

Supplementary File 1-1: Single-enzyme systems toward PET plastic biodegradation (associated with Supplementary Table 1)

Degradation system	Substrate	Brand of substrate	Crystallinity of substrate	Reaction condition	MW (kDa)	Substrates (mg PET)	Total Enzyme (μg)	Enzyme (nM)	Total enzyme (nmol)	Concentration of total products (mM)	System volume (mL)	Total products (umol)	Degradation efficiency (mol total products/mmol enzyme)	Data source	Reference
IsPETase	PET film	N/A	2%	30°C, 18h, pH 7.0	29	N/A		50	0.015	0.3	0.3	0.09	6.00	Figure 2d	Yoshida et al., 2016
THH	PET film			30°C, 18h, pH 7.0	29	N/A		50	0.015	0.00079	0.3	0.000237	0.02		
LCC	PET film			30°C, 18h, pH 7.0	29	N/A		50	0.015	0.0063	0.3	0.00189	0.13		
FsC	PET film			30°C, 18h, pH 7.0	24	N/A		50	0.015	0.00075	0.3	0.000225	0.02		
LCC	Post-consumer coloured-flake PET waste	N/A	29%	72°C, 20 h, pH 8.0	29	16000		8625	690	552.09	80	44167.2	64.01	Figure 4a	Toumier et al., 2020
ICCG (LCC ^{F243UD238C/S283C/V127G})				72°C, 15 h, pH 8.0	29	16000		8625	690	854.17	80	68333.6	99.03		
WCCG (LCC ^{F243WD238C/S283C/V127G})				72°C, 20 h, pH 8.0	29	16000		8625	690	885.42	80	70833.6	102.66		
DuraPETase (IsPETase ^{S214H/I168R/W159H/S188Q/R280A/A180U/G165A/Q119V/L117E/T140D})	PET film	Artificially prepared	30%	50°C, 72 h, pH 9.0	29	1.00	5.00	347.67	0.17	2.63	0.50	1.32	7.56	Figure 3a, and Figure S8	Cui et al., 2021
LCC	PET film			37°C, 72 h, pH 9.0	29	1.00	5.00	347.67	0.17	1.76	0.50	0.88	5.06		
LCC	PET film			37°C, 72 h, pH 9.0	29	1.00	5.00	346.75	0.17	1.04	0.50	0.52	3.00		
TS-PETase (IsPETase^{S121E/D186H/R280A})	PET film	Goodfellow, ES301445	N/A (low-crystallinity, 250 μm in thickness, 18% approximately)	30°C, 6 days, pH 9.0	29	N/A		400.00	0.40	0.05	1.00	0.05	0.13	Figure S8	Zhong-Johnson et al., 2021
Thermobifida fusca cutinase (H184S/Q92G/F209I/I213K)	PET bottle	N/A	N/A (high-crystallinity)	60°C, 96 h, pH 8.0	34	1000.00	50000.00	N/A	1461.18	N/A	N/A	3542.00	2.42	Figure 10	Chen et al., 2022
LCC (H184S/Q92G/F209I/I213K)	PET bottle			60°C, 96 h, pH 8.0	29	1000.00	50000.00	N/A	1742.22	N/A	N/A	1354.00	0.78		
BhrPETase (H184S/Q92G/F209I/I213K)	PET bottle			60°C, 96 h, pH 8.0	29	1000.00	50000.00	N/A	1724.14	N/A	N/A	3802.00	2.21		
HotPETase	PET powder	Goodfellow	30%	60°C, 5 h, pH 9.2	28	20.00	5.80	500.00	0.21	6.07	5.00	30.35	146.52	Extended Data Figure 6	Bell et al., 2022
DuraPETase-4M (DuraPETase ^{N233C/S282C/H214S/S245R})	PET powder	Kexinda Technology Co. Ltd., China	N/A (high-crystallinity)	60°C, 96 h, pH 9.0	29	25.38	87.50	347.38	3.04	15.80	8.75	138.25	45.48	Figure 4d	Liu et al., 2022
DuraPETase	PET powder			60°C, 96 h, pH 9.0	29	25.38	87.50	347.67	3.04	5.70	8.75	49.88	16.39		
FAST-PETase (IsPETase ^{S121E/D186H/R224Q/N233K/R280A})	PET film	Goodfellow, US, 577-529-50	N/A (high-crystallinity, 40-70% approximately)	50°C, 96 h, pH 8.0	31	11.40		200.00	0.12	33.80	0.60	20.28	169.00	Figure 1c, and Figure S2b	Lu et al., 2022
ICCM (LCC^{F243UD238C/S283C/N246M})	PET film			40°C, 96 h, pH 8.0	29	11.40		200.00	0.12	14.75	0.60	8.85	73.75		
	PET film			50°C, 96 h, pH 8.0		11.40		200.00		29.50	0.60	17.70	147.50		
DSI- Tfcutinase^{D284C/E253C}	PET particle	Goodfellow, Germany	8%	70°C, 96 h, pH 8.0	33	200.00		7000.00	14.00	300.00	2.00	600.00	42.86	Figure 4	Z. Liu et al., 2022
IsPETase-Spy (Cyclic monomer)	PET powder	Goodfellow	N/A (Semi-crystalline)	30°C, 24 h, pH 7.5	43	N/A		100.00	0.10	0.40	1.00	0.40	4.03	Figure 7	Hayes & Luk, 2023
IsPETase-Dimer (Cyclic dimer)	PET powder			30°C, 24 h, pH 7.5	55	N/A		50.00	0.05	0.46	1.00	0.46	9.16		
IsPETase-Cat (Catenane)	PET powder			30°C, 24 h, pH 7.5	50	N/A		50.00	0.05	0.50	1.00	0.50	9.95		
IsPETase	PET powder			30°C, 24 h, pH 7.5	33	N/A		100.00	0.10	0.40	1.00	0.40	3.95		
TurboPETase	PET film	Goodfellow, ES301445	7% (250 μm in thickness)	65°C, 12 h, pH 8.0	28	15.00	4.50	324.16	0.16	130.00	0.50	65.00	401.04	Figure S7	Cui et al., 2024
BhrPETase	PET film			65°C, 12 h, pH 8.0	28	15.00	4.50	323.68	0.16	6.00	0.50	3.00	18.54		
LCC^{ICCG}	PET film			65°C, 12 h, pH 8.0	28	15.00	4.50	325.64	0.16	34.00	0.50	17.00	104.41		
FAST-PETase	PET film			65°C, 12 h, pH 8.0	31	15.00	4.50	290.32	0.15	2.00	0.50	1.00	6.89		

Green: the information got from corresponding paper.

Black: caculated results basing on the green words.

Information of materials and reaction systems is presented at "Methods" part of corresponding papers.

N/A: information not available from the corresponding publication.

Supplementary File 1-2: Multi-enzyme systems toward PET plastic biodegradation (associated with Table 1)

Degradation system	Substrate	Brand of substrate	Crystallinity of substrate	Reaction condition	ratio of enzymes	MW (kDa)	Weight of substrate (mg)	Total Enzymes (µg)	Enzyme (nM)	Total enzymes (nmol)	Concentration of total products (mM)	System volume (mL)	Total products (umol)	Improved fold (comparing to single enzyme)	Degradation efficiency (mol total products/mmol enzyme)	Efficiency fold-change (SPEED vs. other systems)	Data source	Reference
TfCa (immobilized) +LCC	PET film	Goodfellow, Germany, 029-198-54	N/A (low-crystallinity, 250 µm in thickness, 18% approximately)	60°C, 24 h, pH 9	3:1	55 of TfCa	6500.00	1600.00	541.96	35.55	10.42	40.00	416.80	2.4 (to TfCut2 with TfCa)	11.72	4.71	Figure 3b.	Barth et al., 2016
						29 of LCC					6.71 (TPA)		268.40		7.55	12.96		
HiC+CALB	PET bottle	Crystal	37% (0.1 mm in thickness)	60°C, 14 days, pH 7	9:1	32 of HiC	200.00	8000.00	49848.48	249.24	2.25	5.00	11.24	2.3 (to HiC)	0.045	133.79	Figure 3	Carniel et al., 2017
HiC+CALB	PET bottle	Crystal	37% (0.1 mm in thickness)	60°C, 14 days, pH 7	1:1	33 of CALB	200.00	4000.00	6060.61	123.11	0.73	10.00	7.28	2.2 (to HiC)	0.06	101.98	Figure 3	de Castro et al., 2017
PETase+MHETase	PET film	Goodfellow, UK	2%-3%	30°C, 96 h, pH 7.5	2:1	30 of PETase 62 of MHETase	5.00	15.00	827.20	0.41	2.87	0.50	1.44	2.17 (to PETase)	3.47	28.60	Table S4	Knott et al., 2020
cPETase	PET film			30°C, 96 h pH 7.0		30	N/A	300.00	N/A	10.00	0.01	N/A	N/A		N/A (0.643 M/mmolenzyme)			
cCALB	PET film	Artificially prepared	27%	30°C, 96 h pH 7.0		33	N/A	330.00	N/A	10.00	0.01	N/A	N/A		N/A (1.12 M/mmolenzyme)		Figure 4b, and Figure 6a	Hwang et al., 2022
PC enzyme complex (cPETase+cCALB+scaffold)	PET film			30°C, 96 h pH 7.0	1:1:1	63 of cPETase with CALB	N/A	1260.00	500.00	20.00	0.09	40.00	3.55	13.8-fold (to cPETase)	0.18	12.14		
	Waste		34%	30°C, 96 h pH 7.0	1:1:1		N/A	1260.00	500.00	20.00	0.04	40.00	1.60	7.9-fold (to cPETase)	0.08	26.92		
LCC+TTCE	PET film	Goodfellow, GF25214475	13% (0.25 mm in thickness)	60°C, 96 h, pH 8	1:1	30 of LCC 29 of TTCE	200.00	58.80	4000.00	2.00	17.97	0.50	8.99	1.22 (to LCC)	4.49	22.08	Figure 5b	Mrigwani et al., 2022
IsPETasePM	PET film			45°C, 24 h, pH 7.5		23	60.00		50.00	0.05	0.40	1.00	0.40		8.00	6.91		
TfCaWA (TfCa ^{169W/376A}) +IsPETasePM (IsPETase ^{S121E/D186H/R280A/N233C/S282C})	PET film	Goodfellow, ES30-FM-0001445	N/A (low-crystallinity, 18% approximately)	45°C, 24 h, pH 7.5	11:1	55 of TfCa 23 of IsPETasePM	60.00	31.40	600.00	0.60	1.68	1.00	1.68	4.2 (to IsPETasePM)	2.80	19.73	Figure 4b	von Haugwitz et al., 2022
	PET powder	Xing-xiang new materials, China	40.82% (high-crystallinity)			40 of FAST 38 of ICCG	100.00	36472.50			143.76	0.50	71.88	4.11 (to FAST-PETase)	95.84	-	Figure 6a	
SPEED (FAST+ICCG+MHETase+scaffold)	PET film	Goodfellow, ES30-FM-0001445	17.99% (low-crystallinity)	40°C, 96 h, pH 7.0	1:1:1:2	66 of MHETase	100.00	36472.50			148.82 (total products)	0.50	74.41	3.47 (to FAST-PETase)	99.21	-	Figure 6b	
	PET film	Goodfellow, ES30-FM-000250	43.31% (high-crystallinity)				100.00	36472.50		1500.00	146.75 (TPA)	0.50	73.38	2.89 (to ICCG)	97.83			This study
	PET film	Goodfellow, ES30-FM-0001445	17.99% (low-crystallinity)	40°C, 24 h, pH 7.0			100.00	36472.50			3.23	0.50	1.62	4.01 (to FAST-PETase)	2.15	-	Figure 6c	
	PET film	Goodfellow, ES30-FM-0001445	17.99% (low-crystallinity)	40°C, 24 h, pH 7.0			100.00	36472.50			82.87	0.50	41.44	2.92 (to ICCG)	55.25	-	Figure 6b	
	PET film	Goodfellow, ES30-FM-000250	43.31% (high-crystallinity)	40°C, 14 days, pH 7.0			100.00	36472.50			189.85	0.50	94.93		126.57	-	Figure 6c	
	PET film	Goodfellow, ES30-FM-000250	43.31% (high-crystallinity)				100.00	36472.50			9.05	0.50	4.52		6.03	-	Figure 6c	

Green: the information got from corresponding paper.

Black: calculated results basing on the green words.

Information of materials and reaction systems is presented at "Methods" part of corresponding papers.

Data of improved fold (comparing to single enzyme) was from corresponding papers.