

Understanding the PLA-wood adhesion interface for the development of PLA-bonded softwood laminates

Warren J. Grigsby,* Desiree Torayno, Marc Gaugler

Supplementary Materials

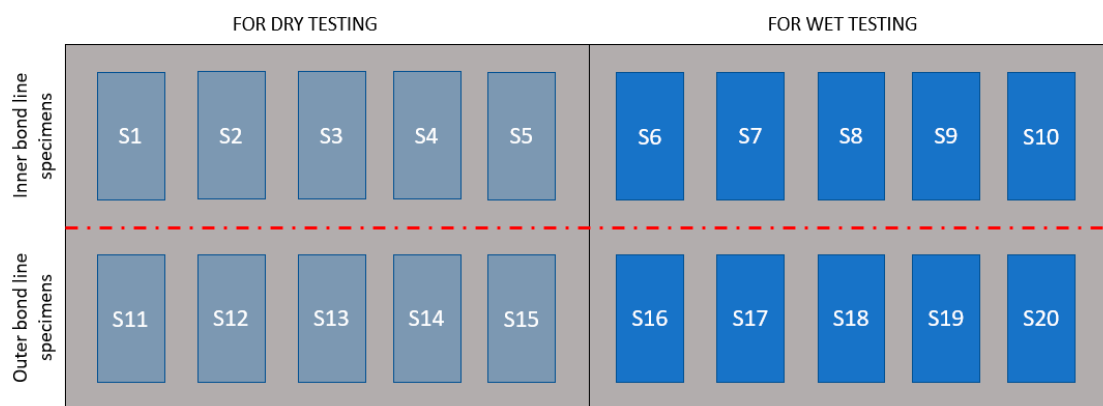


Figure S1. Cutting pattern employed to generate 25 mm x 100 mm test specimens which were then cross-cut to isolate the bondline (inner and outer) for testing bond line.

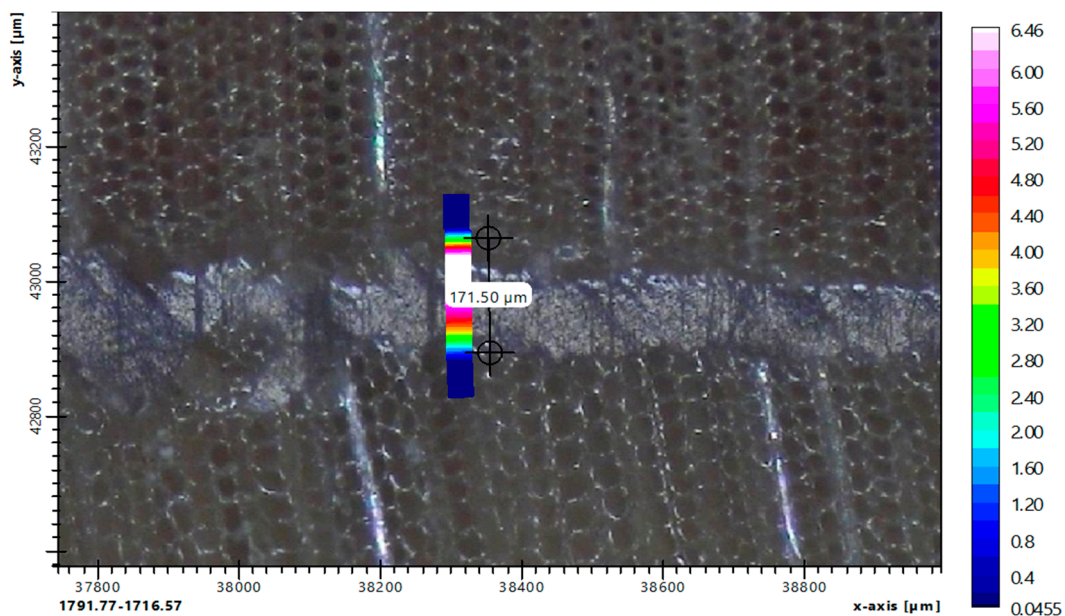


Figure S2. Selected example from chemical spatial imaging analysis showing extent of PLA migration (penetration) from the bondline. Semi-crystalline PLA, 180 °C, 360 seconds.

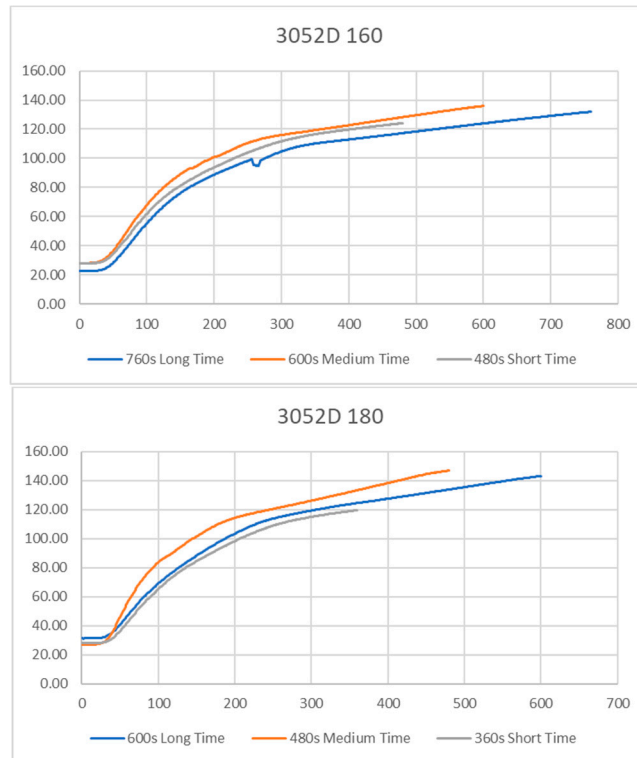


Figure S3. Selected internal panel temperature profiles for 5-ply panels formed at 160 °C (top) and 180 °C (bottom) pressing temperatures with ether semi-crystalline PLA (3052D).

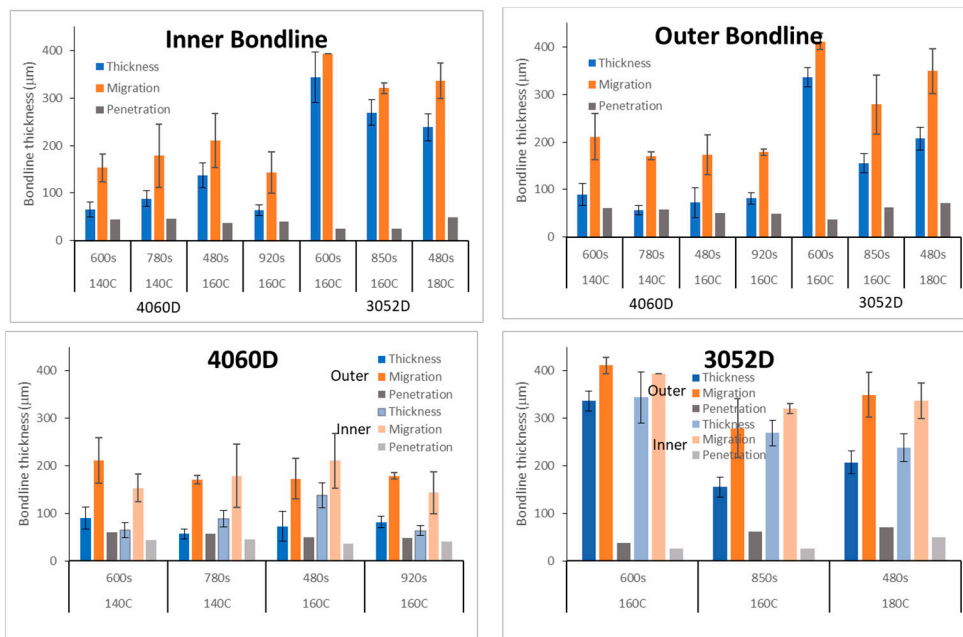


Figure S4. Comparisons of PLA bondline thickness and penetration values (5-ply samples)

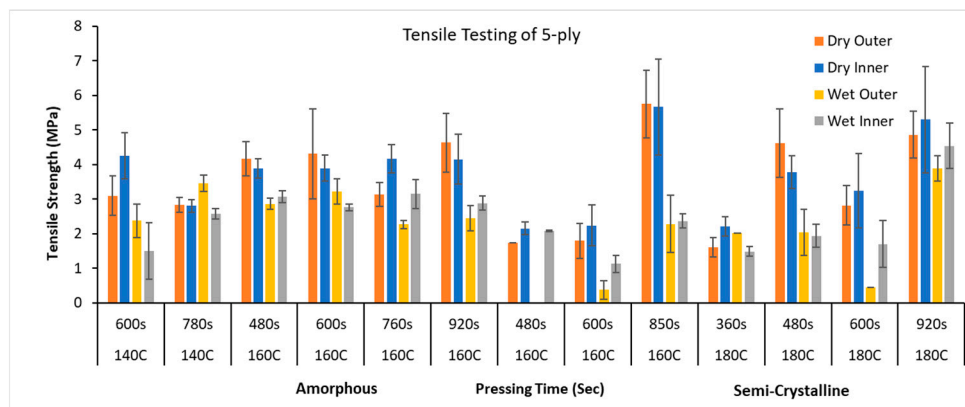


Figure S5. Comparisons of bondline tensile strength values (5-ply samples)

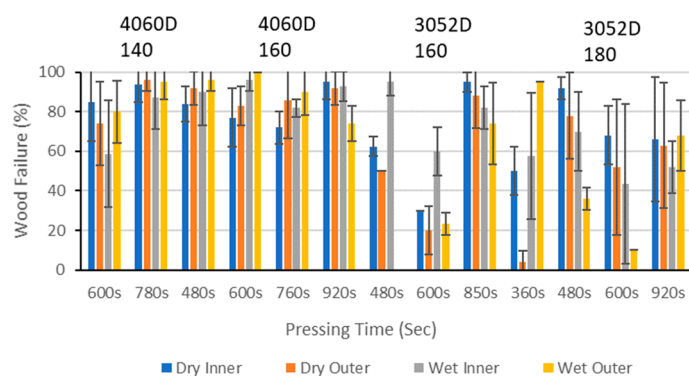


Figure S6. Comparisons of bondline tensile strength values (5-ply samples)

Table S1. Relationships of dry and wet tensile strength with PLA bondline thickness and penetration values for inner and outer bondlines of 5-ply panels.

Tensile strength		Thickness		Penetration	
		Inner	Outer	Inner	Outer
		R ²	R ²	R ²	R ²
4060D	dry	0.04	0.11	0.23	0.86
	wet	0.33	0.96	0.33	0.01
3051	dry	0.41	1	0.006	0.72
	wet	0.63	0.97	0.48	0.86

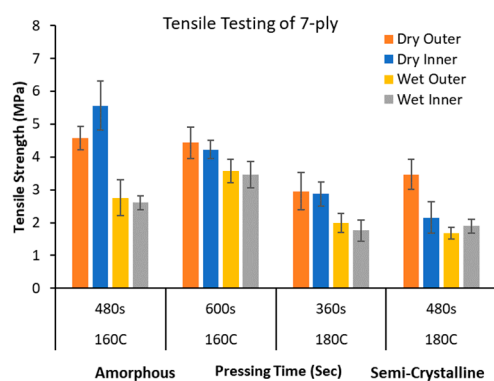


Figure S7. Comparisons of bondline tensile strength values (7-ply samples)

Table S2. Summary of tensile testing results of 5-ply panels formed with radiata pine veneer and semi-crystalline and amorphous PLA grades at differing pressing temperatures and times before soaking

PLA	Press	Press	Dry tensile strength (MPa)				24 h cold water soak tensile strength (MPa)			
Grade	Temperatu re	Time	Inner		Outer		Inner		Outer	
	(°C)	(sec)	Average	Std Dev	Average	Std Dev	Average	Std Dev	Average	Std Dev
5-ply laminate panels										
Amorphous	140	600s	4.26	0.67	3.10	0.58	1.50	0.83	2.38	0.49
		780s	2.81	0.18	2.84	0.21	2.57	0.15	3.46	0.23
	160	480s	3.89	0.27	4.17	0.49	3.08	0.17	2.87	0.17
		600s	3.90	0.37	4.32	1.30	2.76	0.10	3.22	0.37
		760s	4.17	0.41	3.14	0.35	3.15	0.42	2.27	0.13
		920s	4.15	0.72	4.63	0.86	2.89	0.21	2.45	0.37
Semi-Crystalline	160	480s	2.15	0.18	1.75	-	2.09	0.02	-	-
		600s	2.24	0.59	1.80	0.50	1.13	0.25	0.38	0.27
		850s	5.66	1.39	5.75	0.99	2.37	0.20	2.28	0.82
	180	360s	2.21	0.27	1.61	0.29	1.49	0.14	2.01	-
		480s	3.79	0.48	4.62	0.99	1.94	0.34	2.04	0.66
		600s	3.24	1.07	2.82	0.57	1.70	0.67	0.46	-
		920s	5.30	1.53	4.86	0.68	4.54	0.65	3.89	0.36
7 - ply laminate panels										
Amorp Crystall hous ine	160	480s	5.56	0.75	4.58	0.36	2.61	0.22	2.76	0.54
		600s	4.23	0.28	4.43	0.49	3.47	0.40	3.57	0.35
Semi- Crystall hous ine	180	360s	2.88	0.37	2.95	0.56	1.76	0.33	1.99	0.29
		480s	2.15	0.48	3.47	0.45	1.89	0.21	1.67	0.18