Supplementary Material

Multiscale hybridization of natural silk–nanocellulose fibrous composites with exceptional mechanical properties

Jungju Eom†, Subong Park‡, Hyoung-Joon Jin†,, and Hyo Won Kwak ∥ , ⊥,**

†Department of Polymer Science and Engineering, Inha University, 100 Inha-ro, Nam-gu, Incheon 22212, Korea

‡Fisheries Engineering Division, National Institute of Fisheries Science, 216, Gijang-haeanro, Gijang-eup, Gijang-gun, Busan, 46083, South Korea

∥Department of Forest Sciences, Seoul National University, 1 Gwanak-ro, Gwanak-gu, Seoul 08826, Korea

⊥Research Institute of Agriculture and Life Sciences, Seoul National University, 1 Gwanak-ro, Gwanak-gu, Seoul 08826, Korea

Correspondence*:

*Corresponding author. E-mail: hjjin@inha.ac.kr

*Corresponding author. E-mail: bk0502@snu.ac.kr

Table S1. Thickness**, d**ensities (ρ_m), envelope densities (ρ_e), and porosities of SF/CNF composites with different CNF concentrations.

Sample	Thickness (mm)	ρ_m ($g \cdot cm^{-3}$)	ρ_e ($g \cdot cm^{-3}$)	P (%)
SF nonwoven	0.89±0.09	1.36 ± 0.01	0.79 ± 0.03	40.91 ± 1.08
SF/CNF5	1.02±0.12	1.36 ± 0.02	0.84 ± 0.04	38.24 ± 1.49
SF/CNF10	1.12±0.16	1.36 ± 0.02	0.99 ± 0.01	27.21 ± 1.75
SF/CNF15	1.14±0.17	1.37 ± 0.01	1.02 ± 0.02	25.91 ± 1.36

Table S2. Mechanical properties of nonwoven SF and SF/CNF composites with various amounts of CNFs: tensile strength, tensile strain, initial modulus, and impact strength.

Sample	Tensile strength (MPa)	Tensile strain (%)	Initial modulus (GPa)	Impact strength (kJ/m^2)
SF nonwoven	66 ± 18.9	18.6 ± 8.5	1.2 ± 0.2	14.9 ± 4.3
SF/CNF5	111.1 ± 11.7	12.7 ± 0.4	2.0 ± 0.2	22.7 ± 1.9
SF/CNF10	140.1 ± 14.3	12.3 ± 0.6	2.7 ± 0.2	31.2 ± 3.8
SF/CNF15	143.5 ± 8.3	11.4 ± 1.6	3.0 ± 0.1	48.8 ± 1.6

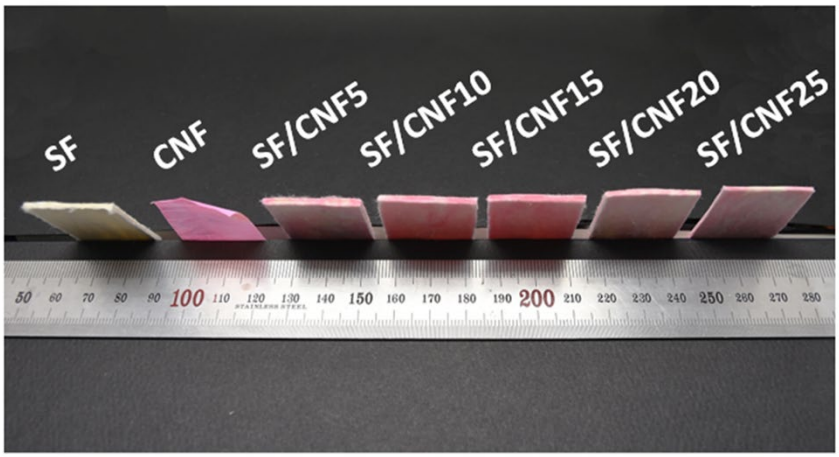

Fig. S1. Cross sectional optical images of Direct Red 80 dyed SF / CNF composites with various amounts of CNF