High Glass Transition Lignin for Carbon Fiber Production

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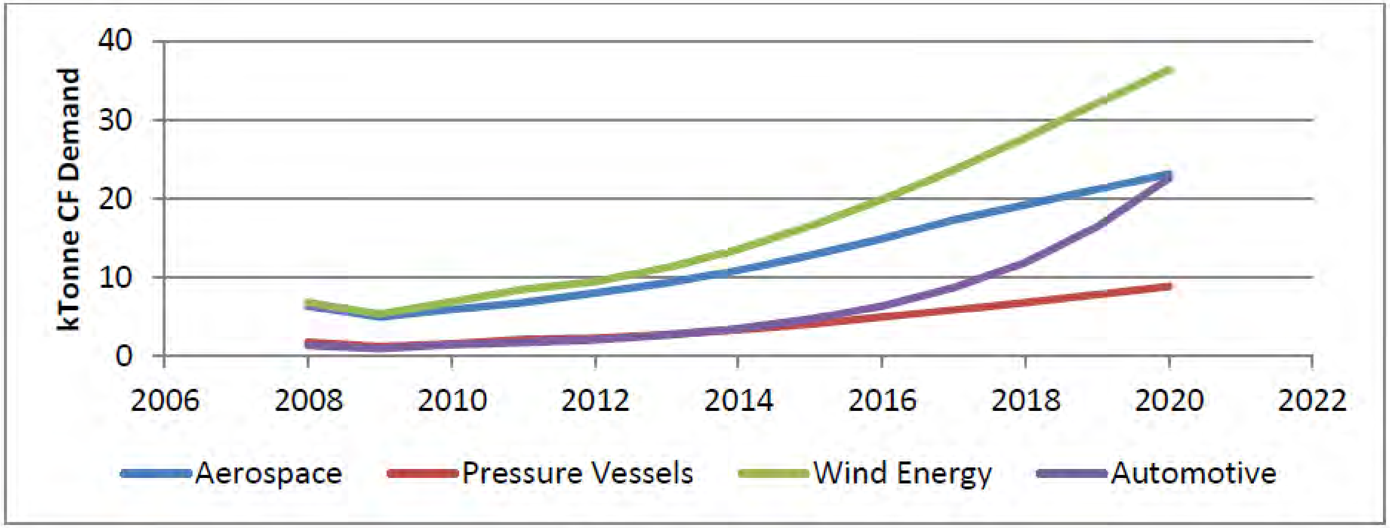
Outline

- Introduction to Carbon fiber (properties, markets, and issues)
- High glass transition (Tg) lignin from directional liquefaction of biomass

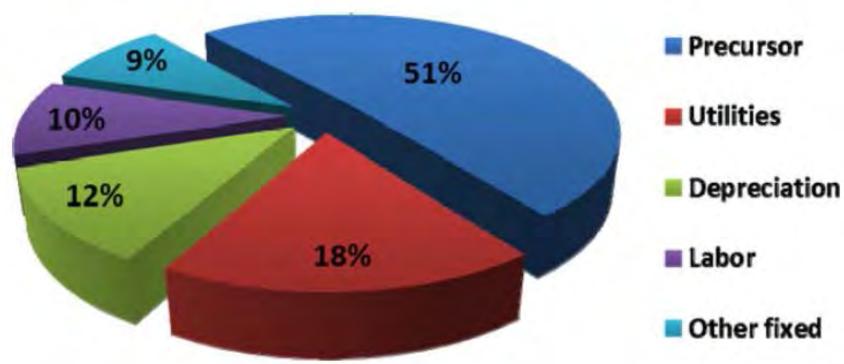
Carbon fiber is strong and light

	Tensile Strength	Young's Modulus	Density
Carbon fiber	3500MPa	230GPa	1.78g/cm^3
Steel	600MPa	200GPa	7.87g/cm^3



Projections of global carbon fiber demand in the four major application areas (Das et al. 2016)

The production cost is >$25/Kg (polyacrylonitrile, PAN based)



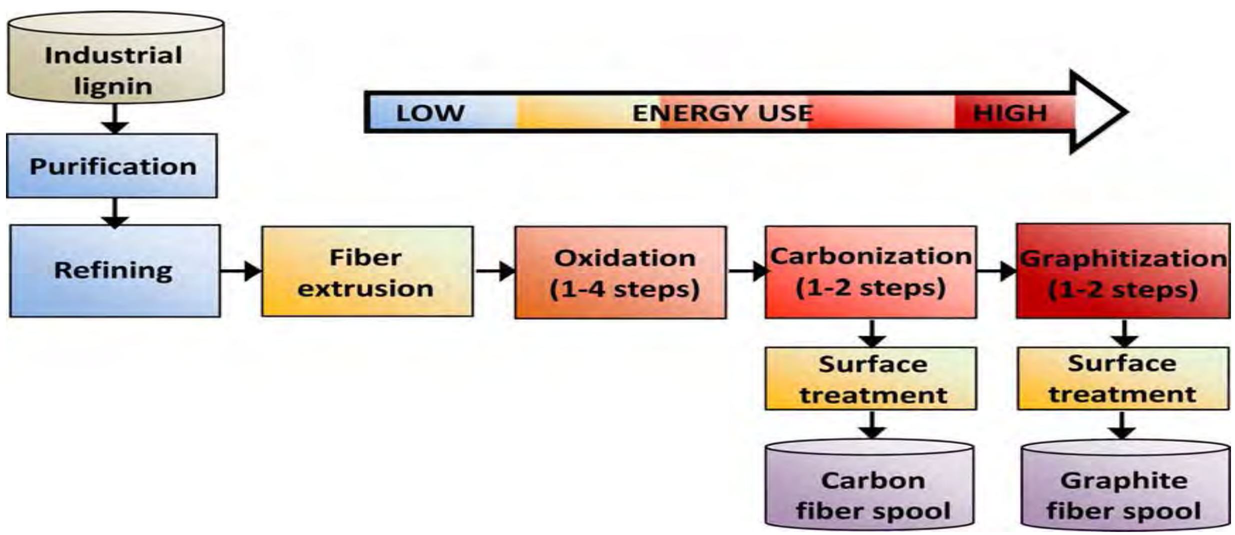
Production cost breakdown of PAN-based carbon fiber
(Baker and Rials 2013)

Lignin is the most cost-effective raw material for CF

- From renewable resources (biomass)
- The second most abundant natural polymer in the world
- An industrial byproduct from current pulping processes and future bio-refinary processes

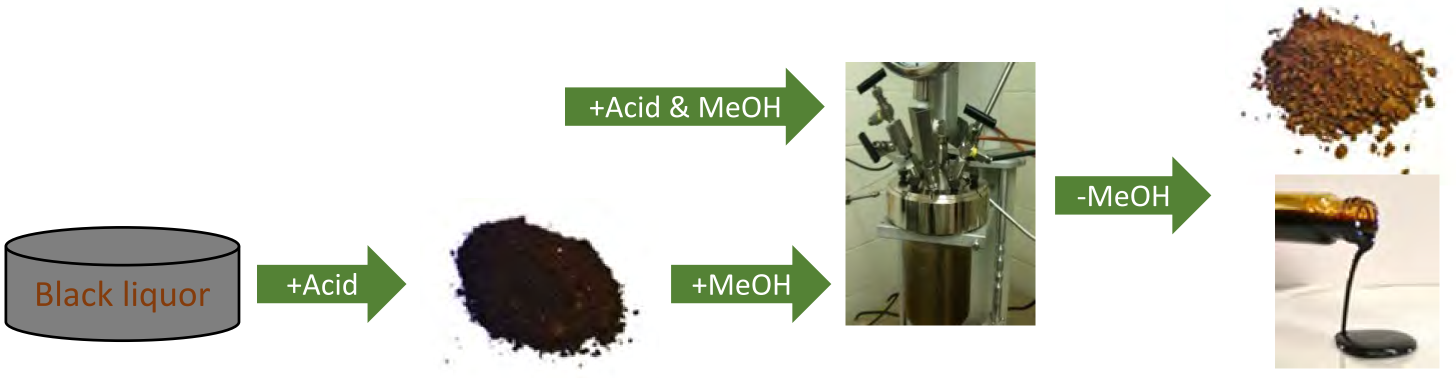
Major issues

- Low strength and modulus
- Long thermal stabilization time



Schematic of carbon fiber production from an technical lignin
(Baker and Rials 2013)

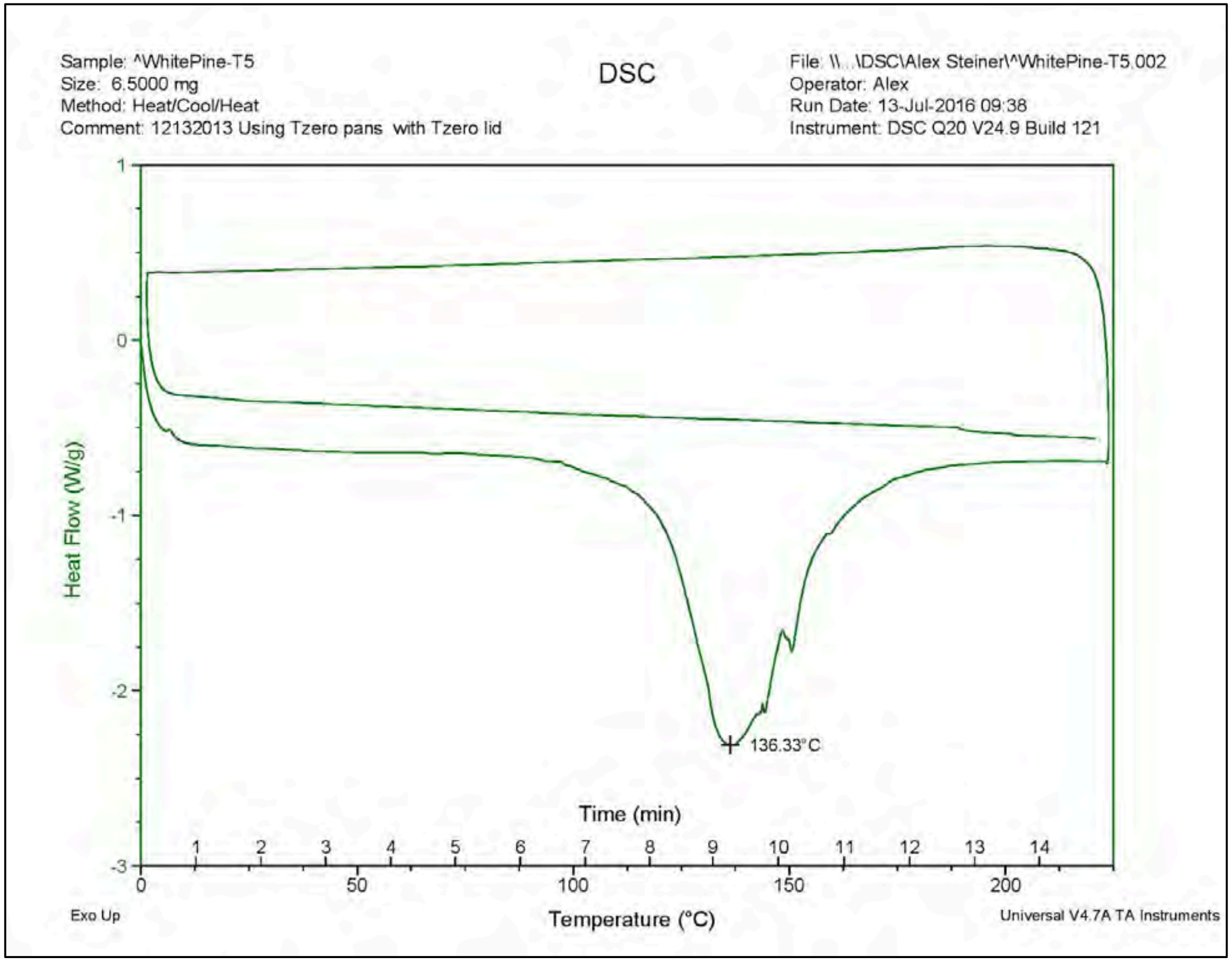
Lignin from directional liquefaction



	Tg (℃)	Cp (J/g℃)	Repeatability (W/g)
Willow	189.12	1.949	0.0198
Red Oak	183.86	2.474	0.0211
White Pine	189.72	1.823	0.0237
Miscanthus	192.86	1.777	0.0168

H_0	P value
Species does not affect Tg	p = 0.309243
Species does not affect Cp	p = 0.667213
Liquefaction temperature does not affect Tg	p = 0.641602
Liquefaction temperature does not affect Cp	p = 0.461010
Drying in vacuum does not affect Cp	p = 0.002343

Thank you!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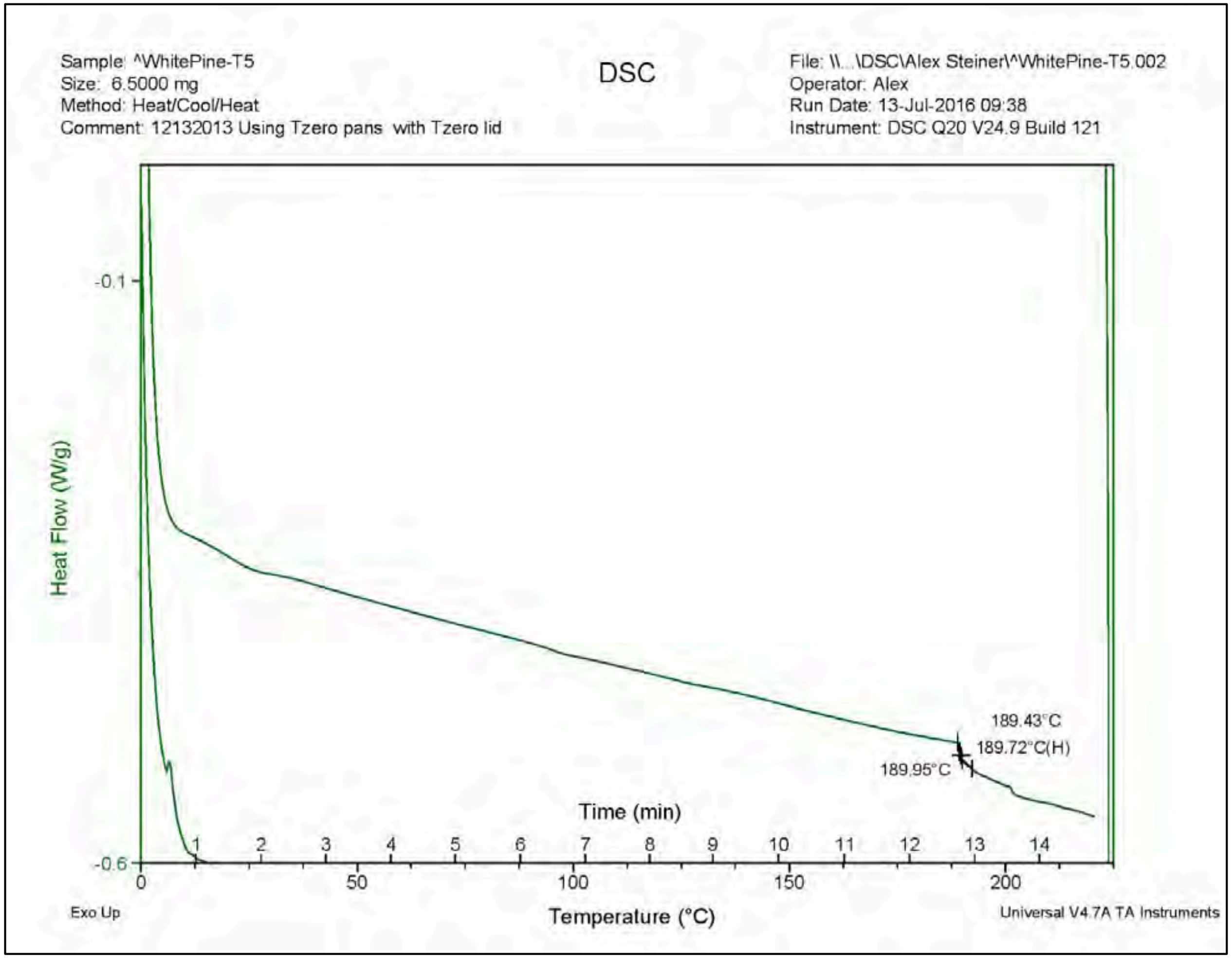
Size: 6.5000 mg
Method: Heat/Cool/Heat
Comment: 12132013 Using Tzero pans with Tzero lid
DSC
File: \\...\DSC\Alex Steiner\^WhitePine-T5.002
Operator: Alex
Run Date: 13-Jul-2016 09:38
Instrument: DSC Q20 V24.9 Build 121
Heat Flow (W/g)
136.33°C
Time (min)
Temperature (°C)
Exo Up
Universal V4.7A TA Instruments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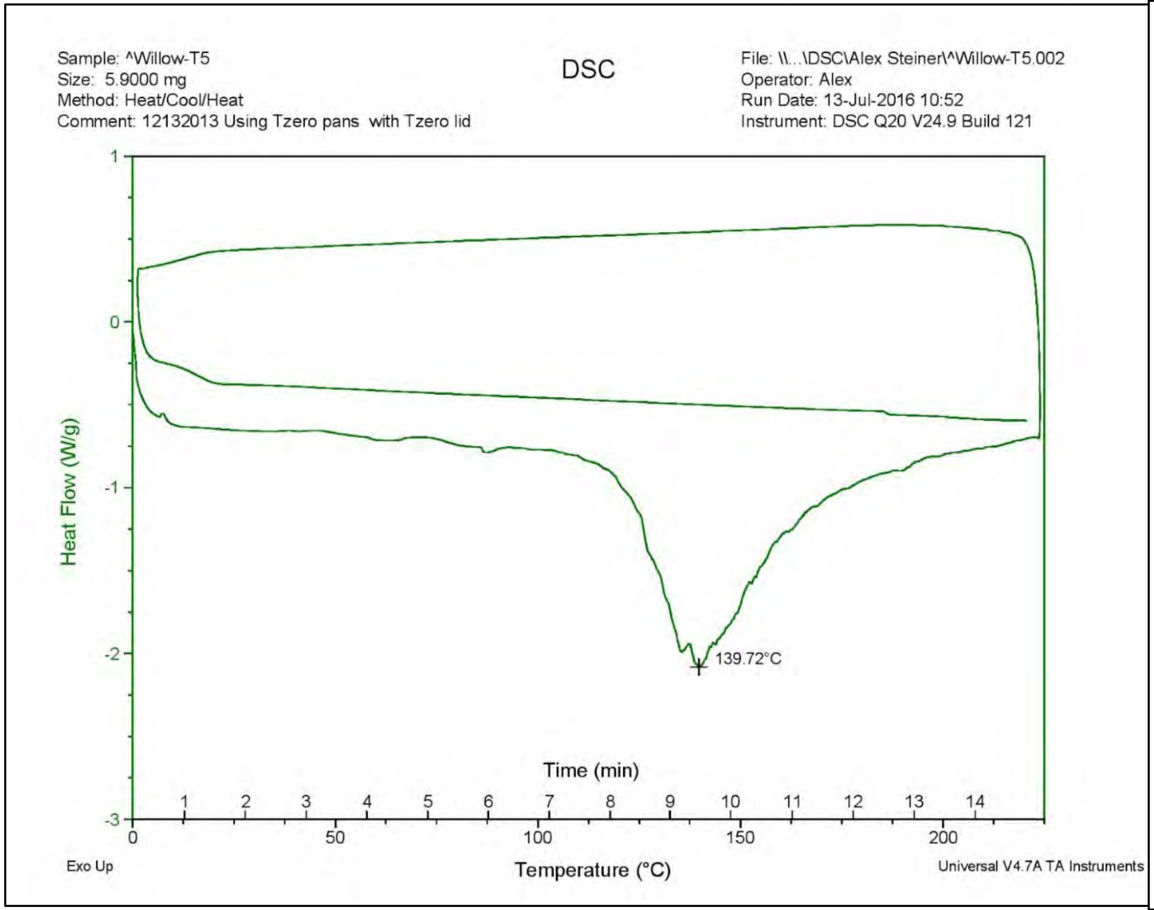
Size: 6.5000 mg
Method: Heat/Cool/Heat
Comment: 12132013 Using Tzero pans with Tzero lid
DSC
File: \\...\DSC\Alex Steiner\^WhitePine-T5.002
Operator: Alex
Run Date: 13-Jul-2016 09:38
Instrument: DSC Q20 V24.9 Build 121
Heat Flow (W/g)
-0.1
-0.6
189.43°C
189.72°C(H)
189.95°C
Time (min)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
0
50
100
150
200
Exo Up
Temperature (°C)
Universal V4.7A TA Instruments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Size: 5.9000 mg
Method: Heat/Cool/Heat
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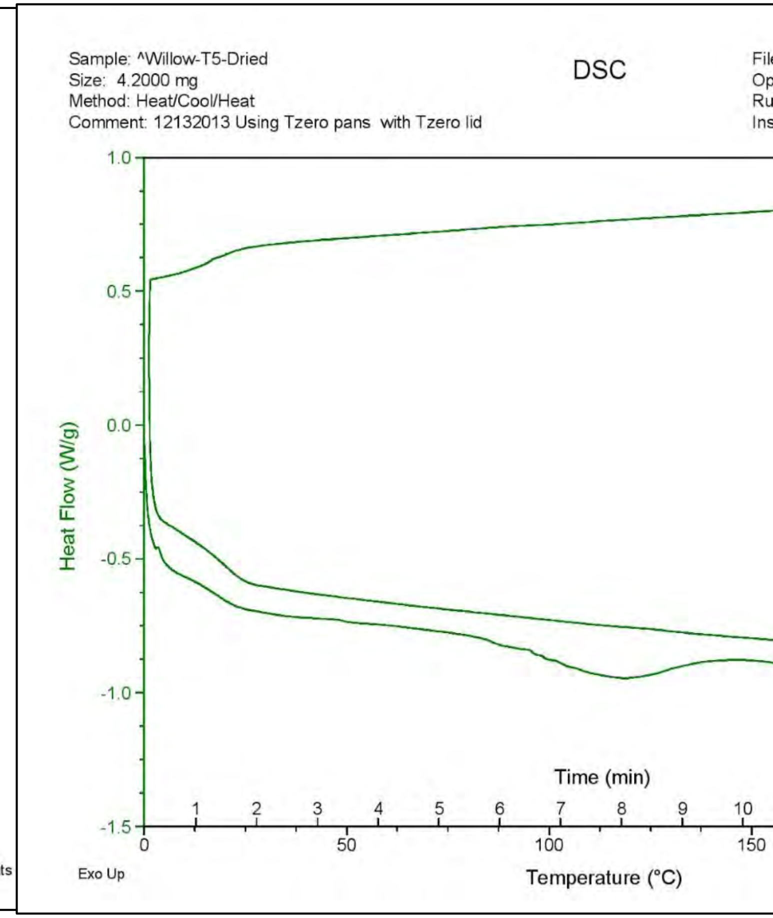
DSC
File: \\...\DSC\Alex Steiner\^Willow-T5.002
Operator: Alex
Run Date: 13-Jul-2016 10:52
Instrument: DSC Q20 V24.9 Build 121
Heat Flow (W/g)
139.72°C
Time (min)
Temperature (°C)
Exo Up
Universal V4.7A TA Instruments


Sample: ^Willow-T5-Dried
Size: 4.2000 mg
Method: Heat/Cool/Heat
Comment: 12132013 Using Tzero pans with Tzero lid
DSC
Heat Flow (W/g)
Time (min)
Temperature (°C)
Exo Up