Supporting Information

Strengthening Eco-Friendly Packaging from Pectin by Filling with Poly(ε-caprolactone) Nanoparticles and Tailoring the Degree of Methyl-Esterification

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A. Complementary Dynamic Light Scattering Data

Table S1: Average size, PdI, and zeta potential of poly(ε-caprolactone) nanoparticles in three repetitions of the same synthesis protocol.

Repetition	Size (nm)	Polydispersity index	Zeta potential (mV)
1	144 ± 7^{b}	0.13 ± 0.01^{a}	-18 ± 1^{a}
2	126 ± 6^{ab}	0.12 ± 0.02^{a}	-17.1 ± 0.5^{a}
3	124 ± 2^{a}	0.10 ± 0.01^{a}	-17.2 ± 0.5^{a}

[ab] Mean values ± standard deviations followed by the same lowercase superscript letters within a column are not different ($p>0.05$).

B. Complementary FT-IR analysis

Table S2: Infrared spectroscopy of poly(ε-caprolactone) (PCL), Tween 80, and poly(ε-caprolactone) nanoparticles (PCLNP).

PCL (cm^{-1})	Tween 80 (cm^{-1})	PCLNP (cm^{-1})	Vibration
-	3489	3431	(-OH)
2954	2923	2932	(C-H) asymmetrical
2862	2860	2866	(C-H) symmetrical
1729	1735	1725	(-C=O)
1235	1249	1240	(-C-O-C-) asymmetrical
1163	1102	1173	(-C-O-C-) symmetrical

C. Complementary spectroscopy analysis

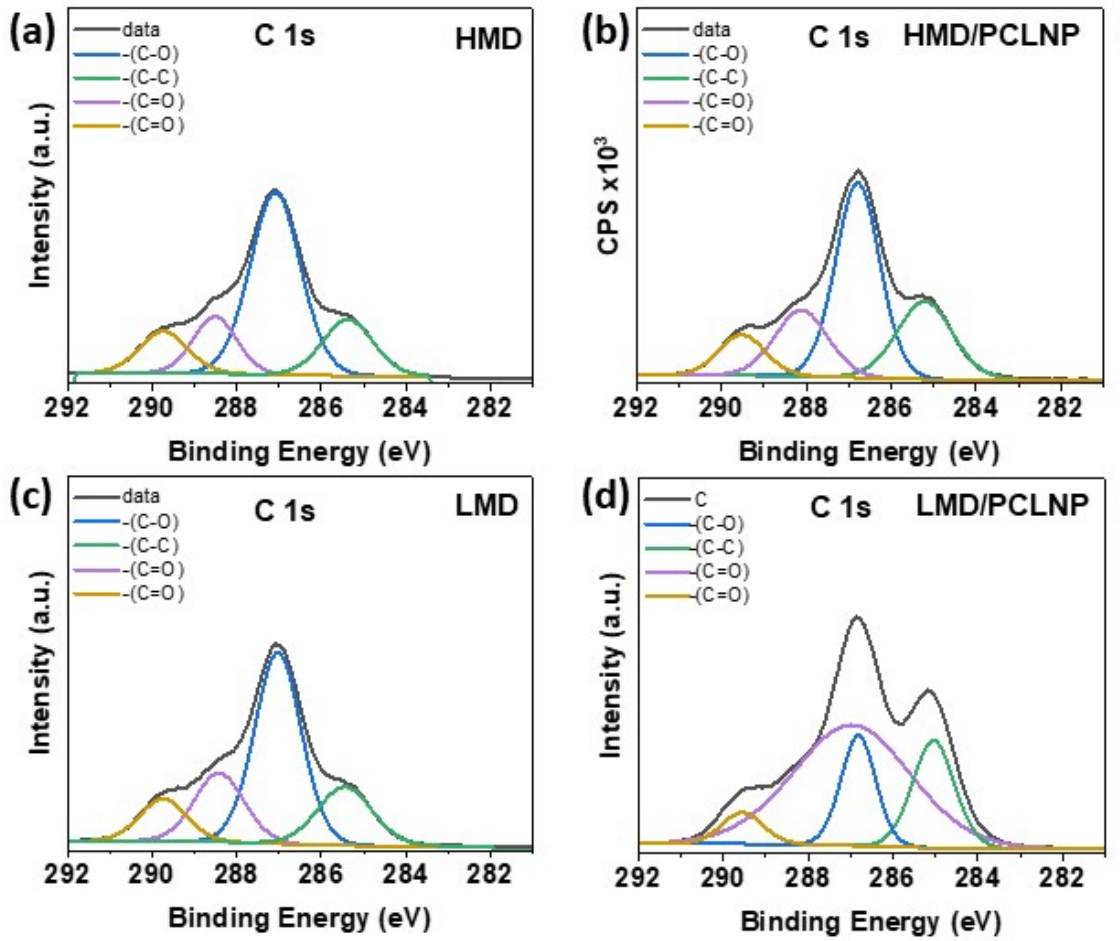

Figure S1. High-resolution XPS spectra of C1s for (a) HMD, (b) HMD/PCLNP, (c) LMD, and (d) LMD/PCLNP pectin-based films.

Table S3: Binding energy of pectin-based nanocomposites determined by C1s XPS deconvolution.

Samples	Peak Binding Energy (eV)			
	C-C/C-H	**C-O**	**O-C-O/C-O-H**	**O-C=O**
HMD	285.4	287.0	288.4	289.7
LMD	285.4	287.0	288.4	289.7
HMD/PCLNP film	285.3	286.9	288.2	289.6
LMD/PCLNP film	285.1	287.1	286.8	289.6

Table S4: Surface composition of pectin-based nanocomposites determined by C1s XPS deconvolution.

Samples	C1s XPS deconvolution (%)			
	C-C/C-H	**C-O**	**O-C-O/C-O-H**	**O-C=O**
HMD	14.3 ± 3	56.0 ± 1	16.9 ± 1	12.8 ± 1
LMD	16.0 ± 2	51.9 ± 1	20.1 ± 1	12.0 ± 1
HMD/PCLNP film	23.2 ± 1	47.1 ± 1	19.3 ± 1	10.4 ± 1
LMD/PCLNP film	15.7 ± 1	59.5 ± 1	19.0 ± 3	5.8 ± 1

D. Complementary mechanical analysis

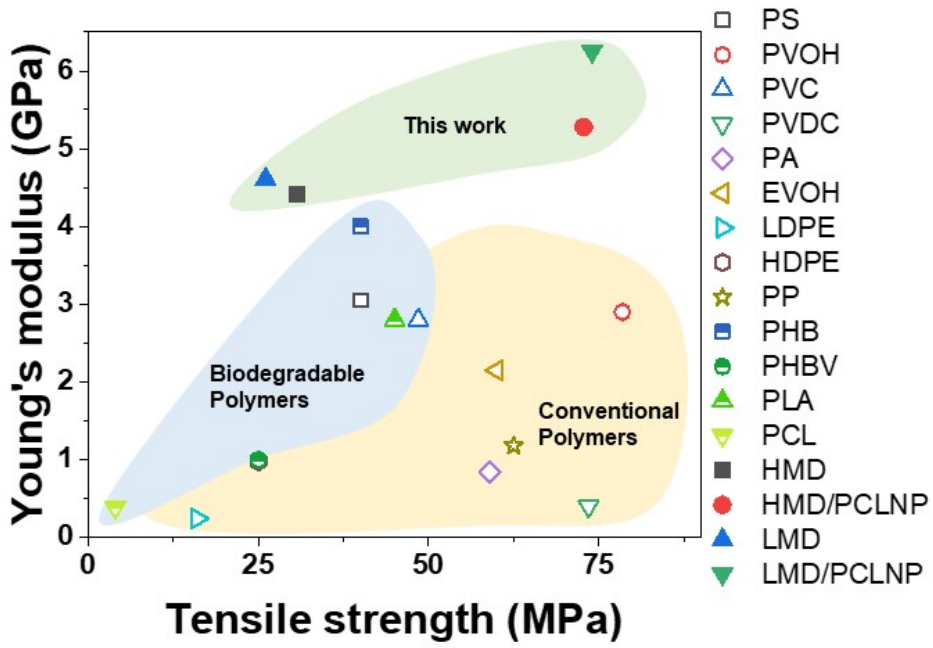

Figure S2. Young's modulus vs. Tensile strength for petroleum-based polymeric and nanocomposites films. The polymer acronyms meaning from up to bottom are: PS – *polystyrene;* PVOH - *polyvinyl alcohol;* PVC - *polyvinylchloride*; PVDC - *poly(vinylidene chloride);* PA - *Polyamide (nylon)*; EVOH - *ethylene–vinyl alcohol copolymer*; LDPE - *low-density polyethylene;* HDPE - *high-density polyethylene*; PP – *polypropylene;* PHB - *Poly 3-hydroxybutyrate*; PHBV - *Poly(3-hydroxybutyrate-co-3-hydroxyvalerate);* ; PLA - *poly(lactic acid);* PCL - *poly(ε-caprolactone);* HMD - *high-methoxyl-degree of pectin*; LMD - *low-methoxyl-degree of pectin.* The highlighted areas in blue. yellow and green have no physical meaning. They indicate. respectively. the biodegradable. conventional and the nanocomposites-BASED polymers compared. Data adapted from [1,2].

E. References

1 L. Bastarrachea. S. Dhawan and S. S. Sablani. *Food Engineering Reviews*. 2011. 3. 79–93.

2 R. A. Gross and B. Kalra. *AIChE (Am. Inst. Chem. Eng.) J*. 2002. **297**. 803–807.