Supporting Information for:

Molecular architecture requirements for polymer-grafted lignin superplasticizers

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NMR spectra of products

Figure 1 shows the NMR spectra of the lignin-grafted polyacrylamide (using reversible addition-fragmentation chain-transfer) macroinitiator.

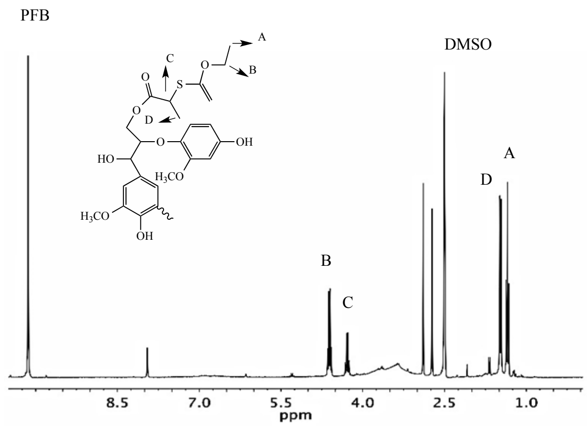


Figure 2 shows the NMR spectra of the lignin-grafted polyacrylamide (using free radical polymerization) macroinitiator.

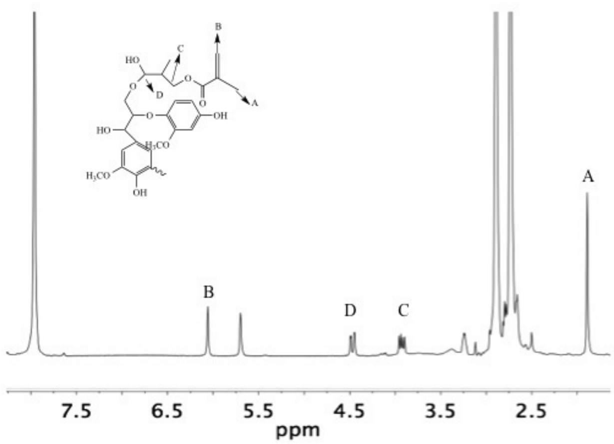
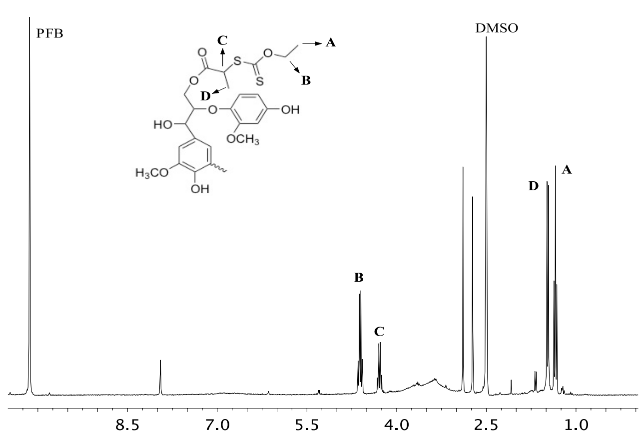


Figure 3 shows the NMR spectra of the lignin-grafted polyacrylamide (using reversible addition-fragmentation chain-transfer).



Slump test calculations

Table 1 shows the relative flow area ratio calculated for each sample using the raw slump test data. The relative flow area ratio was calculated by taking the squared ratio of the difference between the average slump and the diameter of the slump cone.

Superplasticizer Dosage (wt. %)	OPC	PCE	RAFT	FRP
0.0125	0.56	0.67	2.01	0.56
0.025	0.56	1.01	2.96	0.72
0.05	0.56	2.16	3.09	0.84
0.1	0.56	2.47	3.13	0.95
0.15	0.56	2.63	3.85	1.52
0.2	0.56	5.45	4.23	0.84
0.25	0.56	6.11	4.72	0.84

Table 1. Relative flow area ratio for various samples

Table 2 shows the yield stress calculated for each sample using the raw slump test data. The average diameter was used in equation S1 to calculate the yield stress

$$\tau_0 = \frac{225 \rho g V^2}{128 \pi^2 R^5} \tag{S1}$$

Table 2. Yield stress for various concentrations of superplasticizers

Superplasticizer Dosage (wt. %)	OPC (Pa)	PCE (Pa)	RAFT (Pa)	FRP (Pa)
0.0125	236.31	199.23	45.39	235.37
0.025	236.31	124.63	22.93	183.68
0.05	236.31	40.24	21.07	156.71
0.1	236.31	31.89	20.64	134.37
0.15	236.31	28.49	13.83	70.91
0.2	236.31	6.76	11.45	156.71
0.25	236.31	5.29	9.13	156.71

Zeta potential measurements

Table 3 shows the zeta potential and average diameter of the superplasticizers at a high and low concentration. These measurements were performed to understand how likely the superplasticizer solution is going to aggregate and adsorb to the surface of cement.

Table 3. Zeta Potential and diameter for various concentrations of superplasticizer

Sample (mg/mL)	Zeta Potential (mV)	Diameter (nm)
RAFT (0.25)	-36.2, ± 0.6	35.9
FRP (0.25)	-39.2, ± 0.9	101.6
PCE (0.25)	-48.9, ± 0.7	6.5
RAFT (2.7)	-25.7, ± 0.2	98.5
FRP (2.7)	-15.7, ± 0.4	155.1
PCE (2.7)	-33.8, ± 0.2	4.1

XRD characterization of phases

Each cement phase was synthesized using either sol gel or solid state synthesis. Each phases was characterized using X-ray diffraction and was compared to the JCPDS standard. The grey circle represents the characteristic peaks.

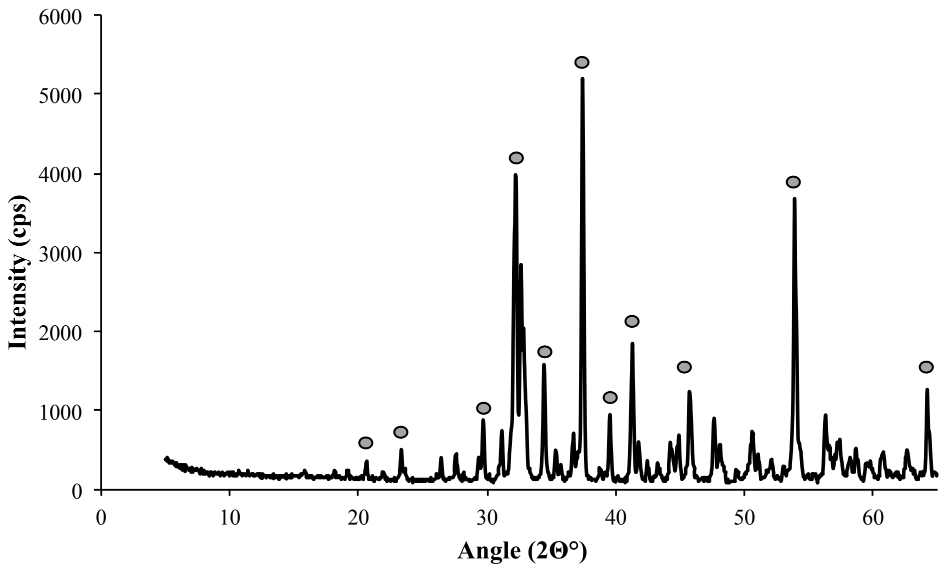


Figure 1. XRD pattern of C_2S phase (JCPDS: 20-0237)

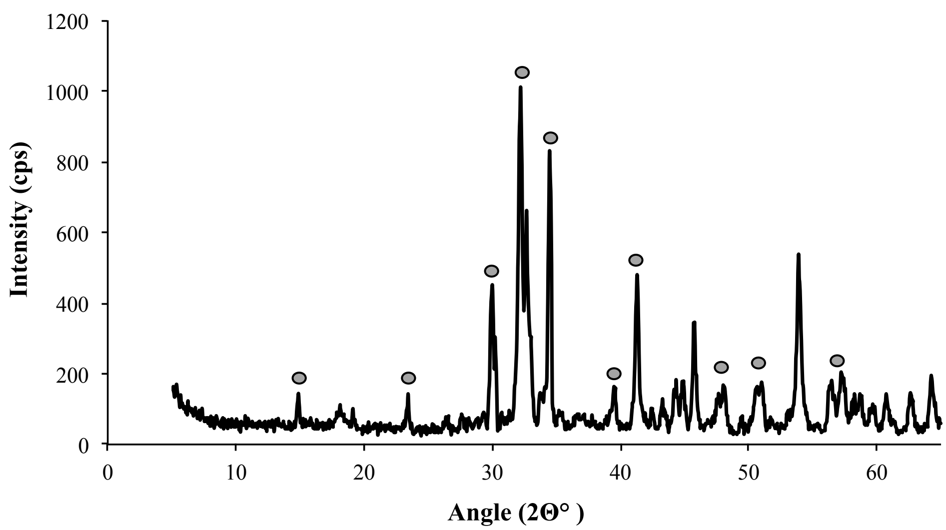


Figure 2. XRD pattern of C_3S phase (JCPDS: 42-0551)

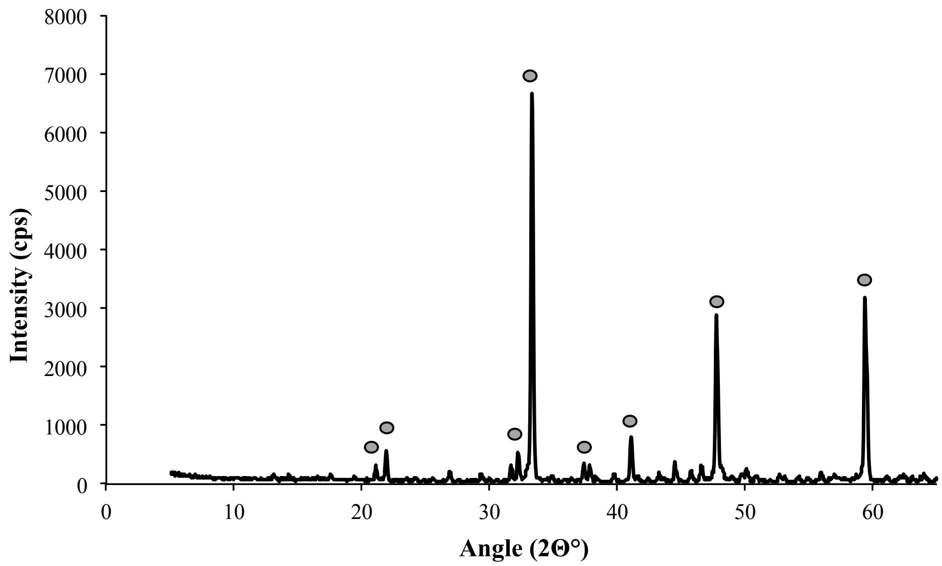


Figure 3. XRD pattern of C_3A phase (JCPDS: 38-1429)

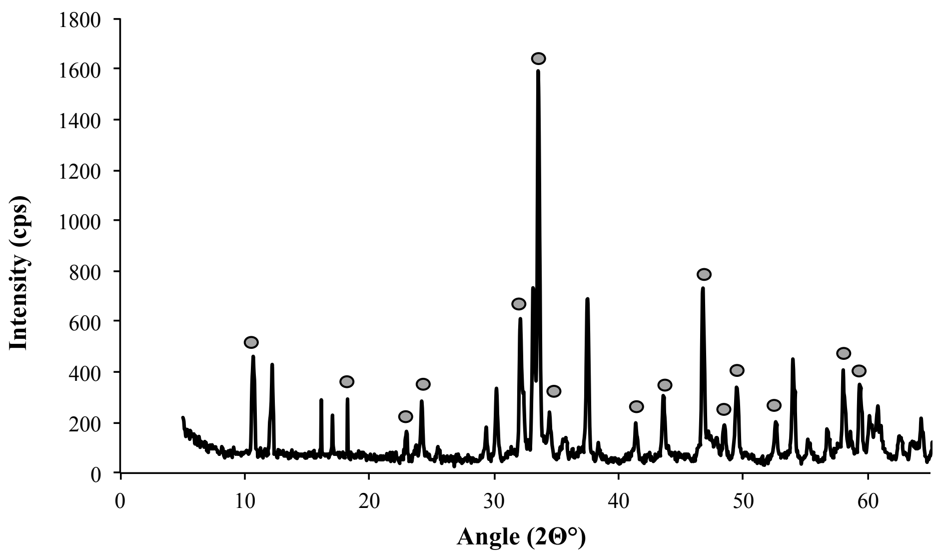


Figure 4. XRD pattern of C_4AF phase (JCPDS: 87-1229, with other impurities)