Supplementary Information

Fully biobased and biodegradable oxygen barrier coating for poly(lactic acid)

Sarah G. Fisher^a, Armaghan Amanipour^b, Maya D. Montemayor^a, Ethan T. Iverson^a, Edward Chang^c, Alexandra V. Moran^c, Reza Ovissipour^b, and Jaime C. Grunlan^{a,c,d}*

^aDepartment of Chemistry, Texas A&M University, 400 Bizzell St., College Station, TX, 77840, USA

^bDepartment of Food Science and Technology, Texas A&M University, 400 Bizzell St., College Station, TX, 77840, USA

^cDepartment of Mechanical Engineering, Texas A&M University, 400 Bizzell St., College Station, TX, 77840, USA

^dDepartment of Materials Science and Engineering, Texas A&M University, 400 Bizzell St., College Station, TX, 77840, USA

*E-mail: jgrunlan@tamu.edu

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CNC characterization

Cellulose nanocrystals exhibit a rodlike structure with an average length of 100 to 300 nm. This can be observed in the AFM images of the cellulose nanocrystals (Fig. S1). The measured length of the CNCs from atomic force microscopy was 171 ± 52 nm (Table S1). The cellulose nanocrystals were determined via DLS to have an average particle size of 129 ± 3 nm (Table S1). These are in agreement with the reported particle size from the manufacturer of approximately 150 nm, and with the typical dimensions of CNC particles from wood, which range from 100 to 300 nm in length.¹



Fig. S1 Atomic force microscope images of cellulose nanocrystals. Scale bars are (a) 400 and (b) 200 nm.

 Table S1 Reported and measured dimensions of cellulose nanocrystals from supplier, atomic force

 microscopy, and dynamic light scattering

Particle Size (Supplier)	150 nm
Particle Size (DLS)	$129 \pm 3 \text{ d.nm}$
Length (AFM)	$171\pm52~\text{nm}$
Width (AFM)	$28\pm5 \text{ nm}$
Height (AFM)	$5\pm 2 \text{ nm}$



Fig. S2 Optical images of (a) untreated PLA, (b) treated PLA, and PLA coated with (c) 20 BL CH/DNA,
(d) 20 BL CH/CNC, (e) 20 BL CH/DNA+CNC, and (f) 10 QL CH/DNA/CH/CNC, and (g) average visible light transmission of treated and coated PLA relative to untreated PLA substrate.

System	Coating Thickness (nm)	0% RH OTR (cm ³ / m ² day)	90% RH OTR (cm ³ / m ² day)	0% RH Film OP (*10 ⁻¹⁶ cm ³ cm / (cm ² s Pa))	90% RH Film OP (*10 ⁻¹⁶ cm ³ cm / (cm ² s Pa))
Untreated PLA		323	276		
Treated PLA		331	285		
CH/DNA 10 BL	128.1 ± 16.5	15.1	23.2	0.05	0.07
CH/CNC 10 BL	71.0 ± 6.9	52.6	112	0.12	0.36
CH/DNA+CNC 20 BL	93.6 ± 5.1	12.0	44.6	0.03	0.11
CH/DNA/CH/CNC 10 QL	83.01 ± 1.15	10.9	44.4	0.02	0.09

Table S2 Oxygen transmission rate (OTR) and oxygen permeability (OP) of systems at 0% and 90% RH. Film oxygen permeability was decoupled from the substrate using a previously described method.²



Fig. S3 Atomic force microscope images of Si wafers coated with (a, e) 20 BL CH/DNA, (b, f) 20 BL CH/CNC, (c, g) 20 BL CH/DNA+CNC, and (d, h) 10 QL CH/DNA/CH/CNC. All scale bars are 2 microns.

References

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