Supporting Information

A novel biocompatible polymeric blend for applications requiring high toughness and tailored degradation rate

Behzad Shiroud Heidari [a,b,c,*], *Peilin Chen* [d], *Ruan Rui* [d], *Seyed Mohammad Davachi* [e], *Hani Al-Salami* [f], *Elena De Juan Pardo* [a,b,g], *Minghao Zheng* [d,h], *Barry Doyle* [a,b,c,i]

a. Harry Perkins Institute of Medical Research, QEII Medical Centre, Nedlands and the UWA Centre for Medical Research, The University of Western Australia, Perth, Australia.

b. School of Engineering, The University of Western Australia, Perth, Australia.

c. Australian Research Council Centre for Personalised Therapeutics Technologies, Australia.

d. Centre for Orthopaedic Research, Faculty of Health and Medical Sciences, The University of Western Australia, Perth, Australia.

e. Department of Food Science, College of Agriculture and Life Sciences, Cornell University, Ithaca, NY, USA

f. Biotechnology and Drug Development Research Laboratory, School of Pharmacy and Biomedical Sciences, Curtin Health Innovation Research Institute, Curtin University, Perth, Western Australia. Australia.

g. Science and Engineering Faculty, Queensland University of Technology, Brisbane, Queensland, Australia.

h. Perron Institute for Neurological and Translational Science, Nedlands, Western Australia, Australia.

i. British Heart Foundation Centre for Cardiovascular Science, The University of Edinburgh, Edinburgh, UK.

*Corresponding author: behzad.shiroudheidari@research.uwa.edu.au

To evaluate the chemical composition of PDO/LCL blends, the FTIR spectra was recorded (**Figure S1**). The broad band at 3200−3650 cm^{-1} for PDO, PDO7LCL3, and PDO5LCL5 is due to the associating vibration hydroxyl *(-O-H*) group. The sequential bands at 2800-3000 cm^{-1} are ascribed to *C−H* stretching of $-CH_2$ groups in all samples [1,2]. The sharp peaks located at 1732 cm^{-1} are assigned to the carbonyl (*C=O*) stretching vibration of PDO and LCL (at 1755 cm^{-1}) at side chains. The peaks at 1050, 1123, and 1202 cm^{-1} belong to *C-O* stretching vibration of PDO and the sequential peaks at 1456, 1431, and 1369 cm^{-1} represent the *-CH* bending vibration of PDO [1,3]. Small shifts in LCL peaks can be seen (**Figure S1B**); for example, the *C-O* stretching vibration peaks appear at 1042, 1084, 1129, and 1181 cm^{-1} and the sequential peaks of *-CH* bending vibrations are located at 1456, 1383, and 1357 cm^{-1} [3,4]. The intensity and wave number of functional groups are changed by blending PDO and LCL (**Figure S1B**). For instance, the spectra of PDO7LCL3 and PDO3LCL7 are similar to the spectra of PDO and LCL, respectively, indicating that the spectrum of each blend strongly depends on the ratio of PDO to LCL. However, no new peaks were found in the spectra of blend samples, indicating that no chemical reaction or functionalization occurred during material preparation process.

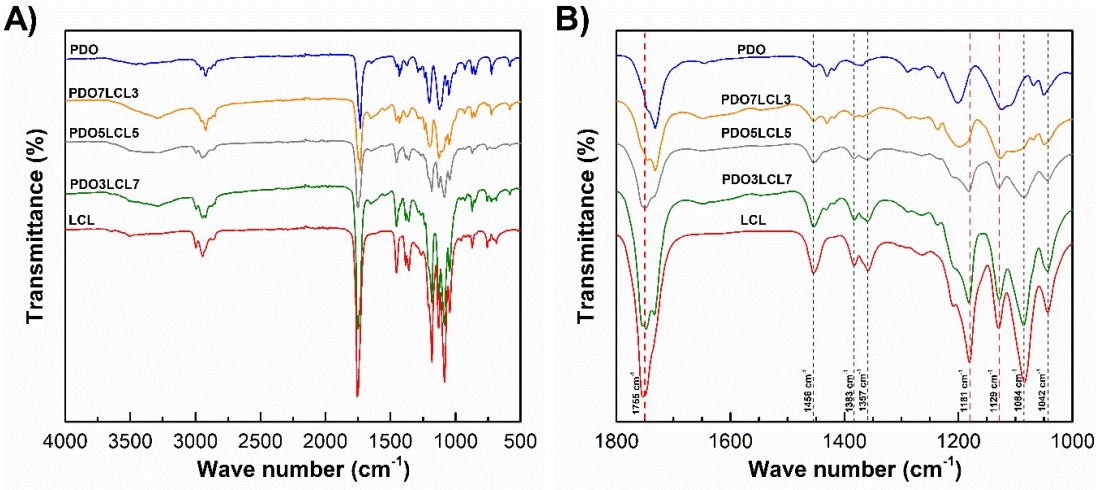
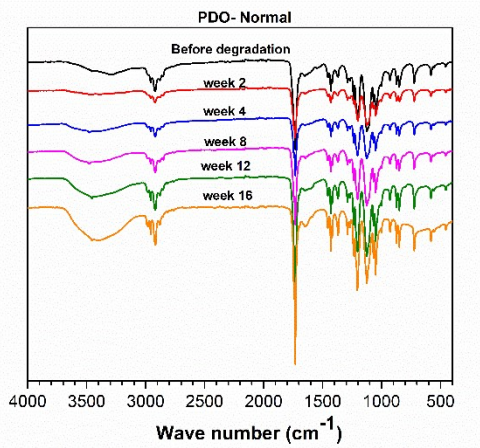
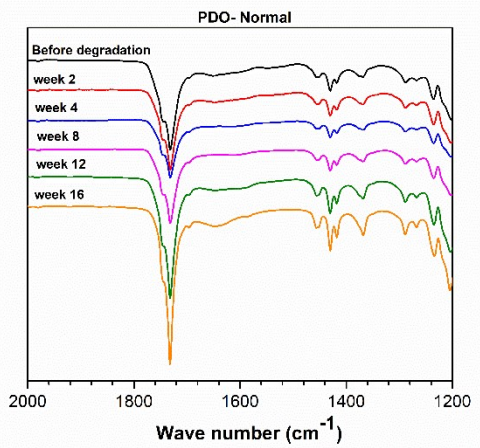
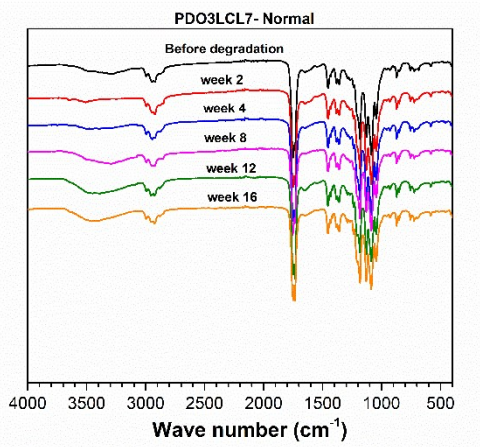
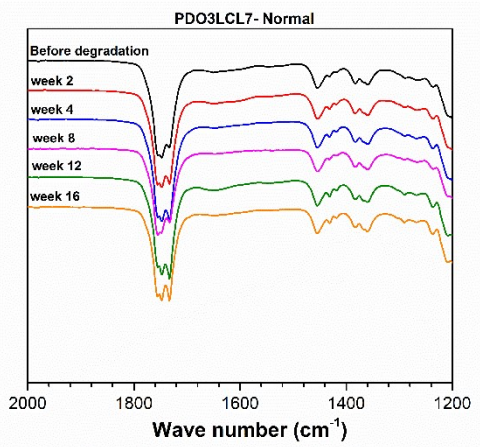


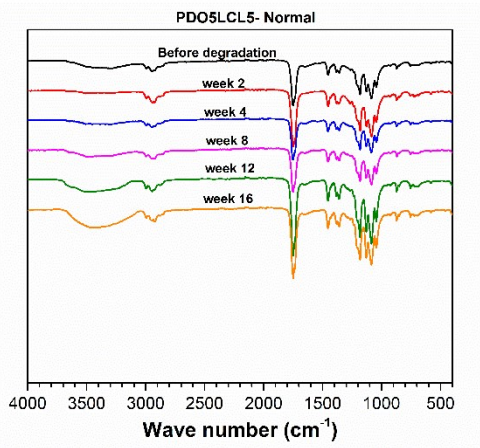
Figure S1. FTIR spectra of LCL/PDO binary blends in **(A)** 500-4000 cm^{-1} and **(B)** 1000-1800 cm^{-1} wave numbers. The red dashed lines indicate the small shift in the peaks associated with the polymer ratio.

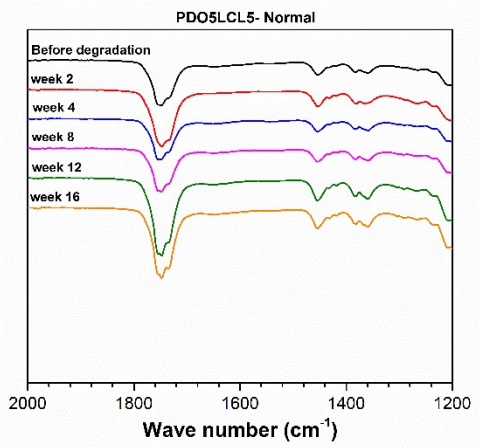

PDO- Normal
Before degradation
week 2
week 4
week 8
week 12
week 16
4000 3500 3000 2500 2000 1500 1000 500
Wave number (cm-1)


PDO- Normal
Before degradation
week 2
week 4
week 8
week 12
week 16
2000 1800 1600 1400 1200
Wave number (cm-1)


PDO3LCL7- Normal
Before degradation
week 2
week 4
week 8
week 12
week 16
4000 3500 3000 2500 2000 1500 1000 500
Wave number (cm-1)


PDO3LCL7- Normal
Before degradation
week 2
week 4
week 8
week 12
week 16
2000 1800 1600 1400 1200
Wave number (cm-1)


PDO5LCL5- Normal
Before degradation
week 2
week 4
week 8
week 12
week 16
4000 3500 3000 2500 2000 1500 1000 500
Wave number (cm-1)


PDO5LCL5- Normal
Before degradation
week 2
week 4
week 8
week 12
week 16
2000 1800 1600 1400 1200
Wave number (cm-1)

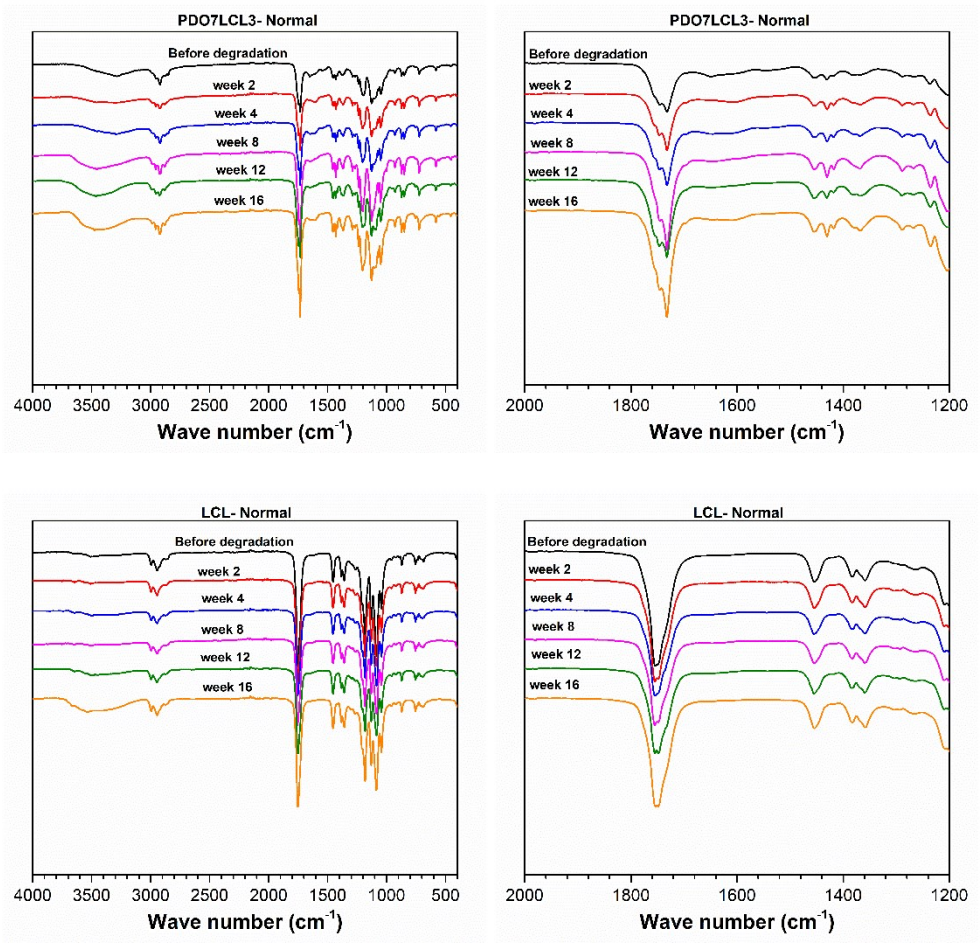
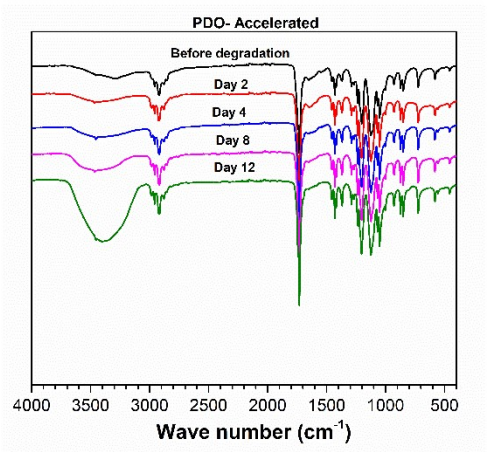
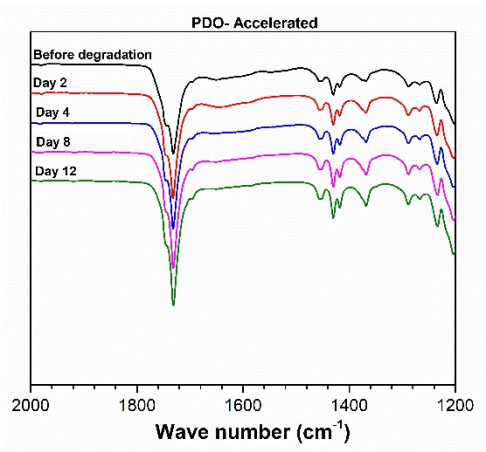
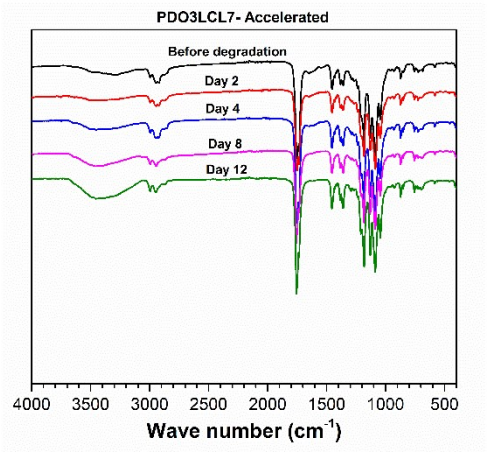
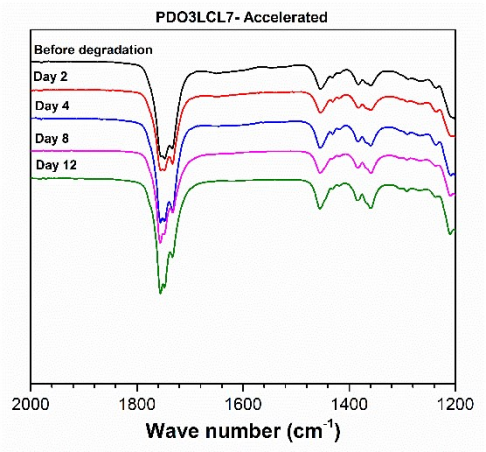


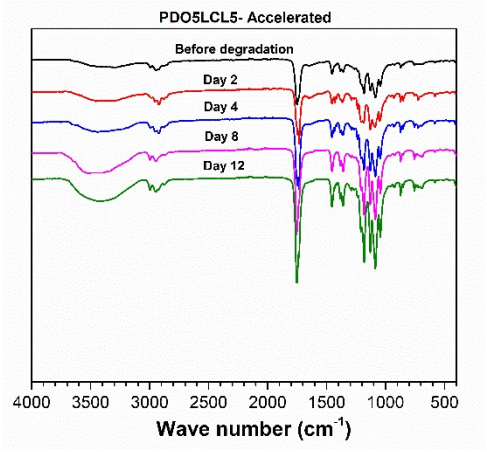
Figure S2. FTIR spectra of PDO/LCL blends during normal degradation. Left and right columns are assigned to 400-4000 cm^{-1} and 1200-2000 cm^{-1} wave numbers, respectively.

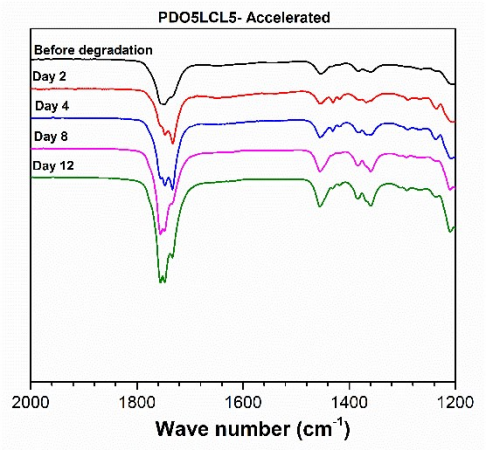

PDO- Accelerated
Before degradation
Day 2
Day 4
Day 8
Day 12
4000 3500 3000 2500 2000 1500 1000 500
Wave number (cm-1)


PDO- Accelerated
Before degradation
Day 2
Day 4
Day 8
Day 12
2000 1800 1600 1400 1200
Wave number (cm-1)


PDO3LCL7- Accelerated
Before degradation
Day 2
Day 4
Day 8
Day 12
4000 3500 3000 2500 2000 1500 1000 500
Wave number (cm-1)


PDO3LCL7- Accelerated
Before degradation
Day 2
Day 4
Day 8
Day 12
2000 1800 1600 1400 1200
Wave number (cm-1)


PDO5LCL5- Accelerated
Before degradation
Day 2
Day 4
Day 8
Day 12
4000 3500 3000 2500 2000 1500 1000 500
Wave number (cm-1)


PDO5LCL5- Accelerated
Before degradation
Day 2
Day 4
Day 8
Day 12
2000 1800 1600 1400 1200
Wave number (cm-1)

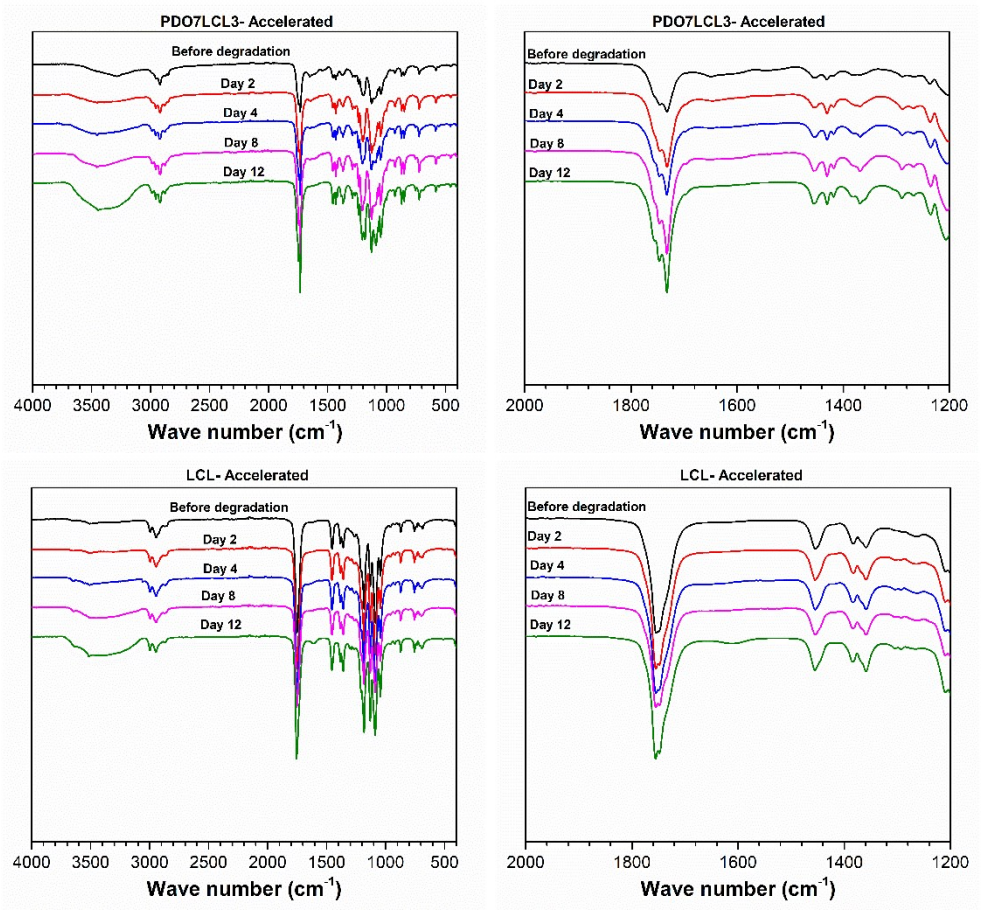
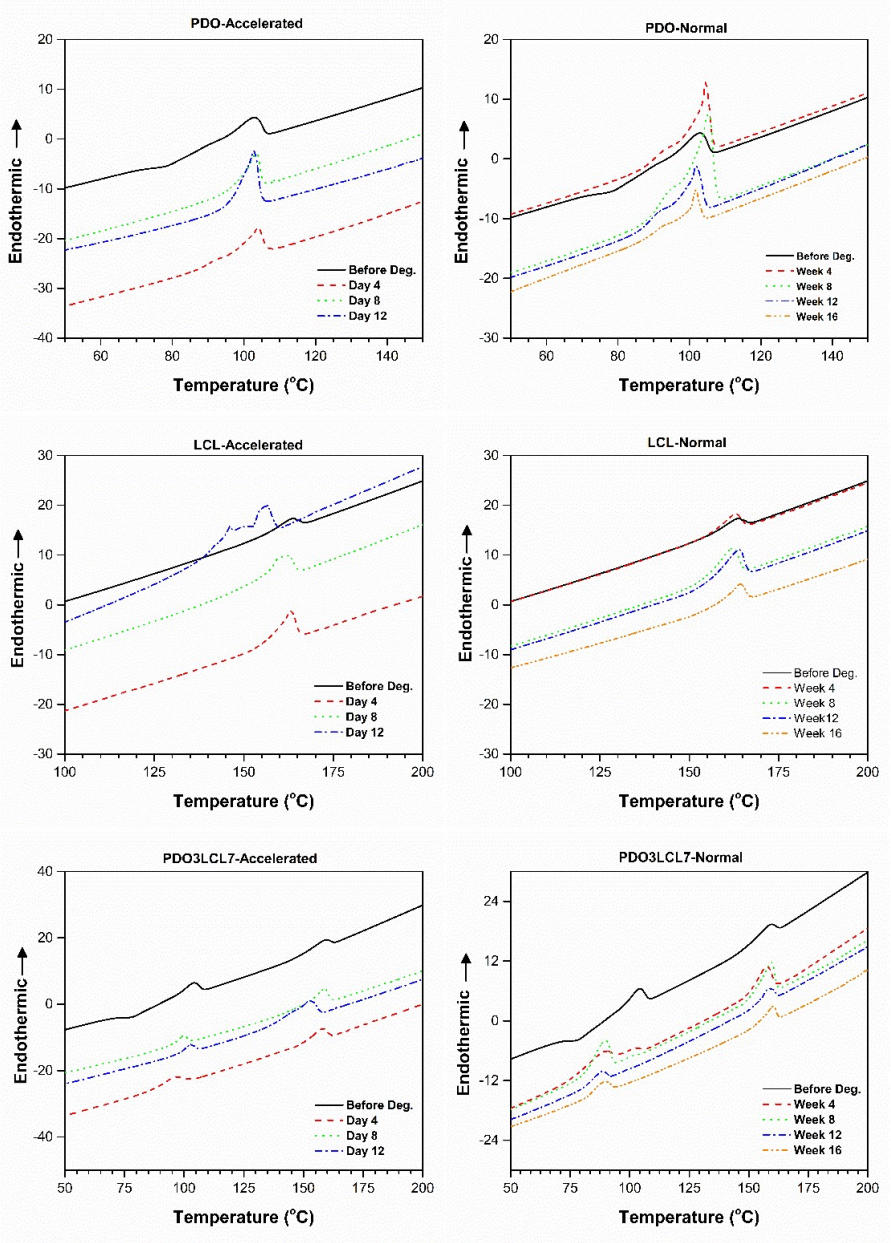


Figure S3. FTIR spectra of PDO/LCL blends during accelerated degradation. Left and right columns are assigned to 400-4000 cm^{-1} and 1200-2000 cm^{-1} wave numbers, respectively.


PDO-Accelerated
Endothermic
Temperature (°C)
Before Deg.
Day 4
Day 8
Day 12
PDO-Normal
Endothermic
Temperature (°C)
Before Deg.
Week 4
Week 8
Week 12
Week 16
LCL-Accelerated
Endothermic
Temperature (°C)
Before Deg.
Day 4
Day 8
Day 12
LCL-Normal
Endothermic
Temperature (°C)
Before Deg.
Week 4
Week 8
Week12
Week 16
PDO3LCL7-Accelerated
Endothermic
Temperature (°C)
Before Deg.
Day 4
Day 8
Day 12
PDO3LCL7-Normal
Endothermic
Temperature (°C)
Before Deg.
Week 4
Week 8
Week 12
Week 16

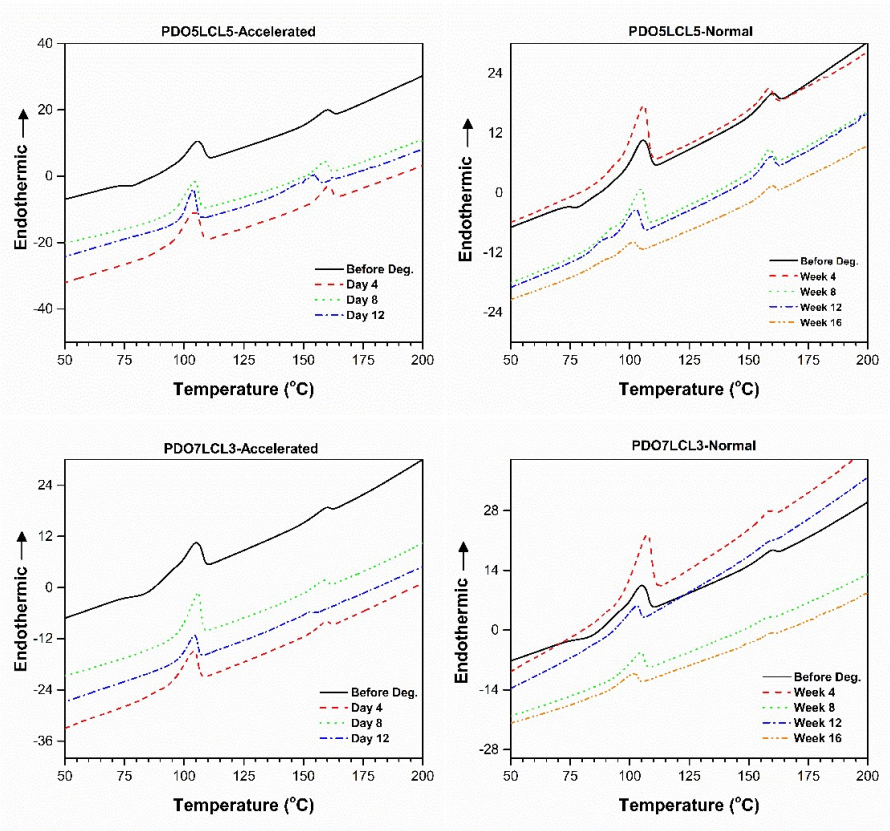


Figure S4. DSC curves of PDO/LCL blends during accelerated *(left column)* and normal degradations *(right column)*.

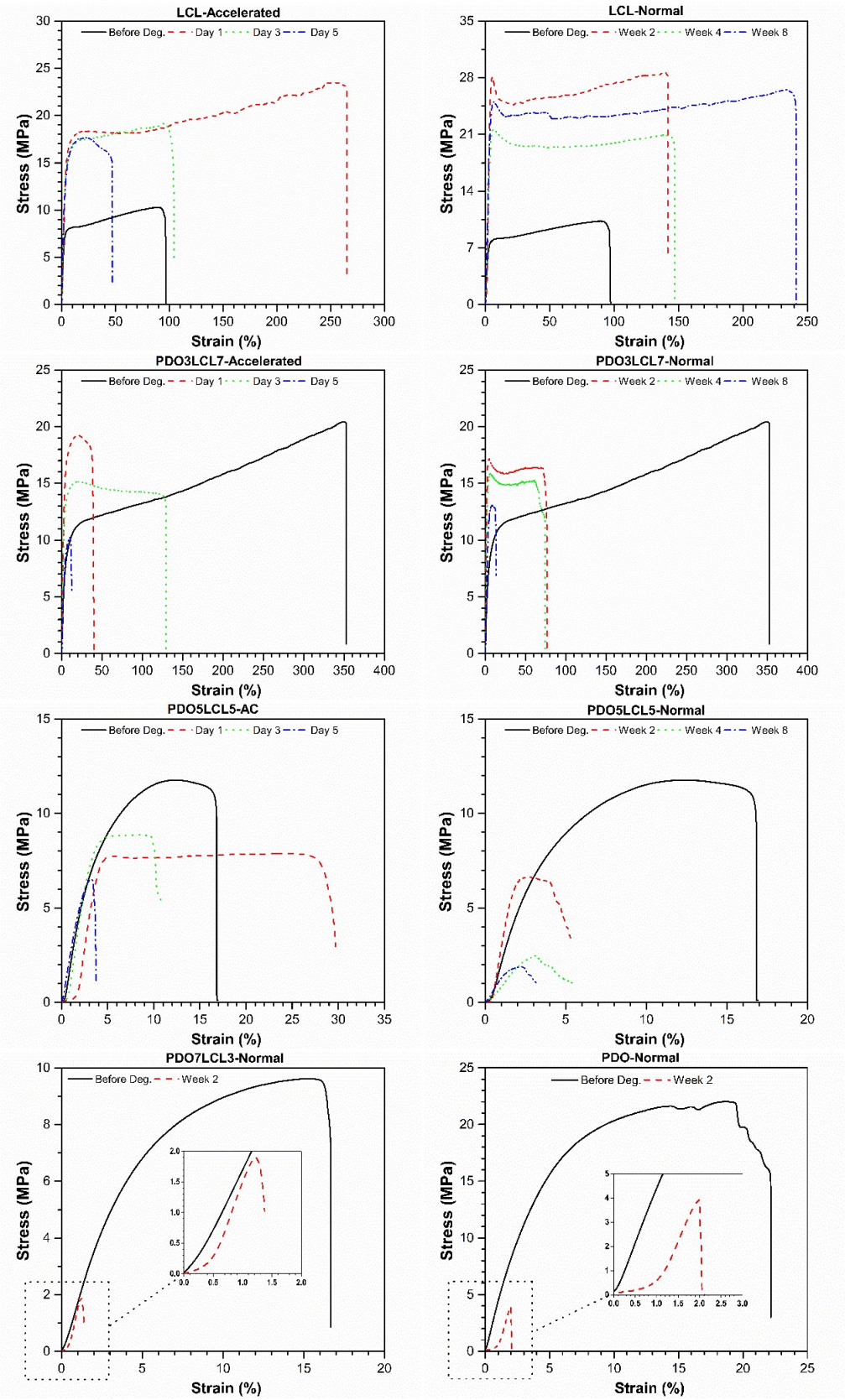


Figure S5. Stress-strain curves of PDO/LCL blends during accelerated and normal degradations.

Table S1. Thermal properties and crystallinity of PDO/LCL blends during accelerated degradation condition.

Deg. Period	PDO			PDO7-LCL3						PDO5-LCL5						PDO3-LCL7						LCL		
				PDO			LCL			PDO			LCL			PDO			LCL					
	T_m (˚C)	ΔH_m (J/g)	X_C (%)	T_m (˚C)	ΔH_m (J/g)	X_C (%)	T_m (˚C)	ΔH_m (J/g)	X_C (%)	T_m (˚C)	ΔH_m (J/g)	X_C (%)	T_m (˚C)	ΔH_m (J/g)	X_C (%)	T_m (˚C)	ΔH_m (J/g)	X_C (%)	T_m (˚C)	ΔH_m (J/g)	X_C (%)	T_m (˚C)	ΔH_m (J/g)	X_C (%)
Before Deg	102.6	57.9	47.3	104.7	43.0	35.9	159.0	3.8	4.2	105.3	29.9	22.6	159.3	7.1	7.9	103.8	15.8	6.5	158.6	9.3	10.3	163.4	10.1	11.2
Day 4	103.9	86.1	83.7	103.9	52.9	51.4	159.1	7.4	8.2	104.2	42.0	40.8	160.4	11.1	12.3	95.9	18.7	18.2	157.8	17.7	19.6	163.1	22.2	24.6
Day 8	103.1	107.3	104.3	105.8	61.2	59.5	158.3	10.9	12.1	104.3	43.3	42.1	158.6	16.8	18.6	99.8	10.1	9.8	158.7	20.9	23.2	159.9	27.1	30.1
Day 12	102.7	109.9	106.8	104.5	56.8	55.2	152.1	9.7	10.8	103.7	32.4	31.5	153.6	18.7	20.7	102.6	6.4	6.2	153.0	31.4	34.8	156.5	39.8	44.1

Table S2. Thermal properties and crystallinity of PDO/LCL blends during normal degradation condition.

Deg. Period	PDO			PDO7-LCL3						PDO5-LCL5						PDO3-LCL7						LCL		
				PDO			LCL			PDO			LCL			PDO			LCL					
	Tm (˚C)	ΔHm (J/g)	XC (%)	Tm (˚C)	ΔHm (J/g)	XC (%)	Tm (˚C)	ΔHm (J/g)	XC (%)	Tm (˚C)	ΔHm (J/g)	XC (%)	Tm (˚C)	ΔHm (J/g)	XC (%)	Tm (˚C)	ΔHm (J/g)	XC (%)	Tm (˚C)	ΔHm (J/g)	XC (%)	Tm (˚C)	ΔHm (J/g)	XC (%)
Before Deg	102.6	57.9	47.3	104.7	43.0	35.9	159.0	3.8	4.2	105.3	29.9	22.6	159.3	7.1	7.9	103.8	15.8	6.5	158.6	9.3	10.3	163.4	10.1	11.2
Week 4	104.5	74.9	72.8	107.1	51.3	49.9	158.2	4.1	4.5	105.6	37.5	36.4	158.3	7.9	8.8	89.7	18.6	18.1	157.5	13.6	15.1	162.7	15.0	16.6
Week 8	105.3	86.4	84.0	104.6	48.8	47.4	157.2	5.3	5.9	104.3	37.6	36.5	158.6	8.5	9.4	89.5	19.7	19.1	159.2	19.1	21.2	161.9	18.8	20.9
Week 12	101.8	88.6	86.1	102.6	49.2	47.8	157.9	8.4	9.3	102.2	37.1	36.1	159.0	12.1	13.4	88.1	16.1	15.6	157.9	19.0	21.1	163.8	21.8	24.2
Week 16	101.8	88.8	86.3	101.2	51.5	50.0	158.9	9.7	10.8	100.9	32.1	31.2	159.4	13.3	14.8	88.7	16.5	16.0	160.0	20.2	22.4	164.1	24.7	27.4

Table S3. Tensile properties of PDO/LCL blends (n = 3 in each group) during normal degradation condition.

Time	LCL				PDO				PDO3LCL7				PDO5LCL5				PDO7LCL3			
	Modulus (MPa)	Yield Strength (MPa)	Ultimate strength (MPa)	Elongation at break (%)	Modulus (MPa)	Yield Strength (MPa)	Ultimate strength (MPa)	Elongation at break (%)	Modulus (MPa)	Yield Strength (MPa)	Ultimate strength (Mpa)	Elongation at break (%)	Modulus (MPa)	Yield Strength (Mpa)	Ultimate strength (Mpa)	Elongation at break (%)	Modulus (MPa)	Yield Strength (Mpa)	Ultimate strength (Mpa)	Elongation at break (%)
Before Deg.	337±39	6.9±1.0	11.7±2.9	107.9±69.7	376±13	15.3±3.1	20.5±1.2	22.8±9.3	186±11	9.0±0.3	18.9±1.1	320.3±29.9	279±24	7.5±0.4	11.9±1.3	16.8±1.9	158±14	6.6±0.2	9.7±0.5	16.3±1.0
Week 2	968±80	24.2±1.8	28.2±2.8	124.0±20.1	322±100	2.2±1.1	2.8±1.1	1.6±00.8	795±104	18.2±2.9	20.8±3.2	61.5±57.7	449±65	6.0±0.2	6.5±0.1	3.8±0.9	219±67	1.9±0.2	2.0±0.1	2.1±1.1
Week 4	761±124	22.6±2.3	26.0±3.8	188.1±37.3	-	-	-	-	572±77	13.9±0.7	16.1±0.2	84.4±29.3	143±40	2.1±0.2	2.3±0.3	3.1±0.5	-	-	-	-
Week 8	868±223	23.8±2.0	29.6±2.8	268.7±33.1	-	-	-	-	413±13	10.1±0.4	12.7±0.5	14.9±2.8	137±32	2.1±0.7	2.4±0.8	3.7±1.1	-	-	-	-

Table S4. Tensile properties of PDO/LCL blends (n = 3 in each group) during accelerated degradation condition.

Time	LCL				PDO3LCL7				PDO5LCL5			
	Modulus (MPa)	Yield Strength (MPa)	Ultimate strength (MPa)	Elongation at break (%)	Modulus (MPa)	Yield Strength (MPa)	Ultimate strength (MPa)	Elongation at break (%)	Modulus (MPa)	Yield Strength (MPa)	Ultimate strength (MPa)	Elongation at break (%)
Before Deg.	337±39	6.9±1.0	11.7±2.9	107.9±69.7	186±11	9.0±0.3	18.9±1.1	320.3±29.9	279±24	7.5±0.4	11.9±1.3	16.8±1.9
Day 1	514±64	18.6±1.6	23.2±1.0	214.4±82.6	503±52	12.4±1.2	18.0±1.1	48.6±24.4	367±37	7.9±0.7	9.0±1.3	24.9±12.7
Day 3	487±23	15.9±1.5	20.2±1.9	193.0±93.4	424±21	11.7±0.8	15.2±1.1	142.2±28.2	373±27	7.7±0.9	9.3±1.1	10.8±2.4
Day 5	420±54	11.2±0.6	20.1±2.2	68.0±67.5	269±31	6.9±0.8	10.1±1.4	15.8±7.8	227±53	5.7±0.1	6.3±0.5	3.6±0.3

References

1 X. T. Dong, W. T. Shi, H. C. Dang, W. Y. Bao, X. L. Wang and Y. Z. Wang, *Ind. Eng. Chem. Res.*, 2012, **51**, 14037–14046.

2 B. S. Heidari, V.-S. Cheraghchi, S. Motahari, G. H. Motlagh and S. M. Davachi, *J. Sol-Gel Sci. Technol.*, 2018, **88**, 236–248.

3 S. M. Davachi, B. Kaffashi, B. Torabinejad and A. Zamanian, *Polymer (Guildf).*, 2016, **83**, 101–110.

4 D. K. Wang, S. Varanasi, P. M. Fredericks, D. J. T. Hill, A. L. Symons, A. K. Whittaker and F. Rasoul, *J. Polym. Sci. Part A Polym. Chem.*, 2013, **51**, 5163–5176.