



Inhaltsverzeichnis

Zusammenfassung	XIII
Abstract.....	XVII
Inhaltsverzeichnis	XXI
Abkürzungsverzeichnis	XXVII
Kapitel 1 – Einleitung.....	1
1.1 Hintergrund.....	1
1.2 Holz.....	3
1.3 Holzaufkommen und -auswahl	6
1.4 Holzmodifizierung	10
1.5 Holzmodifizierung mit Polykondensationsharzen.....	14
1.5.1 Melamin-Formaldehydharz	14
1.5.2 Phenol-Formaldehydharz.....	20
1.6 Verwitterung und Färbung von Holz	27
1.6.1 Azo- und Säurefarbstoffe.....	29
1.6.2 Eisen-Tannin-Verbindungen.....	31
1.7 Farbstabilisierung durch transparente Beschichtungen.....	35
1.8 Zielsetzung und Fragestellung.....	39
1.9 Publikationsliste.....	40
Kapitel 2 – Modification of three hardwoods with an N-methylol melamine compound and a metal-complex dye	41
2.1 Abstract	43
2.2 Introduction	43
2.3 Materials and methods	44
2.3.1 Wood and chemicals	44
2.3.2 NMM-dye treatment.....	45
2.3.3 Fixation of the dye	45
2.3.4 Colour measurements and nitrogen analysis	45
2.3.5 Light microscopy and SEM-EDX analysis	45
2.3.6 UV micro-spectrophotometry (UMSP).....	46
2.4 Results and discussion	46
2.4.1 Solution uptake and weight percent gain.....	46
2.4.2 Penetration of NMM-dye (BS) into the wood	47
2.4.3 Distribution of the dye in the cell wall	48
2.4.4 Topochemistry of NMM-dye-treated wood.....	48



2.5 Conclusion.....	53
Kapitel 3 – Strength changes in ash, beech and maple wood modified with a N-methylol melamine compound and a metal-complex dye	55
3.1 Abstract	57
3.2 Introduction	57
3.3 Materials and methods	58
3.3.1 Wood and chemicals	58
3.3.2 Wood Treatment	58
3.3.3 Mechanical properties	58
3.4 Results and discussion	59
3.5 Conclusions	62
Kapitel 4 – Decay resistance of ash, beech and maple wood modified with N-methylol melamine and a metal-complex dye	65
4.1 Abstract	67
4.2 Introduction	67
4.3 Materials and Methods.....	68
4.3.1 Wood and chemicals	68
4.3.2 Micro-organisms	69
4.3.3 NMM-dye treatment.....	69
4.3.4 White and brown rot testing	69
4.3.5 Soft rot testing.....	70
4.4 Results and discussion	70
4.4.1 White and brown rot decay.....	70
4.4.2 Soft rot decay.....	72
4.5 Conclusions	73
Kapitel 5 – The effect of combined melamine-resin- colouring-agent modification on water related properties of beech-wood.....	75
5.1 Abstract	77
5.2 Introduction	77
5.3 Material and Methods	78
5.3.1 Wood and chemicals	78
5.3.2 NMM resin and NMM resin-dye treatment.....	78
5.3.3 Fixation of chemical.....	79
5.3.4 Bulking, anti-shrink efficiency, maximum swelling.....	79
5.3.5 Equilibrium moisture content (EMC)	79
5.3.6 Capillary water uptake.....	80
5.3.7 Micro-computed tomography	80

5.4 Results and Discussion.....	80
5.4.1 Weight percent gain and solution uptake	80
5.4.2 Bulking, anti-shrink efficiency, and maximum swelling (S_{wmax})	81
5.4.3 Equilibrium moisture content	82
5.4.4 Swelling at various relative humidities (RH)	84
5.4.5 Capillary water uptake.....	85
5.5 Conclusions	87
Kapitel 6 – Application and artificial weathering performance of translucent coatings on resin-treated and dye-stained beech-wood.....	89
6.1 Abstract	91
6.2 Introduction	91
6.3 Materials and methods	93
6.3.1 Wood specimens and chemicals	93
6.3.2 Modification of wood.....	93
6.3.3 Coating application	94
6.3.4 Drying time of finish	94
6.3.5 Water uptake.....	94
6.3.6 Artificial weathering and colour measurement.....	95
6.3.7 Adhesion strength and wood fracture.....	95
6.4 Results and discussion	96
6.4.1 Weight percent gain and solution uptake	96
6.4.2 Drying rate of finishes on wood.....	96
6.4.3 Capillary water uptake.....	98
6.4.4 Artificial weathering and colour change	99
6.4.5 Adhesion of finishes.....	102
6.5 Conclusion.....	105
Kapitel 7 – Natural weathering performance and the effect of light-stabilizers in water-based coating formulations on resin-modified and dye-stained beech-wood	107
7.1 Abstract	109
7.2 Introduction	109
7.3 Materials and methods	111
7.3.1 Wood specimens and chemicals	111
7.3.2 Modification of wood.....	111
7.3.3 Coating application	111
7.3.4 Natural weathering	112
7.3.5 Surface evaluation	112
7.3.6 Optical appearance	113
7.4 Results and discussion	113
7.4.1 Weight percent gain and solution uptake	113



7.4.2	Coatability of wood.....	113
7.4.3	Natural weathering	114
7.4.3.1	Mass changes	114
7.4.3.2	Formation of defects and cracks.....	115
7.4.3.3	Water uptake in course of weathering	117
7.4.3.4	Color change	118
7.5	Conclusion.....	121
Kapitel 8 – Modification of wood with formulations of phenolic resin and iron-tannin-complexes to improve material properties and expand colour variety		123
8.1	Abstract	125
8.2	Introduction	125
8.3	Materials and methods	126
8.3.1	Wood specimens and chemicals	126
8.3.2	Modification of wood.....	127
8.3.3	Fixation of chemical	127
8.3.4	Cell wall bulking, anti-shrink efficiency, maximum swelling	127
8.3.5	Equilibrium moisture content (EMC)	128
8.3.6	Capillary water uptake.....	128
8.3.7	Artificial weathering	128
8.4	Results and discussion	129
8.4.1	Weight percent gain and solution uptake	129
8.4.2	Bulking, anti-shrink efficiency (ASE), and maximum swelling (Sw_{max}).....	129
8.4.3	Equilibrium moisture content	131
8.4.4	Artificial weathering and colour change	133
8.4.5	Capillary water uptake.....	134
8.5	Conclusion.....	135
Kapitel 9 – Zusammenfassung der Ergebnisse und Diskussion.....		137
9.1	Verteilung der Modifizierungskemikalien.....	137
9.1.1	Makroskopische Verteilung.....	137
9.1.2	Mikroskopische Verteilung	141
9.1.3	Einfluss verschiedener Prozessparameter.....	143
9.2	Mechanische Holzeigenschaften	143
9.3	Dauerhaftigkeit und Mechanismen der Dauerhaftigkeitserhöhung.....	146
9.4	Feuchtebedingte Holzeigenschaften	151
9.4.1	Auswaschungsbeanspruchung und Fixierung.....	152
9.4.2	Sorptionsverhalten.....	153
9.4.3	Dimensionsstabilisierung.....	156
9.4.4	Kapillare Wasseraufnahme.....	160
9.5	Bewitterungsverhalten von farbmodifiziertem Holz	161



9.6 Farbstabilisierung durch Modifizierung und Beschichtung	165
9.7 Farbveränderung durch Modifizierung der Polykondensationsharze	169
Kapitel 10 – Schlussbetrachtung und Ausblick	173
Literaturverzeichnis	177
Lebenslauf	207