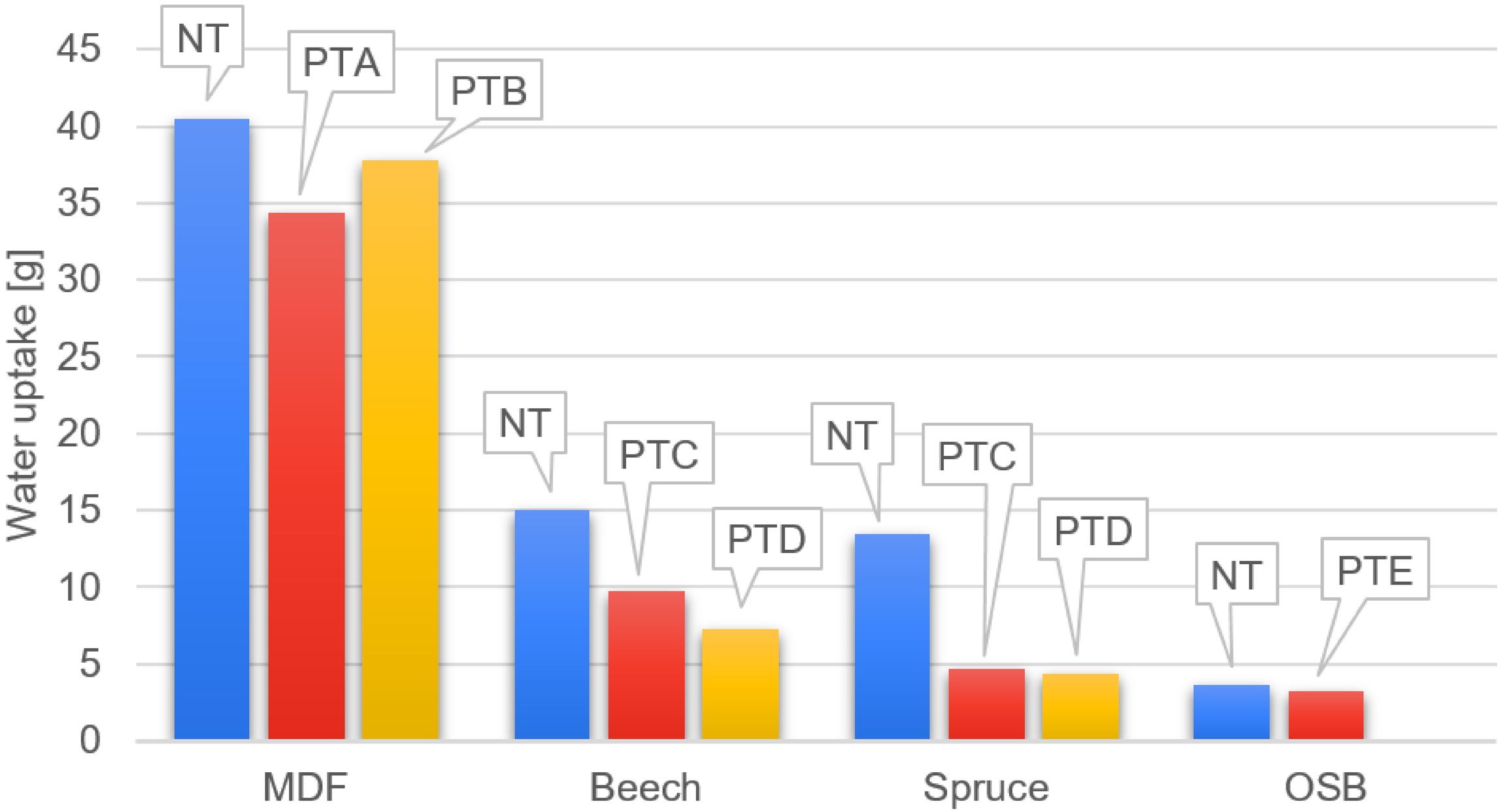
Water uptake after 3 days immersion



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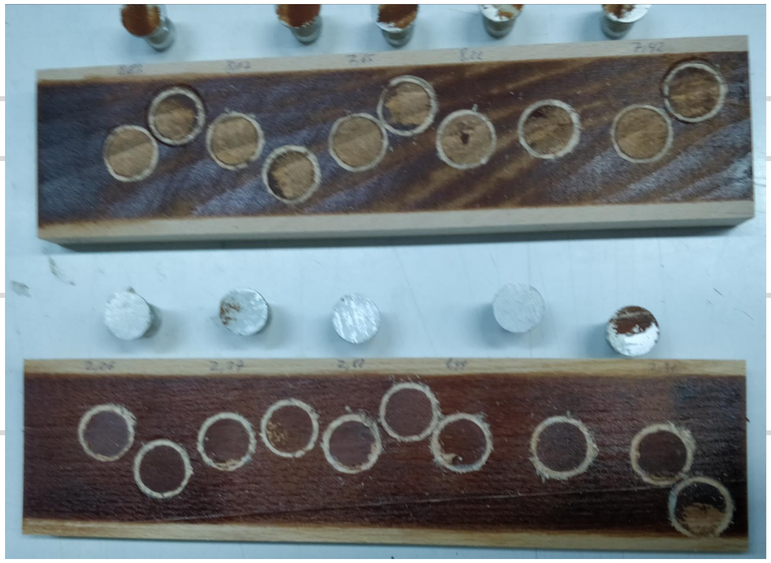
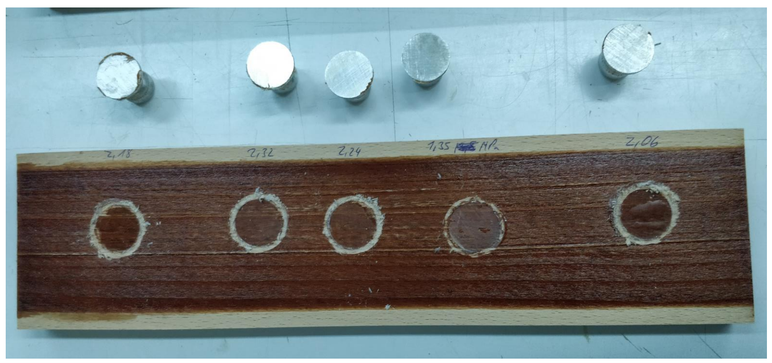
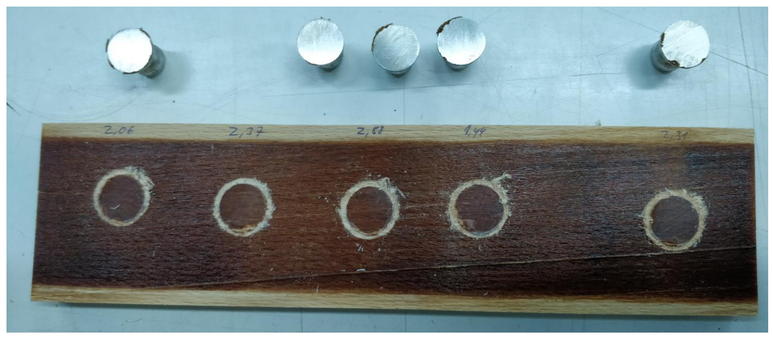
Adhesion strength on Beech





NT PT
both AAW



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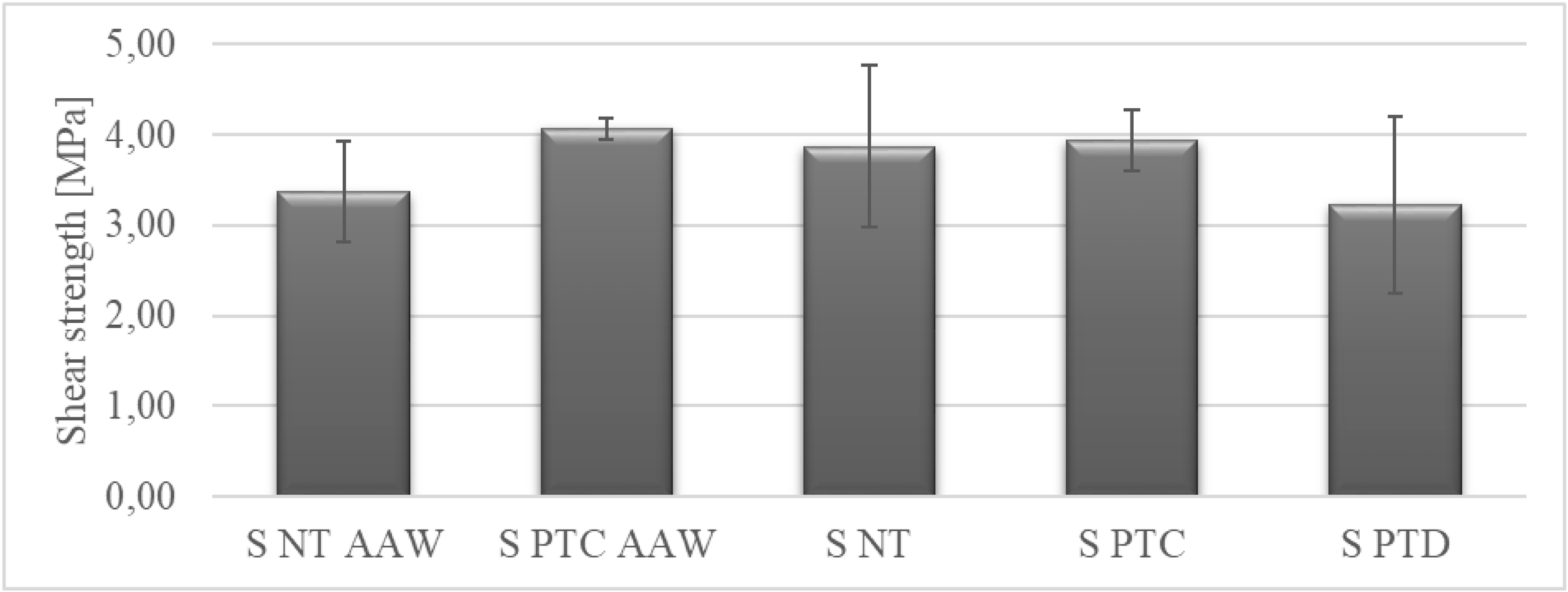
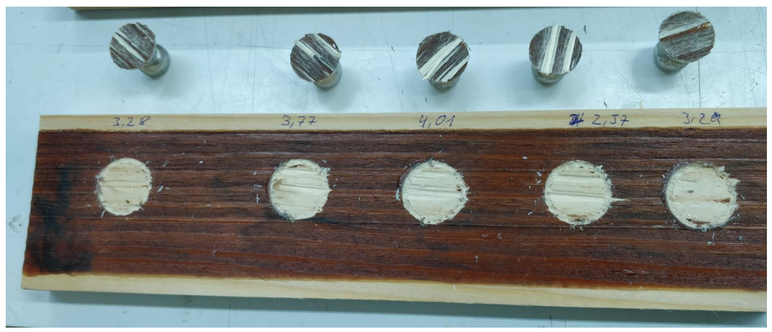
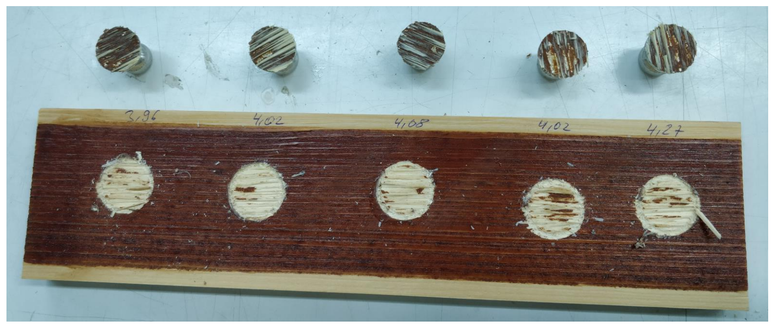
Adhesion strength on Spruce





NT PT
both AAW



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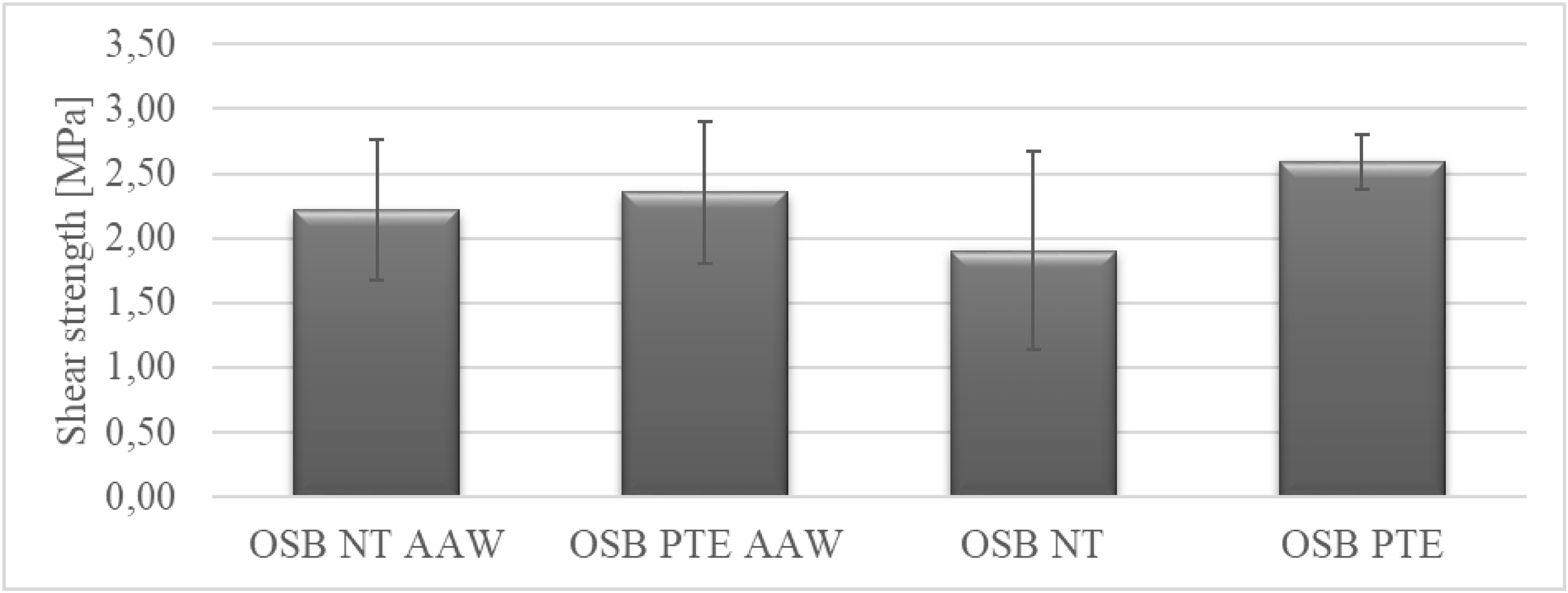
Adhesion strength on OSB



NT PT
both AAW

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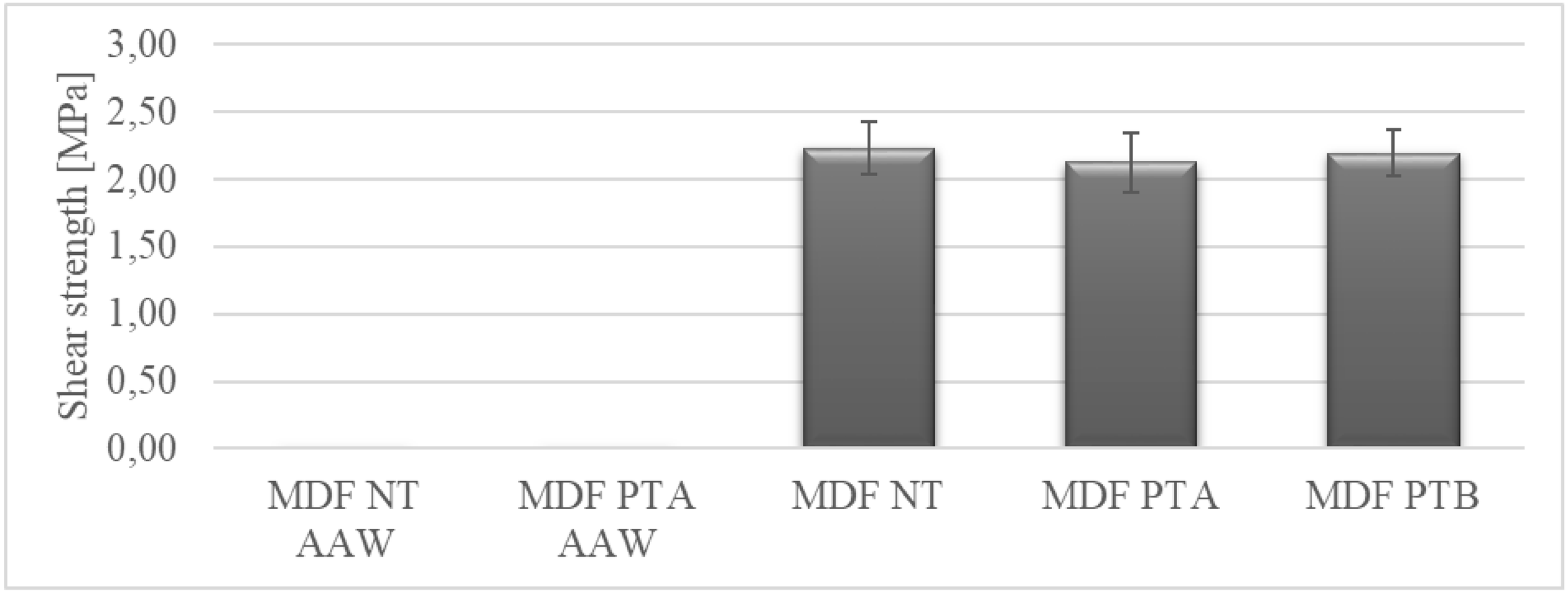
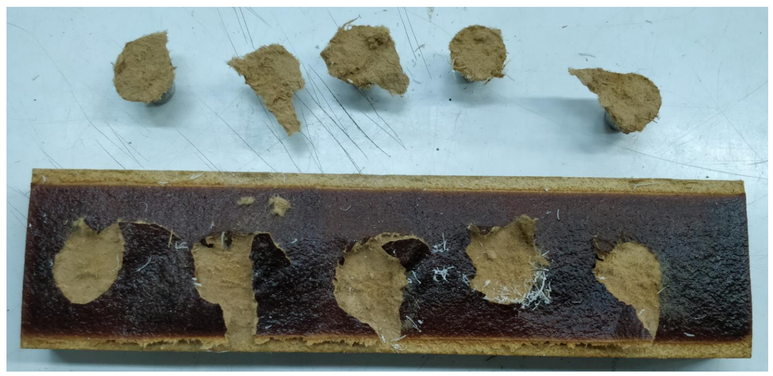
Adhesion strength on MDF



NT PT
both AAW



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Adhesion strength - Summary

Before weathering, bond strengths mostly independent of plasma pre-treatment.

Beech: Reduction to 25% after weathering, but Over-treatment might reduce bond strengths.

Spruce: Bond strength possibly better preserved during weathering on PT substrates.

OSB: Large variations prevent deductions.

MDF: All specimen failed after weathering.

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CONCLUSIONS

Beech: + PT strongly reduced water uptake, but
– increased discoloration during AAW

Spruce: + PT strongly reduced water uptake,
+ higher gloss due to less number of pores,
+ color and gloss better preserved during weathering

OSB: + PT slightly reduced water uptake,
• otherwise no significant influence of plasma pre-treatments

MDF: – poor performance did not improve much by plasma,
+ but water uptake reduced and gloss increased

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