

Supporting information

Carbon fibres from lignin-cellulose precursors: Effect of stabilisation conditions

Andreas Bengtsson^{,†}, Jenny Bengtsson[‡], Maria Sedin[§] and Elisabeth Sjöholm[§]*

[†]Department of Fibre and Polymer Technology, KTH Royal Institute of Technology,
Teknikringen 56-58, SE-100 44 Stockholm, Sweden

[‡]RISE Material & Production, Box 104, SE-431 22 Mölndal, Sweden

[§]RISE Bioeconomy, Box 5604, SE-114 86 Stockholm, Sweden

Corresponding author E-mail: aben4@kth.se

Number of Pages: 7

Number of Figures: 4 (Figure S1–Figure S5)

Number of Tables: 1 (Table S1)

Figures

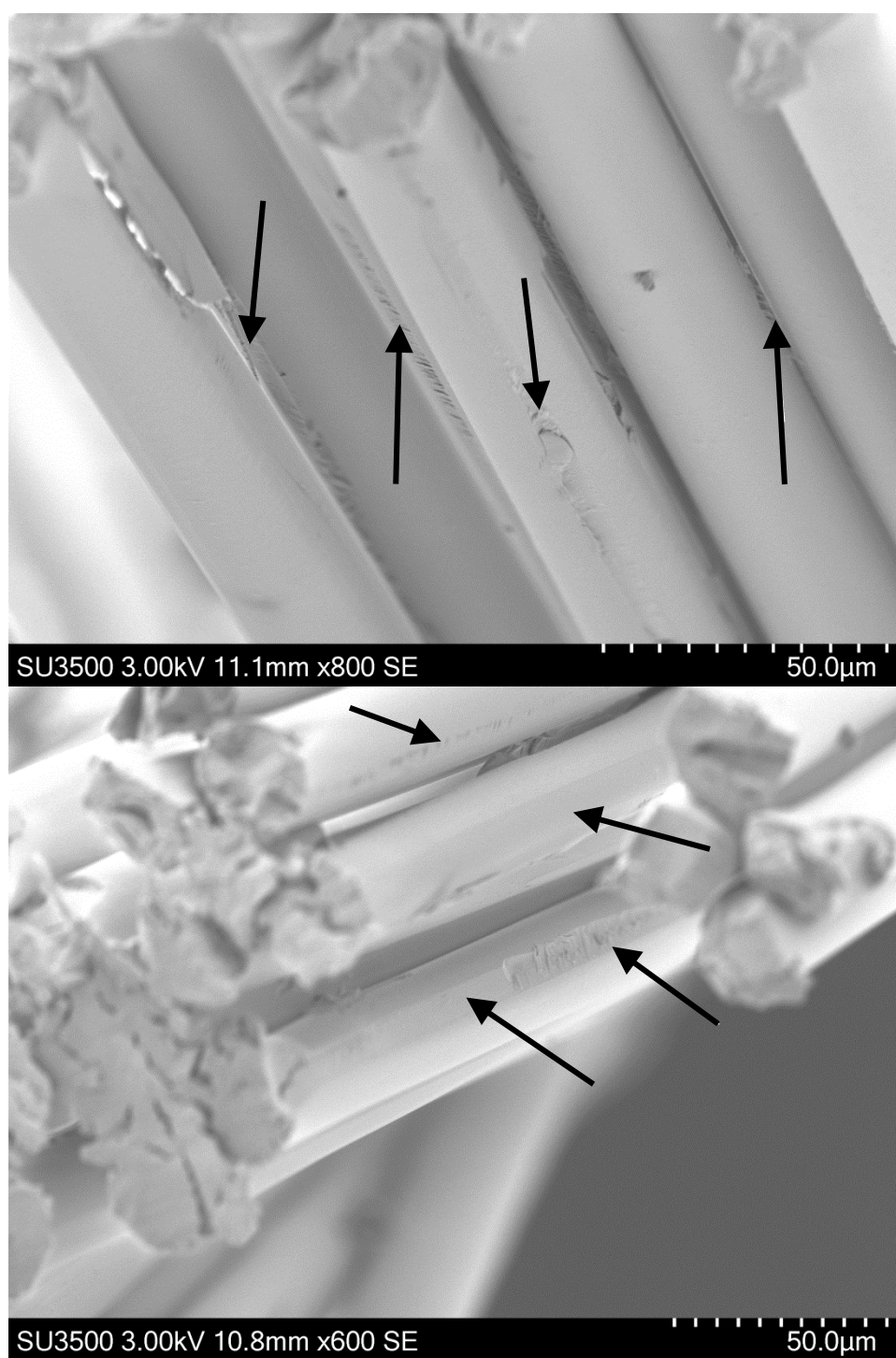


Figure S1. SEM images of SKL:KP precursor fibre (PF) (22 μm) tows showing defects originating from the fibre spinning.

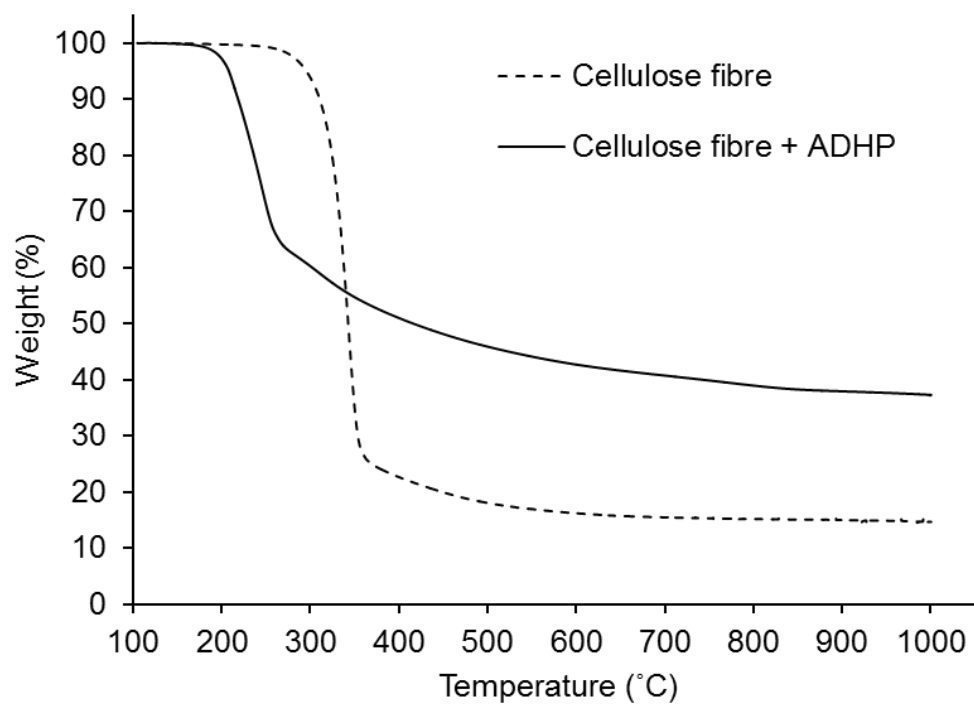


Figure S2. TGA curves of cellulose fibres (KP; 27 μm) with or without ADHP heated at 10 $^{\circ}\text{C}/\text{min}$ in nitrogen.

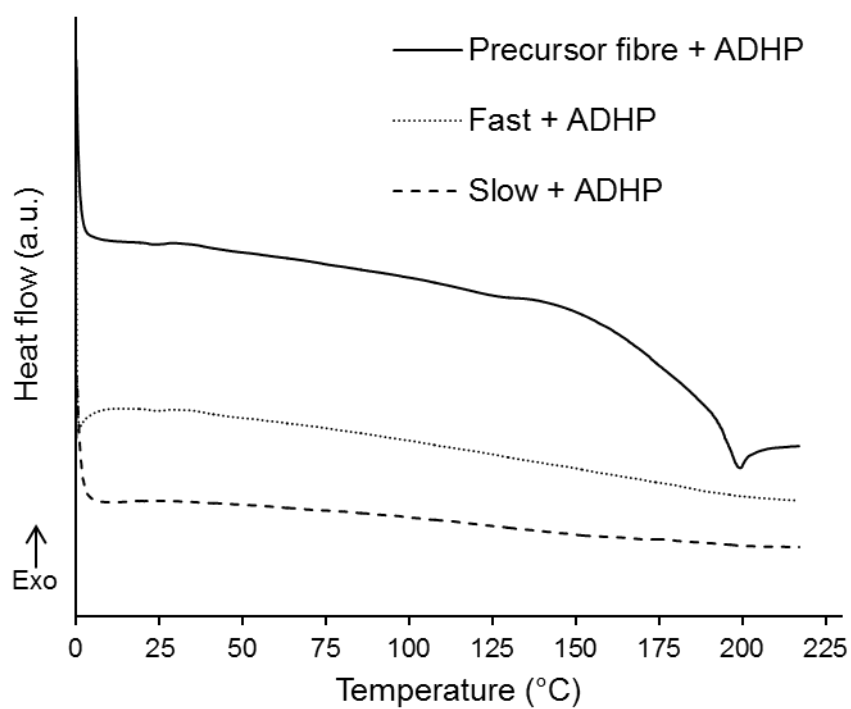


Figure S3. DSC thermogram of ADHP-impregnated SKL:KP precursor fibres (22 μm) stabilised in air for one hour at 250 $^{\circ}\text{C}$. Slow: 0.2 $^{\circ}\text{C}/\text{min}$ to 200 $^{\circ}\text{C}$, then 1.0 $^{\circ}\text{C}/\text{min}$ to 250 $^{\circ}\text{C}$; fast: 5 $^{\circ}\text{C}/\text{min}$ to 250 $^{\circ}\text{C}$.

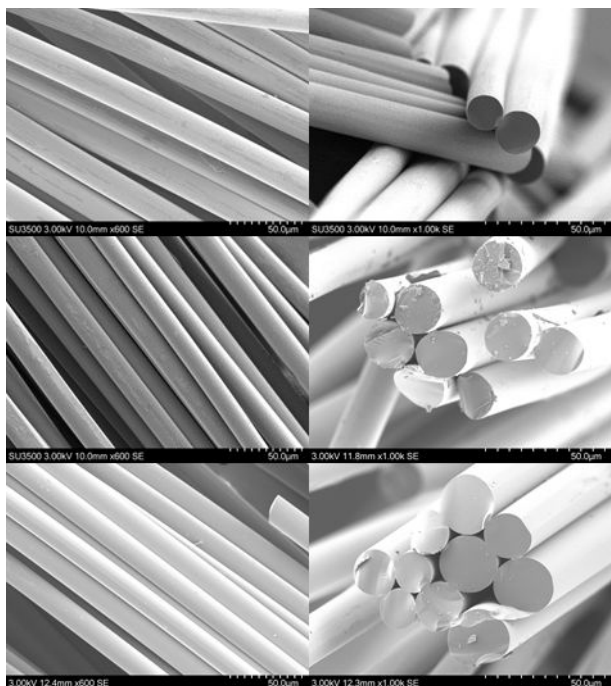


Figure S4. SEM images of surface (left) and cross section (right) of CFs obtained by carbonisation of ADHP-impregnated SKL:KP precursor fibres (22 μm) subjected to different stabilisation profiles. Top: slow stabilisation, 0.2 $^{\circ}\text{C}/\text{min}$ to 200 $^{\circ}\text{C}$, then 1.0 $^{\circ}\text{C}/\text{min}$ to 250 $^{\circ}\text{C}$, one hour isotherm; Middle: fast stabilisation, 5 $^{\circ}\text{C}/\text{min}$ to 250 $^{\circ}\text{C}$, one hour isotherm; Bottom: instant carbonisation.

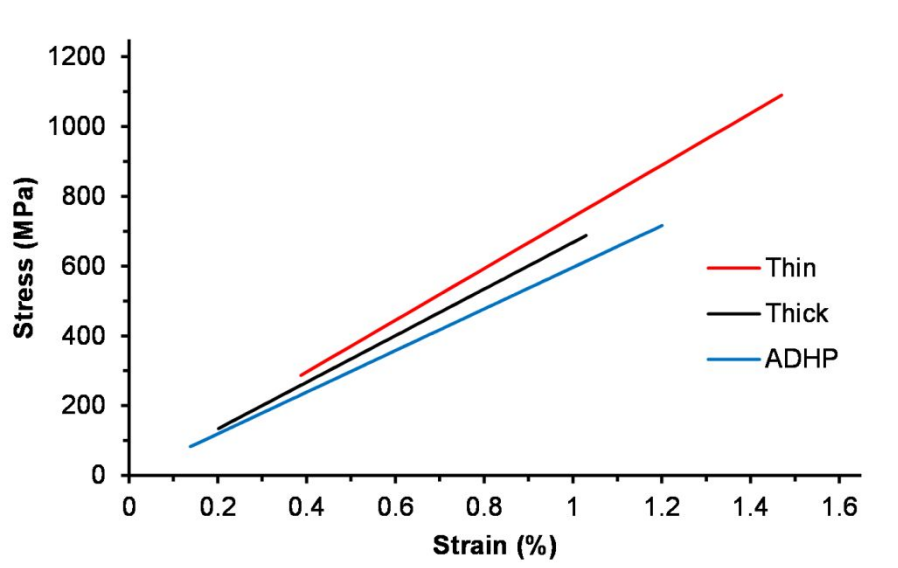


Figure S5. Representative stress-strain curves for carbon fibres derived via fast stabilisation (5 °C/min to 250 °C using one hour isotherm). The tensile tester applies a pre-load force to obtain a reference starting point, which explains why the curves starts above zero stress-strain. For further details regarding the results from the tensile testing, see Table S1.

Table

Table S1. Mechanical properties of CFs derived from SKL:KP precursor fibres with different diameters and by employing different stabilisation conditions. Values in parenthesis represent the standard deviation.

Sample	Diameter (μm)	Elongation (%)	Tensile modulus (GPa)	Tensile strength (MPa)
<i>Thick (PF 22 μm)</i>				
Slow	15 (1.7)	1.4 (0.3)	64 (5.0)	890 (190)
Fast	14 (1.6)	1.0 (0.2)	66 (10)	680 (170)
Instant carbonisation	13 (1.9)	1.2 (0.3)	65 (8.4)	760 (200)
Slow ADHP	16 (2.2)	1.4 (0.3)	50 (7.9)	700 (190)
Fast ADHP	16 (1.2)	1.2 (0.2)	59 (7.6)	680 (170)
Instant carbonisation ADHP	17 (1.3)	1.2 (0.2)	59 (7.0)	730 (170)
<i>Thin (PF 14 μm)</i>				
Slow	7.3 (0.5)	1.5 (0.3)	77 (12.9)	1170 (270)
Fast	7.6 (0.7)	1.4 (0.3)	76 (8.9)	1070 (200)
Instant carbonisation	6.4 (0.5)	1.6 (0.2)	67 (7.3)	1030 (160)