
Supplementary information

Enzyme-embedded polyesters for accelerated biodegradation in the deep sea

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Enzyme-Embedded Polyesters for Accelerated Biodegradation in the Deep Sea

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Supplementary table 1a: Formal name, abbreviation in the paper, and thermal properties of samples

Formal name	Abbr.	Supply company	T _g /°C	T _m /°C	T _{film} /°C ¹	T _{microbeads} /°C ¹
Poly(butylene succinate)	PBS	Mitsubishi Chemical Corporation	-32	114	130/130	130/140
Poly(butylene succinate-co-adipate)	PBSA	Mitsubishi Chemical Corporation	-45	88	100/100	100/140
Poly(ε-caprolactone)	PCL	Sigma Aldrich	-60	54	90/90	-
Poly(butylene adipate-co-terephthalate)	PBAT	BASF Corporation	-30	124	130/130	130/160
Poly[(R)-3-hydroxybutyrate]	P3HB	Imperial Chemical Industries	4	175	200	-
Polyethylene terephthalate	PET	Sigma Aldrich	70	270	-	-

1. The temperature displayed first is the set temperature for melt extrusion, while second temperature corresponds to compression molding (for films) or heating block (for microbeads).

Supplementary table 1b: Summary of the on-site degradation test sites

Site	Abbr.	Latitude	Longitude	Depth	Salinity	Temp.	DO	Deployment	Recovery	Period	Abbr.	Sample
				m		°C	mg/L	yyyy/mm/dd	yyyy/mm/dd	day		
Port of JAMSTEC Yokosuka Headquarters	PJM	35.3195	139.6510	2-6	30	25.5	5.7	2022/5/2	2022/6/1	30	PJM1	Film
Bathyal hydrocarbon seepage off Hatsushima island	BHT	35.0264	139.2258	855	34.5	3.6	1.8	2021/2/5	2021/10/13	250	BHT8	Film
								2022/11/3	2023/6/8	217	BHT7	Film
								2022/11/3	2023/11/3	365	BHT12	Film
Bathyal seafloor off Misaki port	BMS	35.0722	139.5472	757	34.3	4.4	2.1	2021/5/12	2021/10/12	153	BMS5	Film
								2021/5/12	2022/11/3	540	BMS18	Film
								2023/6/6	2023/11/3	150	BMS5-2	Film&bead
								2024/5/20	2025/4/5	320	BMS11	Film
Bathyal hydrothermal vent in Myojin knoll	BMJ	32.1083	139.8714	1292	34.3	4.6	2.1	2021/5/12	2022/11/3	540	BMJ18	Film
Abyssal plain near Kuroshio extension observatory	AKR	32.5883	143.7706	5503	34.7	1.6	5.2	2021/5/12	2022/11/3	540	AKR18	Film

Supplementary table 1c: Summary of samples embedded enzyme type details set at each degradation test site.

Embedded Enzyme Type	PJM	BMS	BHT	BMJ	AKR
CaLB	○ PJM1	○ BMS5 & 18	○ BHT8	○ BMJ18	○ AKR18
HIC	○ PJM1	○ BMS5-2	○ BHT7 & 12	-	-

Supplementary Table 2: Detail of samples after biodegradation test at the port of JAMSTEC Yokosuka for 1 months (PJM1).

Sample	Area loss / %	Mass decrease / mg	Mass loss / wt%	Thickness decrease / μm	Thickness loss / %	Biodegradation rate / $\mu\text{g}/\text{cm}^2/\text{day}$	Biodegradation rate / $\mu\text{g}/\text{cm}^3/\text{day}$
PBS	1.4 $\pm$ 2.1	5.5 $\pm$ 0.9	0.8 $\pm$ 0.1	-1.5 $\pm$ 4.3	-0.4 $\pm$ 1.3	5.5 $\pm$ 0.9	326.9 $\pm$ 37.7
PBSA	1.4 $\pm$ 4.1	16.3 $\pm$ 1.2	2.3 $\pm$ 0.4	3.8 $\pm$ 6.2	1.0 $\pm$ 1.6	16.9 $\pm$ 1.5	897.7 $\pm$ 156.8
PCL	1.7 $\pm$ 0.6	143.7 $\pm$ 22.6	23.4 $\pm$ 3.7	30.2 $\pm$ 20.0	8.7 $\pm$ 5.7	148.5 $\pm$ 22.1	8722.7 $\pm$ 1198.5
PBAT	-0.1 $\pm$ 1.8	12.1 $\pm$ 1.3	2.0 $\pm$ 0.2	2.8 $\pm$ 6.1	1.0 $\pm$ 2.0	12.4 $\pm$ 1.3	815.1 $\pm$ 81.0
PBS 0.1 wt% CALB powder	-0.9 $\pm$ 2.0	2.7 $\pm$ 1.1	1.3 $\pm$ 0.1	-16.5 $\pm$ 16.1	-8.7 $\pm$ 9.2	5.0 $\pm$ 2.1	520.4 $\pm$ 75.8
PBSA0.1 wt% CALB powder	100.0 $\pm$ 0.0	171.1 $\pm$ 37.4	78.2 $\pm$ 11.9	100.0 $\pm$ 0.0	100.0 $\pm$ 0.0	310.7 $\pm$ 67.7	31381.6 $\pm$ 3852.6
PCL 0.1 wt% CALB powder	1.1 $\pm$ 1.7	202.4 $\pm$ 10.6	54.0 $\pm$ 8.1	38.6 $\pm$ 17.7	10.6 $\pm$ 6.1	369.8 $\pm$ 22.5	20342.4 $\pm$ 3298.5
PBS 0.1 wt% HiC powder	1.6 $\pm$ 1.8	51.0 $\pm$ 32.4	27.4 $\pm$ 18.9	-8.7 $\pm$ 19.5	-3.7 $\pm$ 10.4	94.3 $\pm$ 60.9	11194.4 $\pm$ 7794.0
PBSA0.1 wt% HiC powder	100.0 $\pm$ 0.0	323.5 $\pm$ 48.9	100.0 $\pm$ 0.0	300.0 $\pm$ 45.2	100.0 $\pm$ 0.0	580.0 $\pm$ 82.0	40025.8 $\pm$ 518.2
PCL 0.1 wt% HiC powder	2.0 $\pm$ 1.5	220.1 $\pm$ 13.2	85.5 $\pm$ 11.2	65.8 $\pm$ 3.6	22.5 $\pm$ 1.3	396.1 $\pm$ 29.7	31954.9 $\pm$ 4179.8
PBAT 0.5 wt% HiC powder	2.0 $\pm$ 1.6	23.2 $\pm$ 2.3	11.3 $\pm$ 1.1	2.2 $\pm$ 0.9	1.2 $\pm$ 0.4	42.1 $\pm$ 4.2	4593.8 $\pm$ 412.6
P3HB	0.5 $\pm$ 1.3	60.8 $\pm$ 7.5	7.1 $\pm$ 0.3	14.7 $\pm$ 10.1	3.3 $\pm$ 2.2	61.1 $\pm$ 6.6	2792.1 $\pm$ 147.0
PET	-0.7 $\pm$ 0.7	-0.2 $\pm$ 0.0	-0.1 $\pm$ 0.0	3.8 $\pm$ 0.0	3.2 $\pm$ 0.2	-0.2 $\pm$ 0.0	-35.1 $\pm$ 2.3

Data are shown as mean values $\pm$ SD; n= 4 independent films for enzyme-free polyester and P3HB, n= 5 for CaLB-embedded film, and n= 5 for HiC-embedded film. n= 2 independent films for PET.

Supplementary Table 3: Detail of samples after biodegradation test at bathyal seafloor of Misaki port for 18 months (BMS18).

Sample	Area loss / %	Mass decrease / mg	Mass loss / wt%	Thickness decrease / μm	Thickness loss / %	Biodegradation rate / $\mu\text{g}/\text{cm}^2/\text{day}$	Biodegradation rate / $\mu\text{g}/\text{cm}^3/\text{day}$
PBS	-1.0 $\pm$ 1.1	6.2 $\pm$ 3.7	1.2 $\pm$ 0.7	-3.0 $\pm$ 3.4	-1.0 $\pm$ 1.1	0.4 $\pm$ 0.2	27.4 $\pm$ 16.8
PBSA	-0.2 $\pm$ 2.5	14.6 $\pm$ 2.1	2.1 $\pm$ 0.3	-0.8 $\pm$ 9.0	-0.2 $\pm$ 2.5	0.8 $\pm$ 0.1	46.1 $\pm$ 7.0
PCL	-0.3 $\pm$ 0.5	39.1 $\pm$ 17.3	6.0 $\pm$ 3.2	-1.2 $\pm$ 1.8	-0.3 $\pm$ 0.5	2.2 $\pm$ 1.0	124.0 $\pm$ 65.3
PBAT	0.4 $\pm$ 1.3	14.5 $\pm$ 3.8	2.7 $\pm$ 0.9	1.0 $\pm$ 3.9	0.4 $\pm$ 1.3	0.8 $\pm$ 0.2	60.4 $\pm$ 18.9
PBS 3 wt% CALB powder	9.8 $\pm$ 2.6	2.9 $\pm$ 0.3	2.1 $\pm$ 0.2	14.4 $\pm$ 3.7	9.8 $\pm$ 2.6	0.3 $\pm$ 0.0	41.3 $\pm$ 3.7
PBS 0.1 wt% CALB powder	4.9 $\pm$ 3.6	3.2 $\pm$ 1.5	1.6 $\pm$ 0.8	8.8 $\pm$ 6.0	4.9 $\pm$ 3.6	0.3 $\pm$ 0.2	34.3 $\pm$ 18.4
PBSA 3 wt% CALB powder	63.5 $\pm$ 45.0	83.0 $\pm$ 44.9	57.3 $\pm$ 29.0	91.6 $\pm$ 64.2	63.5 $\pm$ 45.0	8.6 $\pm$ 4.6	1183.2 $\pm$ 606.9
PBSA 0.1 wt% CALB powder	-0.2 $\pm$ 5.1	3.5 $\pm$ 1.5	1.5 $\pm$ 0.7	-0.5 $\pm$ 10.5	-0.2 $\pm$ 5.1	0.3 $\pm$ 0.2	32.2 $\pm$ 15.1
PCL 3 wt% CALB powder	100.0 $\pm$ 0.0	133.0 $\pm$ 11.8	99.0 $\pm$ 1.1	149.2 $\pm$ 11.9	100.0 $\pm$ 0.0	13.7 $\pm$ 1.4	1846.4 $\pm$ 59.4
PCL 0.1 wt% CALB powder	12.1 $\pm$ 10.4	281.5 $\pm$ 54.0	74.2 $\pm$ 7.0	48.2 $\pm$ 39.0	12.1 $\pm$ 10.4	28.2 $\pm$ 5.3	1543.7 $\pm$ 125.6
P3HB	56.5 $\pm$ 25.2	359.6 $\pm$ 53.8	78.5 $\pm$ 12.5	157.3 $\pm$ 63.0	56.5 $\pm$ 25.2	20.6 $\pm$ 2.9	1490.7 $\pm$ 242.0
PET	13.0 $\pm$ 1.5	-0.4 $\pm$ 0.4	-0.2 $\pm$ 0.2	16.7 $\pm$ 2.1	13.0 $\pm$ 1.5	0.0 $\pm$ 0.0	-3.3 $\pm$ 3.3

Data are shown as mean values $\pm$ SD; n= 4 independent films for enzyme-free polyester and P3HB, n= 5 for CaLB-embedded film. n= 2 independent films for PET.

Supplementary Table 4: Detail of samples after biodegradation test at Bathyal hydrothermal vent in Myojin knoll for 18 months (BMJ18).

Sample	Area loss / %	Mass decrease / mg	Mass loss / wt%	Thickness decrease / μm	Thickness loss / %	Biodegradation rate / $\mu\text{g}/\text{cm}^2/\text{day}$	Biodegradation rate / $\mu\text{g}/\text{cm}^3/\text{day}$
PBS	-8.1 $\pm$ 5.7	1.6 $\pm$ 10.5	0.4 $\pm$ 2.0	-20.1 $\pm$ 14.1	-8.1 $\pm$ 5.7	0.1 $\pm$ 0.6	8.5 $\pm$ 46.5
PBSA	-0.8 $\pm$ 7.7	72.3 $\pm$ 69.2	12.9 $\pm$ 12.4	-2.8 $\pm$ 22.3	-0.8 $\pm$ 7.7	4.2 $\pm$ 4.1	294.1 $\pm$ 291.4
PCL	-50.0 $\pm$ 72.4	65.6 $\pm$ 41.2	8.4 $\pm$ 4.3	-190.0 $\pm$ 263.7	-50.0 $\pm$ 72.4	3.7 $\pm$ 2.3	179.1 $\pm$ 98.1
PBAT	-0.8 $\pm$ 1.2	18.1 $\pm$ 7.6	3.1 $\pm$ 1.3	-2.2 $\pm$ 3.6	-0.8 $\pm$ 1.2	1.0 $\pm$ 0.5	70.4 $\pm$ 28.6
PBS 3 wt% CALB powder	-61.9 $\pm$ 95.4	50.7 $\pm$ 59.2	34.0 $\pm$ 39.3	-80.6 $\pm$ 125.6	-61.9 $\pm$ 95.4	5.2 $\pm$ 6.0	685.9 $\pm$ 789.0
PBS 0.1 wt% CALB powder	1.1 $\pm$ 1.2	3.0 $\pm$ 1.8	1.2 $\pm$ 0.2	3.0 $\pm$ 2.7	1.1 $\pm$ 1.2	0.3 $\pm$ 0.2	25.1 $\pm$ 6.6
PBSA 3 wt% CALB powder	100.0 $\pm$ 0.0	114.1 $\pm$ 27.7	80.5 $\pm$ 17.7	160.6 $\pm$ 0.0	100.0 $\pm$ 0.0	11.5 $\pm$ 2.7	1576.8 $\pm$ 321.3
PBSA 0.1 wt% CALB powder	0.0 $\pm$ 7.3	21.9 $\pm$ 32.7	7.6 $\pm$ 9.6	-3.3 $\pm$ 19.5	0.0 $\pm$ 7.3	2.2 $\pm$ 3.3	168.8 $\pm$ 216.3
PCL 3 wt% CALB powder	-	89.9 $\pm$ 33.9	72.1 $\pm$ 23.9	-	-	9.3 $\pm$ 3.5	1306.0 $\pm$ 428.0
PCL 0.1 wt% CALB powder	5.1 $\pm$ 3.8	254.7 $\pm$ 78.6	75.5 $\pm$ 20.4	15.2 $\pm$ 11.1	5.1 $\pm$ 3.8	25.8 $\pm$ 8.0	1560.1 $\pm$ 454.0
P3HB	30.4 $\pm$ 10.2	190.6 $\pm$ 104.9	34.7 $\pm$ 17.6	107.0 $\pm$ 46.8	30.4 $\pm$ 10.2	10.7 $\pm$ 5.9	628.7 $\pm$ 334.8
PET	22.8 $\pm$ 3.6	0.2 $\pm$ 0.1	0.1 $\pm$ 0.0	32.2 $\pm$ 7.0	22.8 $\pm$ 3.6	0.0 $\pm$ 0.0	1.8 $\pm$ 1.0

Data are shown as mean values $\pm$ SD; n= 4 independent films for enzyme-free polyester and P3HB, n= 5 for CaLB-embedded film. n= 2 independent films for PET.

Supplementary Table 5: Detail of samples after biodegradation test at Abyssal plain near Kuroshio extension observatory for 18 months (AKR18).

Sample	Area loss / %	Mass decrease / mg	Mass loss / wt%	Thickness decrease / μm	Thickness loss / %	Biodegradation rate / $\mu\text{g}/\text{cm}^2/\text{day}$	Biodegradation rate / $\mu\text{g}/\text{cm}^3/\text{day}$
PBS	5.6 $\pm$ 1.5	8.8 $\pm$ 0.5	1.5 $\pm$ 0.1	18.0 $\pm$ 5.6	5.6 $\pm$ 1.5	0.50 $\pm$ 0.02	31.93 $\pm$ 1.77
PBSA	-0.8 $\pm$ 0.8	10.1 $\pm$ 1.0	1.6 $\pm$ 0.2	-2.3 $\pm$ 2.2	-0.8 $\pm$ 0.8	0.57 $\pm$ 0.05	36.24 $\pm$ 5.20
PCL	-0.1 $\pm$ 0.9	25.4 $\pm$ 6.6	3.4 $\pm$ 0.7	-0.4 $\pm$ 4.1	-0.1 $\pm$ 0.9	1.44 $\pm$ 0.37	69.23 $\pm$ 14.62
PBAT	-0.8 $\pm$ 2.1	8.7 $\pm$ 0.5	1.3 $\pm$ 0.1	-2.8 $\pm$ 7.4	-0.8 $\pm$ 2.1	0.51 $\pm$ 0.02	29.15 $\pm$ 1.46
PBS 3 wt% CALB powder	-6.6 $\pm$ 4.6	2.5 $\pm$ 0.4	1.8 $\pm$ 0.2	-8.6 $\pm$ 6.0	-6.6 $\pm$ 4.6	0.26 $\pm$ 0.03	40.81 $\pm$ 5.44
PBS 0.1 wt% CALB powder	1.8 $\pm$ 2.2	2.0 $\pm$ 0.3	1.1 $\pm$ 0.1	3.6 $\pm$ 4.1	1.8 $\pm$ 2.2	0.21 $\pm$ 0.02	23.76 $\pm$ 3.24
PBSA 3 wt% CALB powder	0.3 $\pm$ 2.7	41.7 $\pm$ 6.2	30.5 $\pm$ 2.6	0.4 $\pm$ 3.6	0.3 $\pm$ 2.7	4.35 $\pm$ 0.68	665.47 $\pm$ 71.28
PBSA 0.1 wt% CALB powder	5.6 $\pm$ 3.3	2.9 $\pm$ 0.6	1.2 $\pm$ 0.2	13.4 $\pm$ 8.1	5.6 $\pm$ 3.3	0.29 $\pm$ 0.06	25.81 $\pm$ 5.21
PCL 3 wt% CALB powder	-1.6 $\pm$ 2.4	9.8 $\pm$ 3.9	7.7 $\pm$ 2.7	-2.0 $\pm$ 3.1	-1.6 $\pm$ 2.4	1.01 $\pm$ 0.39	158.57 $\pm$ 59.64
PCL 0.1 wt% CALB powder	0.4 $\pm$ 1.3	15.0 $\pm$ 9.0	3.9 $\pm$ 1.8	1.5 $\pm$ 4.4	0.4 $\pm$ 1.3	1.48 $\pm$ 0.86	80.62 $\pm$ 36.98
P3HB	9.3 $\pm$ 2.3	99.7 $\pm$ 43.1	20.5 $\pm$ 7.7	23.5 $\pm$ 3.6	9.3 $\pm$ 2.3	5.69 $\pm$ 2.46	440.25 $\pm$ 158.82
PET	38.2 $\pm$ 7.1	0.3 $\pm$ 0.0	0.1 $\pm$ 0.0	64.1 $\pm$ 19.7	38.2 $\pm$ 7.1	0.02 $\pm$ 0.00	2.24 $\pm$ 0.32

Data are shown as mean values $\pm$ SD; n= 4 independent films for enzyme-free polyester and P3HB, n= 5 for CaLB-embedded film. n= 2 independent films for PET.

Supplementary Table 6: Detail of samples after biodegradation test at Bathyal hydrocarbon seepage off Hatsushima island for 7 months (BHT7).

Sample	Area loss / %	Mass decrease / mg	Mass loss / wt%	Thickness decrease / μm	Thickness loss / %	Biodegradation rate / $\mu\text{g}/\text{cm}^2/\text{day}$	Biodegradation rate / $\mu\text{g}/\text{cm}^3/\text{day}$
PBS	0.6 $\pm$ 1.1	0.7 $\pm$ 4.3	0.1 $\pm$ 0.7	-2.3 $\pm$ 2.1	-0.8 $\pm$ 0.8	0.1 $\pm$ 0.6	7.7 $\pm$ 40.8
PBSA	0.0 $\pm$ 0.0	12.2 $\pm$ 0.7	1.8 $\pm$ 0.1	-2.0 $\pm$ 2.0	-0.5 $\pm$ 0.5	1.7 $\pm$ 0.1	96.5 $\pm$ 7.7
PCL	1.2 $\pm$ 1.2	22.3 $\pm$ 2.1	2.9 $\pm$ 0.3	4.0 $\pm$ 2.4	0.9 $\pm$ 0.5	3.1 $\pm$ 0.3	146.5 $\pm$ 17.8
PBAT	-0.7 $\pm$ 2.1	5.8 $\pm$ 1.0	0.8 $\pm$ 0.1	-4.6 $\pm$ 2.5	-1.2 $\pm$ 0.7	0.8 $\pm$ 0.1	42.6 $\pm$ 3.5
PBS 3 wt% HiC powder	6.1 $\pm$ 3.1	283.9 $\pm$ 35.5	73.2 $\pm$ 4.3	51.1 $\pm$ 16.6	14.1 $\pm$ 5.9	69.1 $\pm$ 8.8	3740.8 $\pm$ 246.8
PBSA 3 wt% HiC powder	100.0 $\pm$ 0.0	443.8 $\pm$ 78.4	100.0 $\pm$ 0.0	434.0 $\pm$ 86.1	100.0 $\pm$ 0.0	113.5 $\pm$ 20.4	5408.2 $\pm$ 120.9
PCL 3 wt% HiC powder	100.0 $\pm$ 0.0	401.5 $\pm$ 84.9	100.0 $\pm$ 0.0	416.2 $\pm$ 73.4	100.0 $\pm$ 0.0	101.7 $\pm$ 19.6	5006.8 $\pm$ 142.0
PBAT 3 wt% HiC powder	2.6 $\pm$ 2.4	51.5 $\pm$ 13.3	9.8 $\pm$ 1.0	6.8 $\pm$ 2.7	1.4 $\pm$ 0.4	12.4 $\pm$ 2.9	526.0 $\pm$ 47.8
P3HB	1.9 $\pm$ 2.0	136.2 $\pm$ 35.4	23.6 $\pm$ 7.3	9.6 $\pm$ 4.5	3.2 $\pm$ 1.7	19.3 $\pm$ 5.0	1298.7 $\pm$ 412.7
PET	-0.1 $\pm$ 0.0	-0.7 $\pm$ 0.7	-0.3 $\pm$ 0.3	-21.7 $\pm$ 1.5	-21.8 $\pm$ 1.9	-0.1 $\pm$ 0.1	-20.5 $\pm$ 20.5

Data are shown as mean values $\pm$ SD; n= 4 independent films for enzyme-free polyester and P3HB, n= 5 for HiC-embedded film. n= 2 independent films for PET.

Supplementary Table 7: Detail of samples after biodegradation test at Bathyal hydrocarbon seepage off Hatsushima island for 8 months (BHT8).

Sample	Area loss / %	Mass decrease / mg	Mass loss / wt%	Thickness decrease / μm	Thickness loss / %	Biodegradation rate / $\mu\text{g}/\text{cm}^2/\text{day}$	Biodegradation rate / $\mu\text{g}/\text{cm}^3/\text{day}$
PLLA	0.5 $\pm$ 1.0	0.3 $\pm$ 0.2	0.1 $\pm$ 0.0	27.5 $\pm$ 10.2	9.3 $\pm$ 3.3	0.0 $\pm$ 0.0	2.7 $\pm$ 2.0
PBS	0.5 $\pm$ 0.4	3.4 $\pm$ 0.4	0.7 $\pm$ 0.1	6.5 $\pm$ 6.8	2.5 $\pm$ 2.5	0.4 $\pm$ 0.0	32.6 $\pm$ 4.7
PBSA	1.2 $\pm$ 0.5	12.0 $\pm$ 0.9	2.2 $\pm$ 0.1	25.6 $\pm$ 7.4	8.5 $\pm$ 2.8	1.5 $\pm$ 0.1	98.9 $\pm$ 2.7
PCL	2.1 $\pm$ 0.9	10.8 $\pm$ 1.5	2.3 $\pm$ 0.2	23.0 $\pm$ 9.8	7.8 $\pm$ 2.8	1.3 $\pm$ 0.2	94.1 $\pm$ 7.8
PLLA 10wt% IM Pro.K	100.0 $\pm$ 0.0	194.3 $\pm$ 26.1	100.0 $\pm$ 0.0	202.7 $\pm$ 35.2	100.0 $\pm$ 0.0	44.3 $\pm$ 5.8	4463.5 $\pm$ 248.6
PBS 3 wt% CALB powder	0.1 $\pm$ 0.7	7.8 $\pm$ 2.3	4.8 $\pm$ 2.0	-2.5 $\pm$ 7.0	-0.9 $\pm$ 3.4	1.7 $\pm$ 0.5	228.5 $\pm$ 100.1
PBSA3 wt% CALB powder	0.2 $\pm$ 0.0	113.4 $\pm$ 26.1	66.0 $\pm$ 5.4	39.8 $\pm$ 7.3	21.3 $\pm$ 3.4	25.1 $\pm$ 5.8	2679.1 $\pm$ 322.6
PCL 3 wt% CALB powder	-	161.0 $\pm$ 27.9	81.8 $\pm$ 4.1	167.0 $\pm$ 70.1	85.8 $\pm$ 31.7	34.6 $\pm$ 6.5	3600.3 $\pm$ 144.6
P3HB	1.4 $\pm$ 0.8	195.5 $\pm$ 19.3	35.5 $\pm$ 3.6	60.7 $\pm$ 15.6	21.1 $\pm$ 4.9	24.4 $\pm$ 2.3	1725.2 $\pm$ 162.7
PBAT	1.0 $\pm$ 0.3	8.0 $\pm$ 0.5	1.7 $\pm$ 0.1	-9.6 $\pm$ 30.3	-7.2 $\pm$ 18.7	1.0 $\pm$ 0.1	90.7 $\pm$ 20.9
PET	-1.4 $\pm$ 0.3	0.4 $\pm$ 0.3	0.2 $\pm$ 0.1	8.6 $\pm$ 0.4	8.2 $\pm$ 0.4	0.0 $\pm$ 0.0	8.6 $\pm$ 6.2

Data are shown as mean values $\pm$ SD; n= 4 independent films for enzyme-free polyester and P3HB, n= 6 for CaLB-embedded film. n= 2 independent films for PET.

Supplementary Table 8: Detail of samples after biodegradation test at bathyal seafloor of Misaki port for 5 months, 2nd time (BMS5-2).

Sample	Area loss / %	Mass decrease / mg	Mass loss / wt%	Thickness decrease / μm	Thickness loss / %	Biodegradation rate / $\mu\text{g}/\text{cm}^2/\text{day}$	Biodegradation rate / $\mu\text{g}/\text{cm}^3/\text{day}$
PBS	3.2 $\pm$ 3.2	2.5 $\pm$ 0.2	1.2 $\pm$ 0.3	6.3 $\pm$ 2.8	3.1 $\pm$ 0.7	0.9 $\pm$ 0.1	94.0 $\pm$ 24.1
PBSA	-1.0 $\pm$ 2.7	12.9 $\pm$ 0.8	3.4 $\pm$ 0.4	-9.9 $\pm$ 16.5	-2.6 $\pm$ 4.4	4.7 $\pm$ 0.4	271.4 $\pm$ 35.8
PCL	0.8 $\pm$ 3.6	7.3 $\pm$ 1.0	2.5 $\pm$ 0.2	3.9 $\pm$ 5.4	1.6 $\pm$ 2.1	2.7 $\pm$ 0.3	189.3 $\pm$ 17.8
PBAT	0.9 $\pm$ 1.4	3.3 $\pm$ 0.4	1.1 $\pm$ 0.0	16.1 $\pm$ 11.9	5.9 $\pm$ 4.6	1.2 $\pm$ 0.1	88.6 $\pm$ 3.7
PBS 3 wt% HiC powder	100.0 $\pm$ 4.9	261.4 $\pm$ 9.5	97.3 $\pm$ 2.8	131.0 $\pm$ 2.6	47.6 $\pm$ 1.1	97.0 $\pm$ 3.6	8105.5 $\pm$ 247.0
PBSA 3 wt% HiC powder	100.0 $\pm$ 0.0	294.0 $\pm$ 36.3	100.0 $\pm$ 0.0	274.5 $\pm$ 37.8	100.0 $\pm$ 0.0	106.0 $\pm$ 12.6	7881.3 $\pm$ 214.4
PCL 3 wt% HiC powder	100.0 $\pm$ 0.0	294.1 $\pm$ 54.2	100.0 $\pm$ 0.0	292.9 $\pm$ 52.6	100.0 $\pm$ 0.0	105.9 $\pm$ 19.5	7372.5 $\pm$ 140.9
PBAT 3 wt% HiC powder	3.8 $\pm$ 4.9	31.0 $\pm$ 9.5	12.1 $\pm$ 2.8	3.0 $\pm$ 2.6	1.2 $\pm$ 1.1	11.0 $\pm$ 3.6	949.1 $\pm$ 247.0
P3HB	2.0 $\pm$ 2.1	115.5 $\pm$ 32.8	17.3 $\pm$ 6.8	34.2 $\pm$ 12.8	9.5 $\pm$ 4.6	23.7 $\pm$ 6.7	1321.7 $\pm$ 509.4
PET	-0.6 $\pm$ 1.1	0.6 $\pm$ 0.4	0.3 $\pm$ 0.2	-0.6 $\pm$ 1.2	-0.7 $\pm$ 1.1	0.1 $\pm$ 0.1	26.7 $\pm$ 15.3

Data are shown as mean values $\pm$ SD; n= 4 independent films for enzyme-free polyester and P3HB, n= 4 for HiC-embedded film. n= 5 independent films for PET.

Supplementary Table 9: Detail of samples after biodegradation test at bathyal seafloor off Misaki port for 5 months (BMS5).

Sample	Area loss / %	Mass decrease / mg	Mass loss / wt%	Thickness decrease / μm	Thickness loss / %	Biodegradation rate / $\mu\text{g}/\text{cm}^2/\text{day}$	Biodegradation rate / $\mu\text{g}/\text{cm}^3/\text{day}$
PBS	2.9 $\pm$ 2.2	9.9 $\pm$ 0.3	2.0 $\pm$ 0.3	7.7 $\pm$ 6.1	2.9 $\pm$ 2.2	2.0 $\pm$ 0.1	148.1 $\pm$ 17.0
PBSA	1.4 $\pm$ 0.4	10.5 $\pm$ 1.4	1.6 $\pm$ 0.1	4.5 $\pm$ 1.2	1.4 $\pm$ 0.4	2.1 $\pm$ 0.3	120.1 $\pm$ 4.1
PCL	0.7 $\pm$ 2.3	12.7 $\pm$ 1.6	1.6 $\pm$ 0.1	3.2 $\pm$ 10.5	0.7 $\pm$ 2.3	2.5 $\pm$ 0.3	109.1 $\pm$ 10.0
PBAT	1.2 $\pm$ 2.8	10.2 $\pm$ 1.0	1.3 $\pm$ 0.1	4.6 $\pm$ 11.4	1.2 $\pm$ 2.8	2.0 $\pm$ 0.2	97.6 $\pm$ 4.7
PBS 3 wt% CALB powder	8.7 $\pm$ 2.6	2.7 $\pm$ 0.2	1.9 $\pm$ 0.1	13.4 $\pm$ 3.7	8.7 $\pm$ 2.6	1.0 $\pm$ 0.1	123.3 $\pm$ 7.9
PBS 0.1 wt% CALB powder	2.3 $\pm$ 2.5	2.3 $\pm$ 0.3	1.0 $\pm$ 0.2	5.2 $\pm$ 5.9	2.3 $\pm$ 2.5	0.8 $\pm$ 0.1	68.5 $\pm$ 5.5
PBSA 3 wt% CALB powder	7.3 $\pm$ 0.0	65.9 $\pm$ 5.5	44.3 $\pm$ 2.5	11.2 $\pm$ 0.0	7.3 $\pm$ 0.0	23.7 $\pm$ 2.0	2997.6 $\pm$ 195.1
PBSA 0.1 wt% CALB powder	5.8 $\pm$ 3.7	2.6 $\pm$ 0.5	1.2 $\pm$ 0.1	10.2 $\pm$ 6.4	5.8 $\pm$ 3.7	0.9 $\pm$ 0.2	88.1 $\pm$ 7.3
PCL 3 wt% CALB powder	9.8 $\pm$ 1.3	47.9 $\pm$ 3.2	39.7 $\pm$ 2.9	13.1 $\pm$ 1.2	9.8 $\pm$ 1.3	17.5 $\pm$ 1.2	2518.6 $\pm$ 234.3
PCL 0.1 wt% CALB powder	0.4 $\pm$ 1.4	71.0 $\pm$ 13.2	18.6 $\pm$ 4.1	1.3 $\pm$ 5.7	0.4 $\pm$ 1.4	25.5 $\pm$ 4.9	1281.4 $\pm$ 293.1
P3HB	21.2 $\pm$ 5.0	56.1 $\pm$ 10.5	10.7 $\pm$ 3.0	72.6 $\pm$ 17.9	21.2 $\pm$ 5.0	11.2 $\pm$ 1.9	640.6 $\pm$ 156.5
PET	28.9 $\pm$ 5.8	0.0 $\pm$ 0.0	0.0 $\pm$ 0.0	41.3 $\pm$ 11.9	28.9 $\pm$ 5.8	0.0 $\pm$ 0.0	0.0 $\pm$ 0.0

Data are shown as mean values $\pm$ SD; n= 4 independent films for enzyme-free polyester and P3HB, n= 5 for CaLB-embedded film. n= 2 independent films for PET.

Supplementary Table 10: Detail of samples after biodegradation test at Bathyal hydrocarbon seepage off Hatsushima island for 12 months (BHT12).

Sample	Area loss / %	Mass decrease / mg	Mass loss / wt%	Thickness decrease / μm	Thickness loss / %	Biodegradation rate / $\mu\text{g}/\text{cm}^2/\text{day}$	Biodegradation rate / $\mu\text{g}/\text{cm}^3/\text{day}$
PBS	1.0 $\pm$ 1.1	5.6 $\pm$ 0.4	0.9 $\pm$ 0.0	3.2 $\pm$ 18.0	1.0 $\pm$ 5.4	0.5 $\pm$ 0.0	29.0 $\pm$ 1.8
PBSA	1.9 $\pm$ 1.0	19.3 $\pm$ 5.9	2.7 $\pm$ 0.9	-4.2 $\pm$ 5.0	-1.3 $\pm$ 1.4	1.6 $\pm$ 0.5	90.4 $\pm$ 28.6
PCL	2.8 $\pm$ 2.3	26.8 $\pm$ 11.4	3.8 $\pm$ 1.3	-5.5 $\pm$ 4.2	-1.5 $\pm$ 1.2	2.2 $\pm$ 0.9	112.4 $\pm$ 39.7
PBAT	0.5 $\pm$ 1.0	7.5 $\pm$ 1.0	0.9 $\pm$ 0.0	-2.1 $\pm$ 4.8	-0.5 $\pm$ 1.1	0.6 $\pm$ 0.1	30.5 $\pm$ 1.7
PBS 3 wt% HiC powder	1.5 $\pm$ 1.6	287.2 $\pm$ 15.7	73.7 $\pm$ 5.7	-70.1 $\pm$ 236.3	-21.3 $\pm$ 69.7	42.4 $\pm$ 2.1	2423.7 $\pm$ 218.9
PBSA 3 wt% HiC powder	100.0 $\pm$ 0.0	449.9 $\pm$ 74.1	100.0 $\pm$ 0.0	427.9 $\pm$ 65.7	100.0 $\pm$ 0.0	66.8 $\pm$ 9.4	3218.0 $\pm$ 66.1
PCL 3 wt% HiC powder	100.0 $\pm$ 0.0	404.7 $\pm$ 73.7	100.0 $\pm$ 0.0	413.6 $\pm$ 74.1	100.0 $\pm$ 0.0	60.2 $\pm$ 10.4	2998.1 $\pm$ 21.3
PBAT 3 wt% HiC powder	2.6 $\pm$ 3.7	84.8 $\pm$ 22.3	19.1 $\pm$ 2.1	5.9 $\pm$ 13.5	1.4 $\pm$ 3.2	12.2 $\pm$ 3.0	608.2 $\pm$ 64.5
P3HB	1.7 $\pm$ 1.2	362.9 $\pm$ 156.1	47.9 $\pm$ 12.8	51.9 $\pm$ 23.4	15.5 $\pm$ 7.5	30.7 $\pm$ 13.1	1909.3 $\pm$ 1039.7
PET	-5.2 $\pm$ 2.2	0.5 $\pm$ 0.3	0.2 $\pm$ 0.1	-1.1 $\pm$ 2.4	-1.1 $\pm$ 2.3	0.0 $\pm$ 0.0	9.4 $\pm$ 4.8

Data are shown as mean values $\pm$ SD; n= 5 independent films for enzyme-free polyester and P3HB, n= 5 for HiC-embedded film. n= 2 independent films for PET.

Supplementary Table 11: Statistical results of two-sided Student's t-tests for all comparisons shown in Figure 2a.

Figure	Fig. 2a	Fig. 2a	Fig. 2a	Fig. 2a	Fig. 2a	Fig. 2a	Fig. 2a	Fig. 2a
Comparison 1	PBS vs PBS + CaLB	PBS vs PBS + CaLB	PBS vs PBS + CaLB	PBS vs PBS + CaLB	PBSA vs PBSA + CaLB	PBSA vs PBSA + CaLB	PBSA vs PBSA + CaLB	PBSA vs PBSA + CaLB
Comparison 2	PJM	BMS	BMJ	AKR	PJM	BMS	BMJ	AKR
t value	4.98938	2.29975	1.51107	2.82671	11.22645	3.36009	5.69264	19.489
Degrees of freedom (df)	7	7	7	7	7	7	7	7
P value	0.00158	0.05501	0.17452	0.02553	9.93123E-6	0.01208	7.40966E-4	2.33652E-7
n (group 1)	4	4	4	4	4	4	4	4
n (group 2)	5	5	5	5	5	5	5	5

Figure	Fig. 2a	Fig. 2a	Fig. 2a	Fig. 2a
Comparison 1	PCL vs PCL + CaLB	PCL vs PCL + CaLB	PCL vs PCL + CaLB	PCL vs PCL + CaLB
Comparison 2	PJM	BMS	BMJ	AKR
t value	6.14783	54.00499	4.62984	2.72105
Degrees of freedom (df)	7	7	7	7
P value	4.68532E-4	1.95659E-10	0.0024	0.02972
n (group 1)	4	4	4	4
n (group 2)	5	5	5	5

Supplementary Table 12: Statistical results of two-sided Student's t-tests for all comparisons shown in Figure 2c & Extended Data Figure 5a.

Figure	Fig. 2c	Fig. 2c	Fig. 2c	Fig. 2c	Fig. 2c	Fig. 2c	Fig. 2c	Fig. 2c
Comparison 1	PBS vs PBS + 3%CaLB	PBS + 3%CaLB vs PBS + 3%HiC	PBS vs PBS + 3%HiC	PBSA vs PBSA + 3%CaLB	PBSA + 3%CaLB vs PBSA + 3%HiC	PBSA vs PBSA + 3%HiC	PCL vs PCL + 3%CaLB	PCL + 3%CaLB vs PCL + 3%HiC
Comparison 2	Mass loss	Mass loss	Mass loss	Mass loss	Mass loss	Mass loss	Mass loss	Mass loss
t value	-4.03682	-31.65146	29.89254	21.26237	Zero variance	Zero variance	34.58121	Zero variance
Degrees of freedom (df)	8	9	7	8	Zero variance	Zero variance	8	Zero variance
P value	0.00375	1.5397E-10	1.20862E-8	2.51708E-8	Zero variance	Zero variance	5.34652E-10	Zero variance
n (group 1)	4	6	4	4	6	4	4	6
n (group 2)	6	5	5	6	5	5	6	5

Figure	Fig. 2c	Fig. 2c	Fig. 2c	Fig. 2c	Fig. 2c	Fig. 2c	Fig. 2c	Fig. 2c
Comparison 1	PCL vs PCL + 3%HiC	PBAT vs PBAT + 3%HiC	PBS vs PBS + 3%CaLB	PBS + 3%CaLB vs PBS + 3%HiC	PBS vs PBS + 3%HiC	PBSA vs PBSA + 3%CaLB	PBSA + 3%CaLB vs PBSA + 3%HiC	PBSA vs PBSA + 3%HiC
Comparison 2	Mass loss	Mass loss	Degradation rate	Degradation rate	Degradation rate	Degradation rate	Degradation rate	Degradation rate
t value	Zero variance	15.26067	3.88603	17.00471	13.86635	7.16885	9.14762	9.64592
Degrees of freedom (df)	Zero variance	7	8	9	7	8	9	7
P value	Zero variance	1.24949E-6	0.00464	3.77817E-8	2.39722E-6	9.53129E-5	7.47265E-6	2.71199E-5
n (group 1)	4	4	4	6	4	4	6	4
n (group 2)	5	5	6	5	5	6	5	5

Figure	Fig. 2c	Fig. 2c	Fig. 2c	Fig. 2c
Comparison 1	PCL vs PCL + 3%CaLB	PCL + 3%CaLB vs PCL + 3%HiC	PCL vs PCL + 3%HiC	PBAT vs PBAT + 3%HiC
Comparison 2	Degradation rate	Degradation rate	Degradation rate	Degradation rate
t value	8.72224	7.13016	8.86537	7.06131
Degrees of freedom (df)	8	9	7	7
P value	2.33204E-5	5.48349E-5	4.70457E-5	2.00375E-4
n (group 1)	4	6	4	4
n (group 2)	6	5	5	5

Supplementary Table 13: Statistical results of two-sided Student's t-tests for all comparisons shown in Figure 3a & 3b and Figure 4a.

Figure	Fig. 3a	Fig. 3a	Fig. 3a	Fig. 3a	Fig. 4a	Fig. 4a	Fig. 4a	Fig. 4a
Comparison 1	PBS vs PBS + 3%HiC	PBSA vs PBSA + 3%HiC	PCL vs PCL + 3%HiC	PBAT vs PBAT + 3%HiC	PBS vs PBS + 3%HiC	PBSA vs PBSA + 3%HiC	PCL vs PCL + 3%HiC	PBAT vs PBAT + 3%HiC
Comparison 2	-	-	-	-	-	-	-	-
t value	72.33855	Zero variance	Zero variance	6.93107	2.47965	Zero variance	9.35878	14.65748
Degrees of freedom (df)	6	Zero variance	Zero variance	6	7	Zero variance	7	7
P value	4.69655E-10	Zero variance	Zero variance	4.46819E-4	0.04223	Zero variance	3.30578E-5	1.64446E-6
n (group 1)	4	4	4	4	4	4	4	4
n (group 2)	4	4	4	4	5	5	5	5

Figure	Fig. 3b	Fig. 3b	Fig. 3b	Fig. 3b	Fig. 3b	Fig. 3b	Fig. 3b	Fig. 3b
Comparison 1	PBS vs PBS + 0.1%HiC	PBSA vs PBSA + 0.1%HiC	PCL vs PCL + 0.1%HiC	PBAT vs PBAT + 0.5%HiC	PBS vs PBS + 3%HiC	PBSA vs PBSA + 3%HiC	PCL vs PCL + 3%HiC	PBAT vs PBAT + 3%HiC
Comparison 2	Tensile strength	Tensile strength	Tensile strength	Tensile strength	Tensile strength	Tensile strength	Tensile strength	Tensile strength
t value	0.54364	1.88754	1.20933	12.43871	14.87321	17.62348	6.87952	36.91255
Degrees of freedom (df)	8	8	8	8	8	8	8	8
P value	0.60162	0.09574	0.26084	0.00001	0.00001	0.00001	0.00017	0.00001
n (group 1)	5	5	5	5	5	5	5	5
n (group 2)	5	5	5	5	5	5	5	5

Supplementary Table 14: Statistical results of two-sided Student's t-tests for comparisons of degradation rate shown in Extended Data Figure 4a.

Figure	Extended Fig. 4a	Extended Fig. 4a	Extended Fig. 4a	Extended Fig. 4a	Extended Fig. 4a	Extended Fig. 4a	Extended Fig. 4a	Extended Fig. 4a
Comparison 1	PBS vs PBS + CaLB	PBSA vs PBSA + CaLB	PBS vs PBS + CaLB	PBS vs PBS + CaLB	PBSA vs PBSA + CaLB	PBSA vs PBSA + CaLB	PBSA vs PBSA + CaLB	PBSA vs PBSA + CaLB
Comparison 2	PJM(speed)	BMS(speed)	BMJ(speed)	AKR(speed)	PJM(speed)	BMS(speed)	BMJ(speed)	AKR(speed)
t value	0.39952	2.29975	1.48029	11.37492	7.64816	2.99054	2.87744	9.83445
Degrees of freedom (df)	7	7	7	7	7	7	7	7
P value	0.70142	0.05501	0.18234	9.09727E-6	1.21332E-4	0.02021	0.02374	2.38806E-5
n (group 1)	4	4	4	4	4	4	4	4
n (group 2)	5	5	5	5	5	5	5	5

Supplementary Table 15: Statistical results of two-sided Student's t-tests for all comparisons shown in Extended Data Figure 4c.

Figure	Extended Fig. 4c	Extended Fig. 4c	Extended Fig. 4c	Extended Fig. 4c	Extended Fig. 4c	Extended Fig. 4c	Extended Fig. 4c	Extended Fig. 4c
Comparison 1	PBS vs PBS	PBS + 3%CaLB vs PBS + 3%CaLB	PBS vs PBS + 3%CaLB	PBS vs PBS + 3%CaLB	PBSA vs PBSA	PBSA + 3%CaLB vs PBSA + 3%CaLB	PBSA vs PBSA + 3%CaLB	PBSA vs PBSA + 3%CaLB
Comparison 2	Mass loss	Mass loss	Mass loss	Mass loss	Mass loss	Mass loss	Mass loss	Mass loss
t value	1.78195	1.9192	0.84743	2.29975	2.39851	0.8897	30.47101	3.36009
Degrees of freedom (df)	6	8	7	7	6	8	7	7
P value	0.12504	0.09123	0.42478	0.05501	0.0534	0.39959	1.05783E-8	0.01208
n (group 1)	4	5	4	4	4	5	4	4
n (group 2)	4	5	5	5	4	5	5	5

Figure	Extended Fig. 4c	Extended Fig. 4c	Extended Fig. 4c	Extended Fig. 4c	Extended Fig. 4c	Extended Fig. 4c
Comparison 1	PCL vs PCL	PCL + 3%CaLB vs PCL + 3%CaLB	PCL vs PCL + 3%CaLB	PCL vs PCL + 3%CaLB	PBAT vs PBAT	P3HB vs P3HB
Comparison 2	Mass loss	Mass loss	Mass loss	Mass loss	Mass loss	Mass loss
t value	2.43134	38.85127	23.52139	54.00499	2.84983	9.15265
Degrees of freedom (df)	6	8	7	7	6	6
P value	0.05107	2.11696E-10	6.37593E-8	1.95659E-10	0.02919	9.57397E-5
n (group 1)	4	5	4	4	4	4
n (group 2)	4	5	5	5	4	4

Supplementary Table 16: Statistical results of two-sided Student's t-tests for all comparisons shown in Extended Data Figure 4e.

Figure	Extended Fig. 4e	Extended Fig. 4e	Extended Fig. 4e	Extended Fig. 4e	Extended Fig. 4e	Extended Fig. 4e	Extended Fig. 4e	Extended Fig. 4e	Extended Fig. 4e
Comparison 1	PBS vs PBS + 0.1%CaLB	PBS + 0.1%CaLB vs PBS + 3%CaLB	PBS vs PBS + 3%CaLB	PBSA vs PBSA + 0.1%CaLB	PBSA + 0.1%CaLB vs PBSA + 3%CaLB	PBSA vs PBSA + 3%CaLB	PCL vs PCL + 0.1%CaLB	PCL + 0.1%CaLB vs PCL + 3%CaLB	PCL vs PCL + 3%CaLB
Comparison 2	Mass loss	Mass loss	Mass loss	Mass loss	Mass loss	Mass loss	Mass loss	Mass loss	Mass loss
t value	5.43057	-9.47042	0.84743	5.57053	-34.82068	-30.47101	-8.22542	-8.43323	-23.52139
Degrees of freedom (df)	6	7	7	7	8	7	7	8	7
P value	0.00162	3.05895E-5	0.42478	8.41553E-4	5.06101E-10	1.05783E-8	7.62976E-5	2.98165E-5	6.37593E-8
n (group 1)	4	4	4	4	5	4	4	5	4
n (group 2)	4	5	5	5	5	5	5	5	5

Supplementary Table 17: Statistical results of two-sided Student's t-tests for all comparisons shown in Extended Data Figure 4d.

Figure	Extended Fig. 4d	Extended Fig. 4d	Extended Fig. 4d	Extended Fig. 4d	Extended Fig. 4d	Extended Fig. 4d	Extended Fig. 4d	Extended Fig. 4d
Comparison 1	PBS vs PBS	PBS + 3%HiC vs PBS + 3%HiC	PBS vs PBS + 3%HiC	PBS vs PBS + 3%HiC	PBSA vs PBSA	PBSA + 3%HiC vs PBSA + 3%HiC	PBSA vs PBSA + 3%HiC	PBSA vs PBSA + 3%HiC
Comparison 2	Mass loss	Mass loss	Mass loss	Mass loss	Mass loss	Mass loss	Mass loss	Mass loss
t value	2.02335	0.1264	29.89254	25.64892	1.9411	Zero variance	Zero variance	Zero variance
Degrees of freedom (df)	7	8	7	8	7	Zero variance	Zero variance	Zero variance
P value	0.08272	0.90254	1.20862E-8	5.72487E-9	0.09338	Zero variance	Zero variance	Zero variance
n (group 1)	4	5	4	5	4	5	4	5
n (group 2)	5	5	5	5	5	5	5	5

Figure	Extended Fig. 4d	Extended Fig. 4d	Extended Fig. 4d	Extended Fig. 4d	Extended Fig. 4d	Extended Fig. 4d	Extended Fig. 4d	Extended Fig. 4d
Comparison 1	PCL vs PCL	PCL + 3%HiC vs PCL + 3%HiC	PCL vs PCL + 3%HiC	PCL vs PCL + 3%HiC	PBAT vs PBAT	PBAT + 3%HiC vs PBAT + 3%HiC	PBAT vs PBAT + 3%HiC	PBAT vs PBAT + 3%HiC
Comparison 2	Mass loss	Mass loss	Mass loss	Mass loss	Mass loss	Mass loss	Mass loss	Mass loss
t value	1.05335	Zero variance	Zero variance	Zero variance	4.45944	8.01392	15.26067	17.65279
Degrees of freedom (df)	7	Zero variance	Zero variance	Zero variance	7	8	7	8
P value	0.32718	Zero variance	Zero variance	Zero variance	0.00294	4.31251E-5	1.24949E-6	1.0841E-7
n (group 1)	4	5	4	5	4	5	4	5
n (group 2)	5	5	5	5	5	5	5	5

Figure	Extended Fig. 4d
Comparison 1	P3HB vs P3HB
Comparison 2	Mass loss
t value	2.98252
Degrees of freedom (df)	7
P value	0.02044
n (group 1)	4
n (group 2)	5

Supplementary Table 18: Statistical results of two-sided Student's t-tests for all comparisons shown in Extended Data Figure 6a.

Figure	Extended Fig. 6a	Extended Fig. 6a	Extended Fig. 6a	Extended Fig. 6a	Extended Fig. 6a	Extended Fig. 6a	Extended Fig. 6a	Extended Fig. 6a
Comparison 1	PBS vs PBS + 0.1%CaLB	PBS + 0.1%CaLB vs PBS + 0.1%HiC	PBS vs PBS + 0.1%HiC	PBSA vs PBSA + 0.1%CaLB	PBSA + 0.1%CaLB vs PBSA + 0.1%HiC	PBSA vs PBSA + 0.1%HiC	PCL vs PCL + 0.1%CaLB	PCL + 0.1%CaLB vs PCL + 0.1%HiC
Comparison 2	Mass loss	Mass loss	Mass loss	Mass loss	Mass loss	Mass loss	Mass loss	Mass loss
t value	-4.98938	-2.76143	-2.47965	-11.22645	Zero variance	Zero variance	-6.14783	-4.54139
Degrees of freedom (df)	7	8	7	7	Zero variance	Zero variance	7	8
P value	0.00158	0.02462	0.04223	9.93123E-6	Zero variance	Zero variance	9.93123E-6	0.0019
n (group 1)	4	5	4	4	5	4	4	5
n (group 2)	5	5	5	5	5	5	5	5

Figure	Extended Fig. 6a	Extended Fig. 6a	Extended Fig. 6a	Extended Fig. 6a	Extended Fig. 6a	Extended Fig. 6a	Extended Fig. 6a	Extended Fig. 6a
Comparison 1	PCL vs PCL + 0.1%HiC	PBAT vs PBAT + 0.5%HiC	PBS vs PBS + 0.1%CaLB	PBS + 0.1%CaLB vs PBS + 0.1%HiC	PBS vs PBS + 0.1%HiC	PBSA vs PBSA + 0.1%CaLB	PBSA + 0.1%CaLB vs PBSA + 0.1%HiC	PBSA vs PBSA + 0.1%HiC
Comparison 2	Mass loss	Mass loss	Degradation rate	Degradation rate	Degradation rate	Degradation rate	Degradation rate	Degradation rate
t value	-9.35878	-14.65748	0.39952	-2.92888	-2.56964	-7.64816	-5.06188	-12.10289
Degrees of freedom (df)	7	7	7	8	7	7	8	7
P value	3.30578E-5	1.64446E-6	0.70142	0.01903	0.03703	1.21332E-4	9.74777E-4	6.00413E-6
n (group 1)	4	4	4	5	4	4	5	4
n (group 2)	5	5	5	5	5	5	5	5

Figure	Extended Fig. 6a	Extended Fig. 6a	Extended Fig. 6a	Extended Fig. 6a
Comparison 1	PCL vs PCL + 0.1%CaLB	PCL + 0.1%CaLB vs PCL + 0.1%HiC	PCL vs PCL + 0.1%HiC	PBAT vs PBAT + 0.5%HiC
Comparison 2	Degradation rate	Degradation rate	Degradation rate	Degradation rate
t value	-13.05347	-1.41282	-12.25745	-12.01752
Degrees of freedom (df)	7	8	7	7
P value	3.60806E-6	0.19541	5.51339E-6	6.29636E-6
n (group 1)	4	5	4	4
n (group 2)	5	5	5	5