

Supporting Information

Chemical Pulping Advantages of Zip-lignin Hybrid Poplar

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Tables

Table S1. Bleaching conditions.

Stage	Conditions
O	Pressurized with O ₂ to 80 psig, 10% csc, 100 °C, 2.5% NaOH, 60 min.
D	0.20 Kappa factor, 3.5% csc, 50 °C, 45 min., initial pH adjusted to 4.0 with 10% H ₂ SO ₄
EP	0.5% H ₂ O ₂ , 10% csc, 70 °C, 60 min., 2.5% NaOH, terminal pH ~ 11.0
D	Varying % ClO ₂ , 10% csc, 75 °C, 120 min., initial pH measured at 8.4 but not adjusted to achieve final pH of approximately 4.5

Table S2. Handsheet physical properties. Average values with standard deviation from n=4 in parentheses.

PFI mill (rev)	CS Freeness (mL)		Specific volume (cm ³ /g)		Tensile Index (N-m/g)	
	L7	WT	L7	WT	L7	WT
100	555 (12)	563 (10)	2.11 (0.14)	2.09 (0.12)	22.1 (1.4)	21.7 (1.3)
500	501 (15)	521 (11)	1.96 (0.14)	1.95 (0.15)	32.3 (0.9)	32.1 (1.1)
1000	491 (11)	487 (12)	1.87 (0.11)	1.85 (0.11)	38.8 (1.2)	39.5 (1.4)
2000	438 (15)	445 (17)	1.80 (0.13)	1.78 (0.14)	48.8 (1.3)	49.1 (1.5)

* Number in brackets is standard deviation.

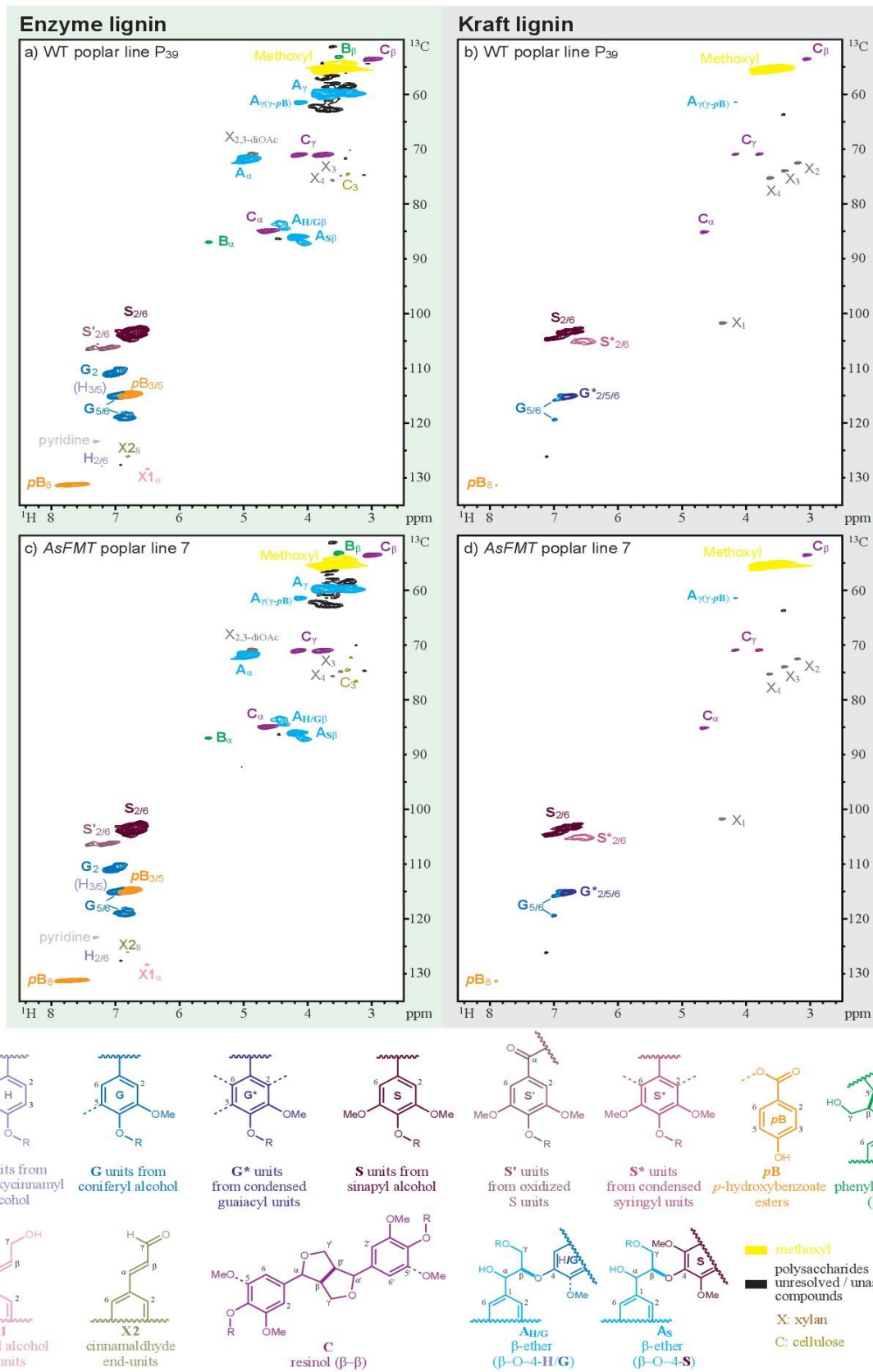


Figure S1. 2D ^1H - ^{13}C HSQC NMR spectra of lignins from wild-type (WT) and Zip-lignin (line 7) poplar isolated before (enzyme lignin) and after (kraft lignin) kraft cooking (Contours are labeled and color coded to match the lignin substructures at the bottom of the figure).

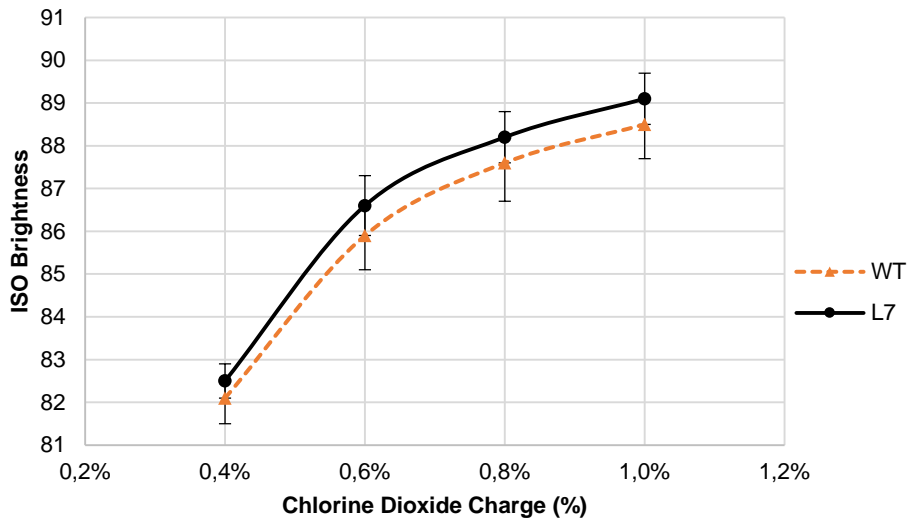


Figure S2. Brightness of the pulps as a function of final chlorine dioxide charge.