Supplementary Information

Closed-loop utilization of polyester in the textile industry

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Supplementary Information

1. General

1.1 Reagents

Ethylene glycol (EG, analytically pure, $\geq$ 99.5%) was purchased from Shanghai Titan Technology Co., Ltd. Commercial BHET was purchased from Shanghai Adamas Reagent Co., Ltd. Polyester (Mn $\approx 1.6 \times 10^4$ g/mol) fiber was self-made in the laboratory. Anhydrous potassium carbonate (analytically pure) was purchased from Sinopharm Chemical Reagent Co., Ltd. Nuclear magnetic deuterium reagent deuteromethanol (97%, including TMS) was purchased from Shanghai Haohong Biomedical Technology Co., Ltd. Ethylene glycol antimony (antimony content is about 200 ppm) as polycondensation catalyst was purchased from Shanghai McLean Biochemical Technology Co., Ltd. The waste clothes were donated by the Love House of Donghua University.

1.2 Instrument parameters of characterization

1.2.1 NMR of recovered BHET

Nuclear Magnetic Resonance Spectroscopy (NMR) including ^{1}H (600 MHz), ^{13}C{^{1}H } (151 MHz) were recorded at ambient temperature by using Bruker AVANCE Ⅲ, HD 600 MHz spectrometers.

1.2.2 HPLC of recovered BHET

BHET purity test was carried out on American Waters high performance liquid chromatography. The chromatographic column was ACQUITY UPLC BEH C18 column (1. 7 μm, 2.1 mm × 100 mm). The mobile phase was acetonitrile-0.1% H_3PO_4 solution. The detection wavelength was 287nm. The column temperature was 35 ^{o}C. The flow rate was 0.3 mL/min and the injection volume was 3 μL.

1.2.3 The chromaticity analysis on recovered BHET and recycled PET

The chromaticity (L^*, a^*, b^* value) test was carried out on the WSB-2 whiteness meter. The light source was D65. The angle was 10°. The whiteness index was the national standard GB/T17644. The measuring aperture was 4 mm in diameter and the resolution was 0.01.

1.2.4 The GPC of recycled PET and the textile samples

The molecular weight and molecular weight distribution of the polymers were measured on the Agilent PL-GPC50 gel permeation chromatography. The mobile phase was tetrahydrofuran and hexafluoroisopropanol with a flow rate of 1.0 mL/min. The standard sample was polystyrene.

1.2.5 The FT-IR analysis on recycled dyes

Fourier Transform Infrared Spectroscopy (FT-IR) were measured on Thermo Scientific Nicolet iS5.

1.2.6 The determination of decolorization rate

The decolorization rate of a textile was calculated with the following formula,

$$P = \frac{K_0 - K_1}{K_0} * 100\%$$

where P denotes the decolorization rate, K_0 denotes the K/S value of the original sample, and K_1 denotes the K/S value of the fabric after decolorization.

The K/S value was calculated with the Kubelka Munk's law[1],

$$K/S = \frac{[1 - 0.01R]^2}{2[0.01R]}$$

where R denotes the reverse color ratio of the object. R was measured on Shimadzu UV-3600 Ultraviolet-Visible-Near Infrared Spectroscopy by measuring the light reflectance R of the sample in the visible light wavelength range (380~750 nm). The scanning speed was medium. The sampling interval was 0.5 nm. The slit width was 20 nm and the detection unit was external (dual detector).

1.2.7 Computational Details

All the calculations were performed using Gaussian16 software packages. Geometry optimization uses the ωb97xd function with Grimme dispersion corrections D3 in combination with the def2tzvp basis set, which includes the solvation effects of experimentally used SMD solvation model (solvent=ethylene glycol). Vibrational frequency analysis was calculated at the same level of theory to validate each structure as either a minimum or a transition state and to evaluate its zero-point energy and thermal corrections at 298 K. For the transition state, the intrinsic reaction coordinate (IRC) analysis was conducted to ensure that it connects the right reactant and product. The heat of vaporization (ΔH_{vap}) of BHET melt[2], heat of sublimation (ΔH_{sub}) of BHET powder[2] and the enthalpy of transition state of the condensation reaction ($\Delta H_{polym.}$)[3] were calculated using the parameters listed in the literatures.

2. Chemical reactions

2.1 The glycolysis reaction of polyester materials

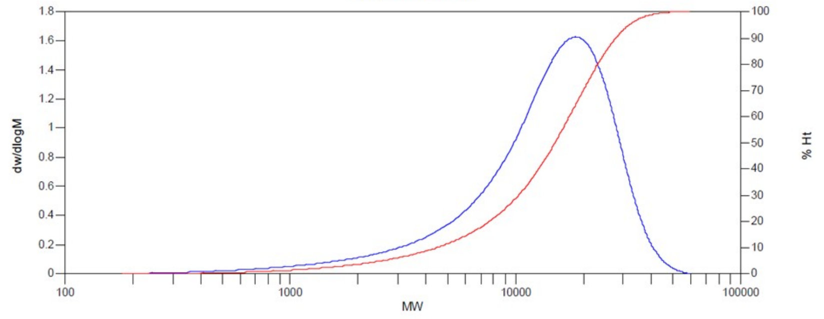
2.1.1 The glycolysis reaction of pure PET and the purification of BHET

The glycolysis reaction was carried out in a 100 mL round-bottom flask, which was connected to a condenser. A mixture of a PET sample (2 g), potassium carbonate (0.04 g, 2 wt%) and ethylene glycol (12 g, a mass ratio of PET to ethylene glycol is 1:6) was heated at 250 °C for 2.5h. After reaction, the solution was let to slowly cool down to room temperature (8~12℃) to afford BHET crystals. The crystals were quickly filtered under reduced pressure. The mother liquor was concentrated under reduced pressure to approximately a half volume, and was heated to 190 °C until a clear solution was obtained. The solution was then let to slowly cool down to room temperature (8~12℃) to allow a second recrystallization. The crystalline BHET obtained was combined with the previous portion. The combined crystals were sublimated under reduced pressure (1.33 kPa) at 135 °C with a glass sublimation setup to afford purified BHET in solid state (2.286 g, 86.4% yield). The product BHET was characterized by ^{1}H NMR, HPLC and chromaticity test.

2.1.2 The decolorization of waste polyester textile

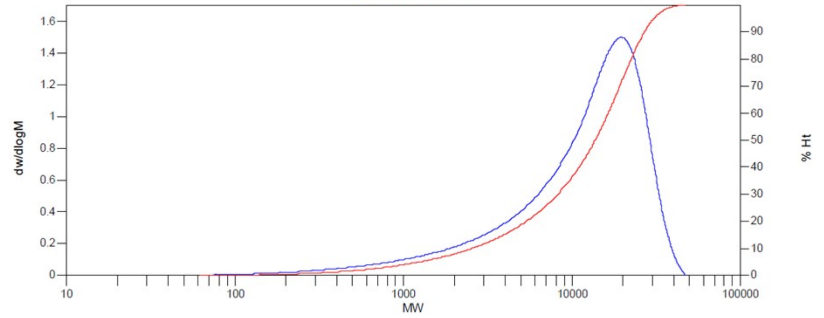
The textile sample was cut into a size of approximately 5×5 cm^2 and then hung above the surface of a boiling steam of ethylene glycol in a 100 mL round-bottom flask, which was connected with a condenser. After the color did not change, the textile sample was taken out from the flask and washed with ethanol to remove ethylene glycol sucked by the textile. The decolorized textile was then subjected a vacuum for 5 min to completely remove ethanol.

Gel permeation chromatography (GPC) analysis was applied to monitor the changes of the PET molecules of the textile during the decolorization process. Fig. S1 shows the GPC results of the polyester textile sample before and after decolorization treatment.



MW Averages

Peak No	Mp	Mn	Mw	Mz	Mz+1	Mv	PD
1	14837	11975	18623	22666	25881	17955	1.55516



MW Averages

Peak No	Mp	Mn	Mw	Mz	Mz+1	Mv	PD
1	15952	8667	17786	22048	24883	17025	2.05215

Fig. S1 The GPC spectra of a polyester textile sample before decolorization (above) and after a decolorization treatment with ethylene glycol steam in 10 min (below).

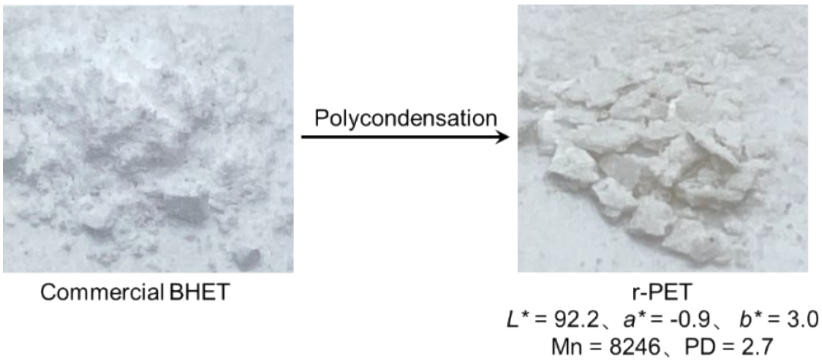
2.1.3 The glycolysis reaction of decolorized textile and the purification of BHET

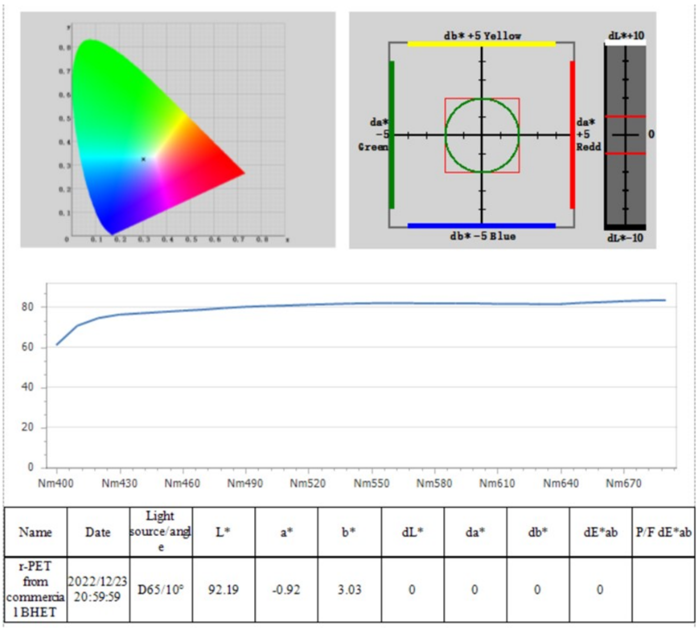
The same procedure for the glycolysis of pure PET and purification of product BHET was used with the decolorized textile sample.

2.2 The polycondensation of BHET to produce recycled PET

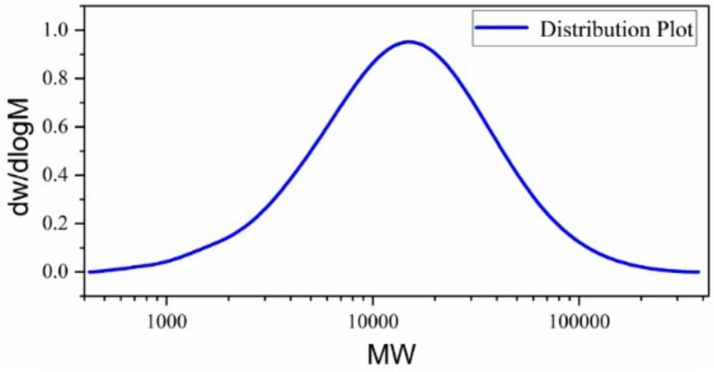
2.2.1 The polycondensation of commercial BHET

A two-stage condensation procedure for the polycondensation of BHET to synthesize recycled PET (r-PET) was employed, including a pre-condensation at 250 ^{o}C for 1h and a final condensation at 280 ^{o}C for 1h. In a 5 mL round-bottom flask that was charged with a stirring bar, BHET (0.7 g) and ethylene glycol antimony (200 ppm) was heated at 250 ^{o}C and 1.33 kPa pressure with stirring for 1h. Then the temperature was slowly raised to 280 ^{o}C in a period of 10 min. The mixture was further heated at 280 ^{o}C and 1.33 kPa pressure with stirring for 1h. After the completion of polycondensation reaction, the flask was slowly cooled to room temperature under a nitrogen atmosphere. The PET obtained was characterized by GPC and chromaticity tests.





Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
r-PET from commercial BHET	2022/12/23 20:59:59	D65/10°	92.19	-0.92	3.03	0	0	0	0	



Mw Averages

Peak No.	Mp	Mn	Mw	Mz	Mz+1	Mv	PD
1	15054	8246	22203	51141	96084	19384	2.69258

Fig. S2 the photograph, chromaticity and GPC results of r-PET derived from commercial BHET.

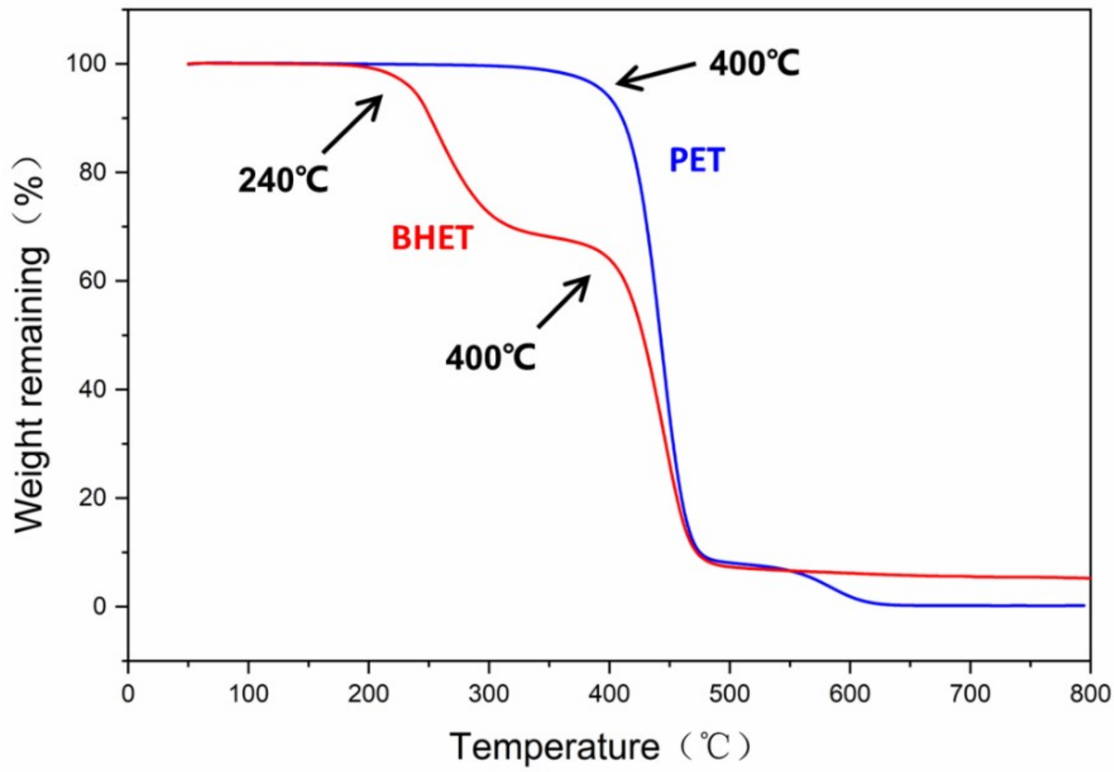
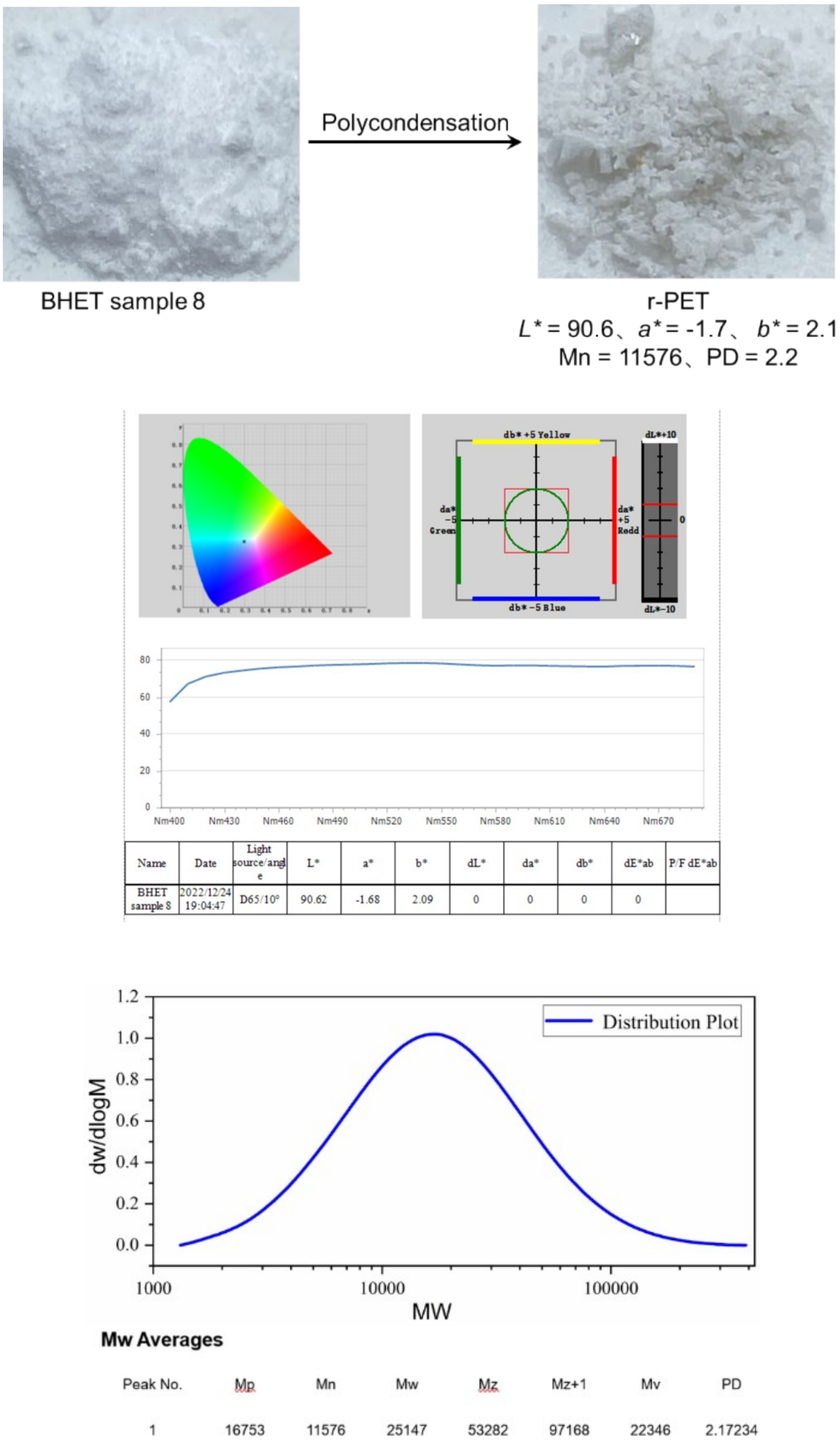


Fig. S3 The thermogravimetric analyses (TGA) spectra of commercial BHET (red) and PET (blue) produced by polycondensation of BHET. TGA8000 (PerkinElmer) was conducted in a nitrogen atmosphere during a temperature range from 50 ^{o}C to 800 ^{o}C at a heating rate of 20 ^{o}C /min.

2.2.2 The polycondensation of recovered BHET from waste polyester textiles

The same procedure for the polycondensation of commercial BHET was used in the polycondensation of recovered BHET from waste polyester textiles.

2.2.2.1 The properties of recycled PET derived from BHET sample 8



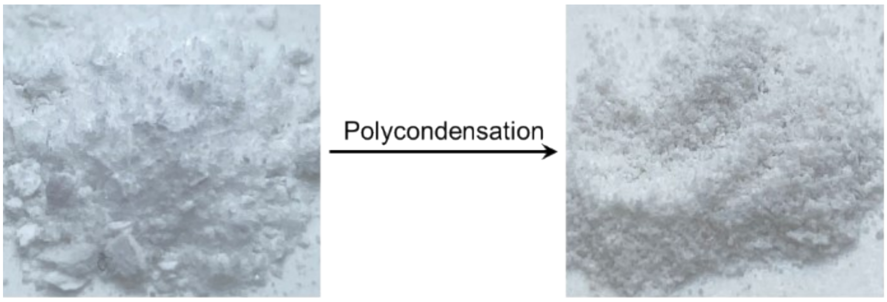
Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
BHET sample 8	2022/12/24 19:04:47	D65/10°	90.62	-1.68	2.09	0	0	0	0	

Mw Averages

Peak No.	Mp	Mn	Mw	Mz	Mz+1	Mv	PD
1	16753	11576	25147	53282	97168	22346	2.17234

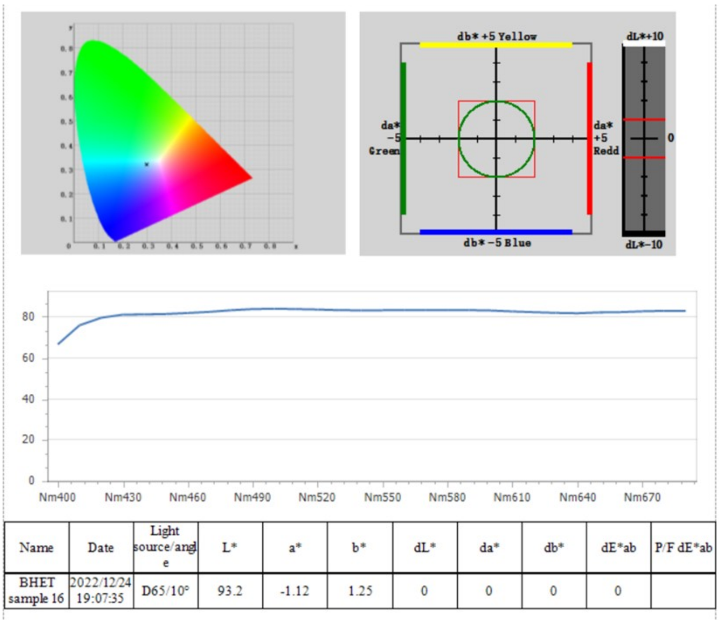
Fig. S4 the photograph, chromaticity and GPC results of r-PET derived from recovered BHET (sample 8).

2.2.2.2 The properties of recycled PET derived from BHET sample 16

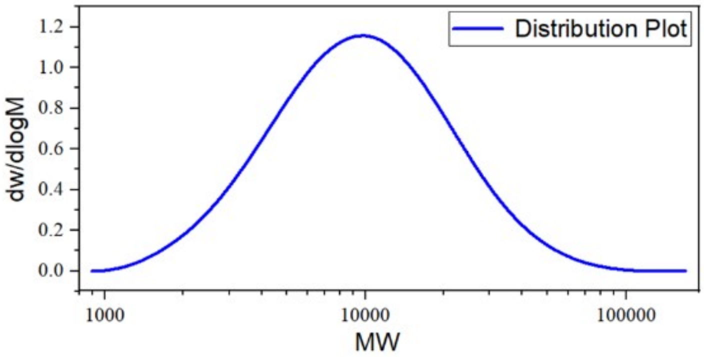


BHET sample 16

r-PET
L^* = 93.2、a^* = -1.1、 b^* = 1.3
Mn = 7117、PD = 1.8



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
BHET sample 16	2022/12/24 19:07:35	D65/10°	93.2	-1.12	1.25	0	0	0	0	

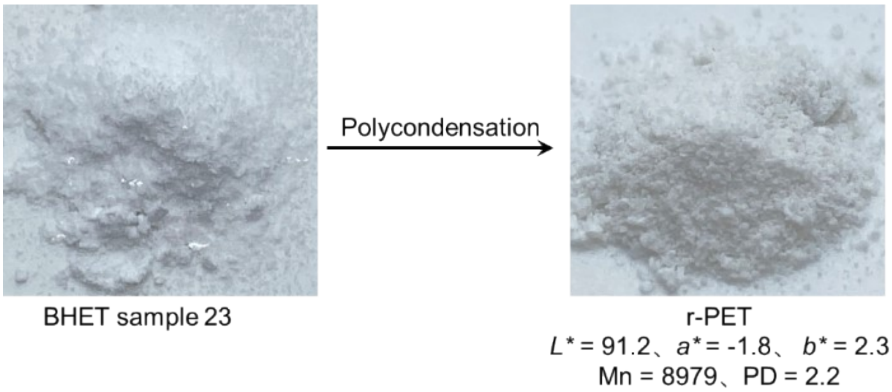


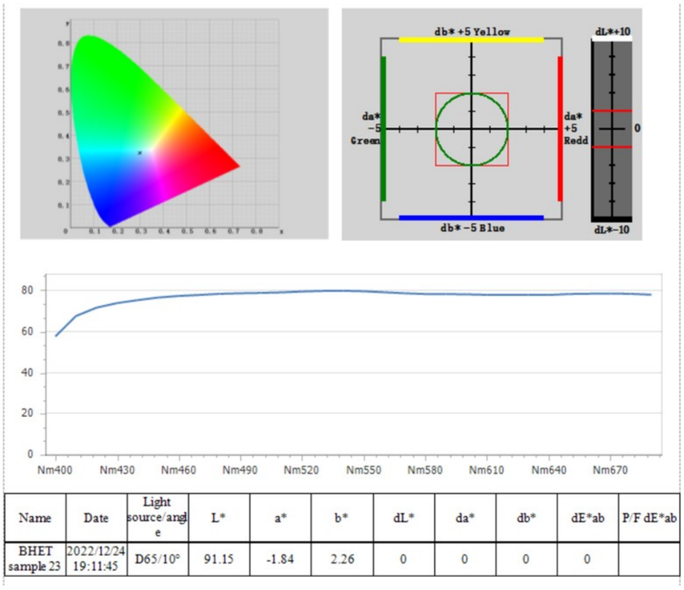
Mw Averages

Peak No.	Mp	Mn	Mw	Mz	Mz+1	Mv	PD
1	9816	7117	12773	22014	34145	11713	1.79472

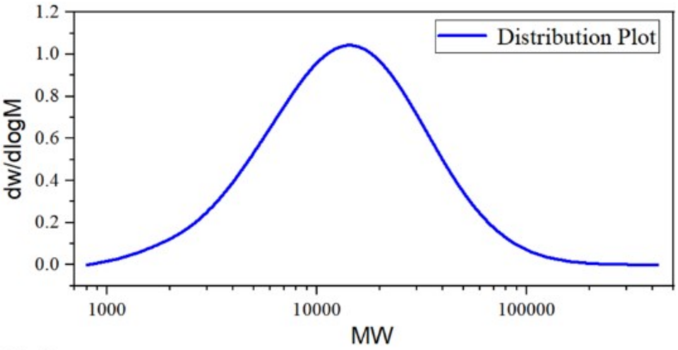
Fig. S5 the photograph, chromaticity and GPC results of r-PET derived from recovered BHET (sample16).

2.2.2.3 The properties of recycled PET derived from BHET sample 23





Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
BHET sample 23	2022/12/24 19:11:45	D65/10°	91.15	-1.84	2.26	0	0	0	0	

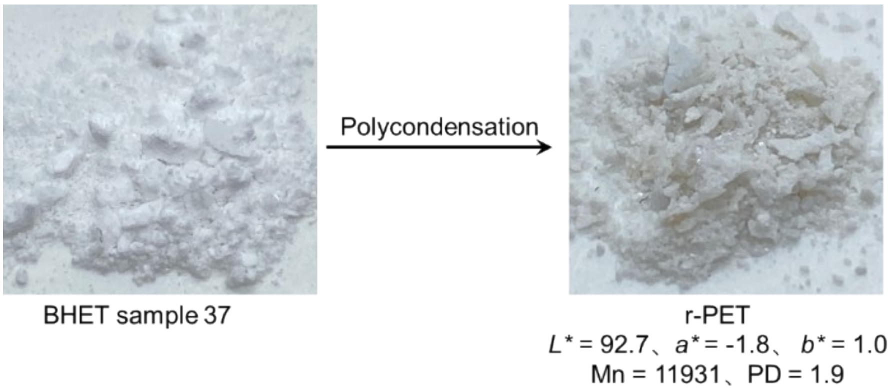


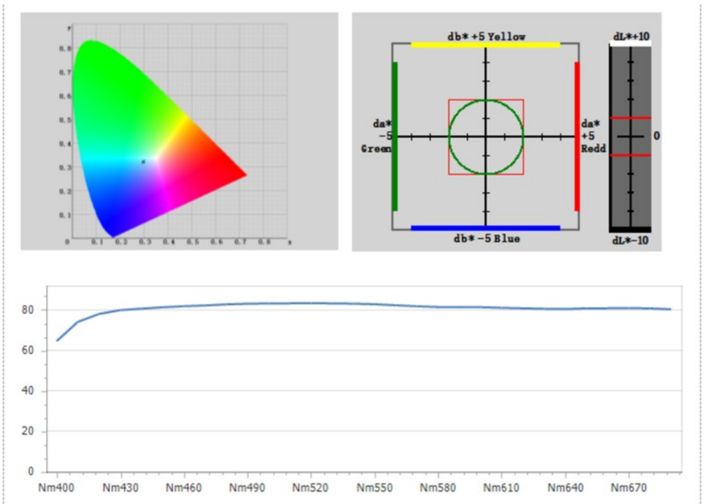
Mw Averages

Peak No.	Mp	Mn	Mw	Mz	Mz+1	Mv	PD
1	14119	8979	19619	40433	77397	17532	2.18499

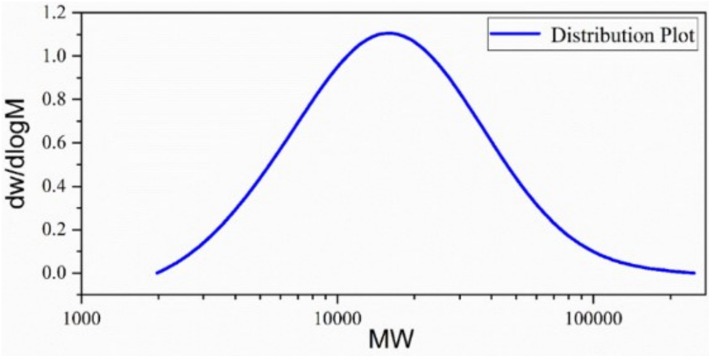
Fig. S6 the photograph, chromaticity and GPC results of r-PET derived from recovered BHET (sample 23).

2.2.2.4 The properties of recycled PET derived from BHET sample 37





Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
BHET sample 37	2022/12/24 19:15:46	D65/10°	92.74	-1.75	0.99	0	0	0	0	

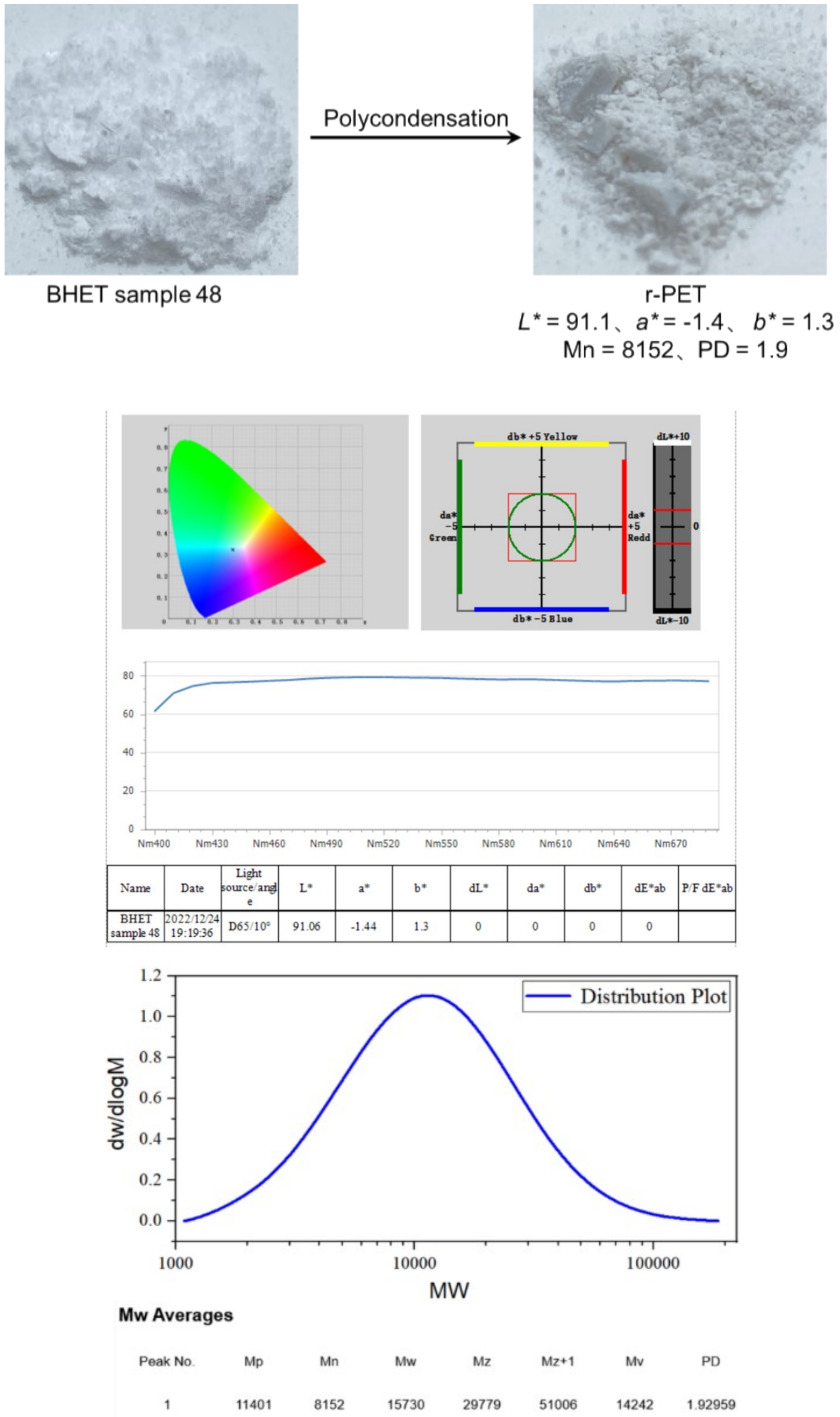


Mw Averages

Peak No.	Mp	Mn	Mw	Mz	Mz+1	Mv	PD
1	16051	11931	22563	42722	72653	20435	1.89112

Fig. S7 the photograph, chromaticity and GPC results of r-PET derived from recovered BHET (sample 37).

2.2.2.5 The properties of recycled PET derived from BHET sample 48



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
BHET sample 48	2022/12/24 19:19:36	D65/10°	91.06	-1.44	1.3	0	0	0	0	

Mw Averages

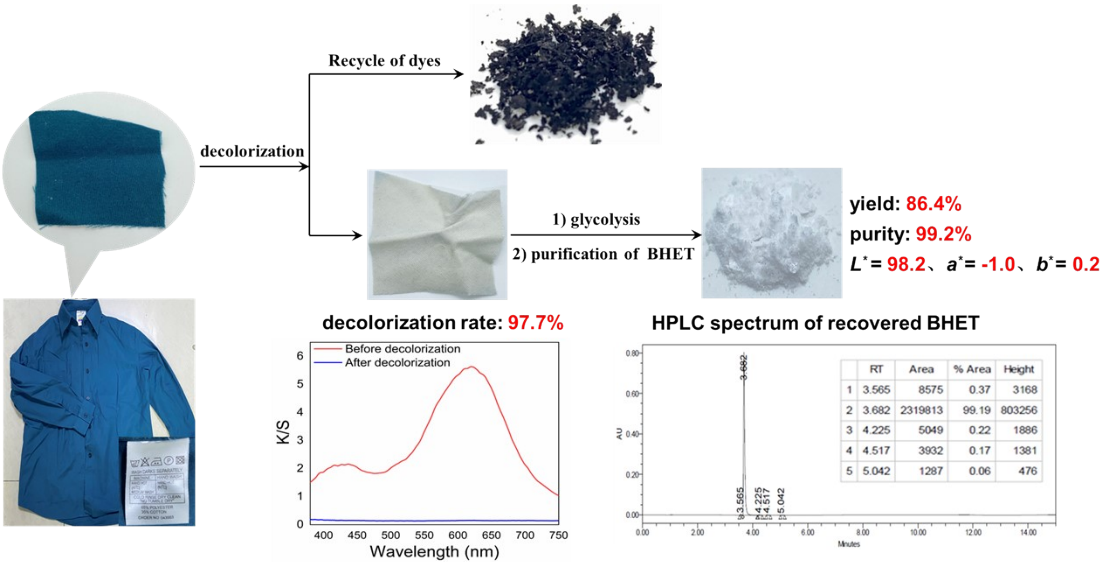
Peak No.	Mp	Mn	Mw	Mz	Mz+1	Mv	PD
1	11401	8152	15730	29779	51006	14242	1.92959

Fig. S8 the photograph, chromaticity and GPC results of r-PET derived from recovered BHET (sample 48).

3. The decolorization of waste polyester textiles, the recycling of dyes and the recovery of BHET

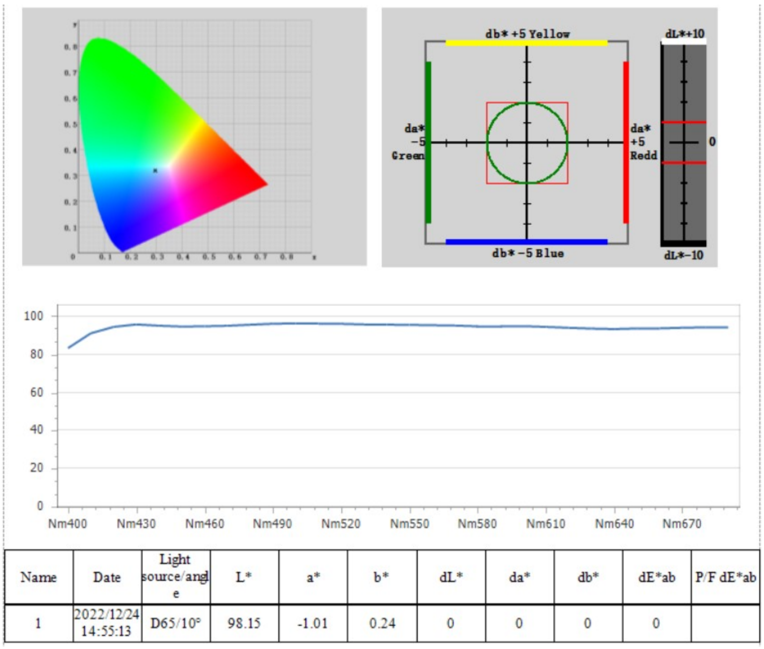
3.1 Sample 1

Composition: 65% Polyester、35% Cotton



	RT	Area	% Area	Height
1	3.565	8575	0.37	3168
2	3.682	2319813	99.19	803256
3	4.225	5049	0.22	1886
4	4.517	3932	0.17	1381
5	5.042	1287	0.06	476

Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
1	2022/12/24 14:55:13	D65/10°	98.15	-1.01	0.24	0	0	0	0	

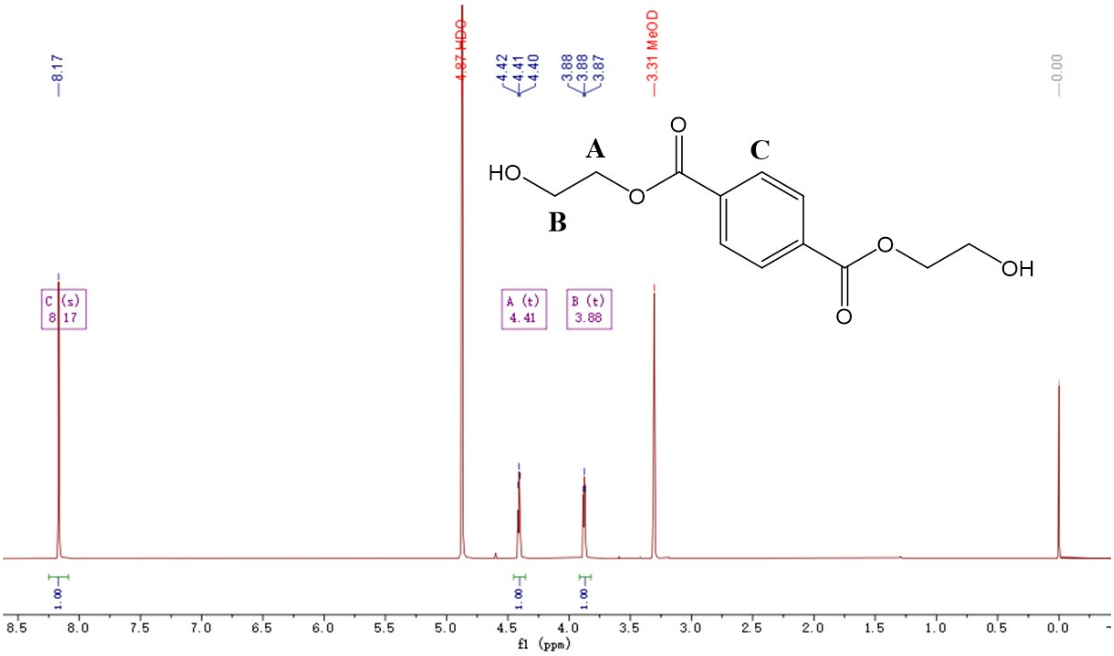


Fig. S9 The ^{1}H NMR (600 MHz, *d4*-methanol) of recovered BHET.

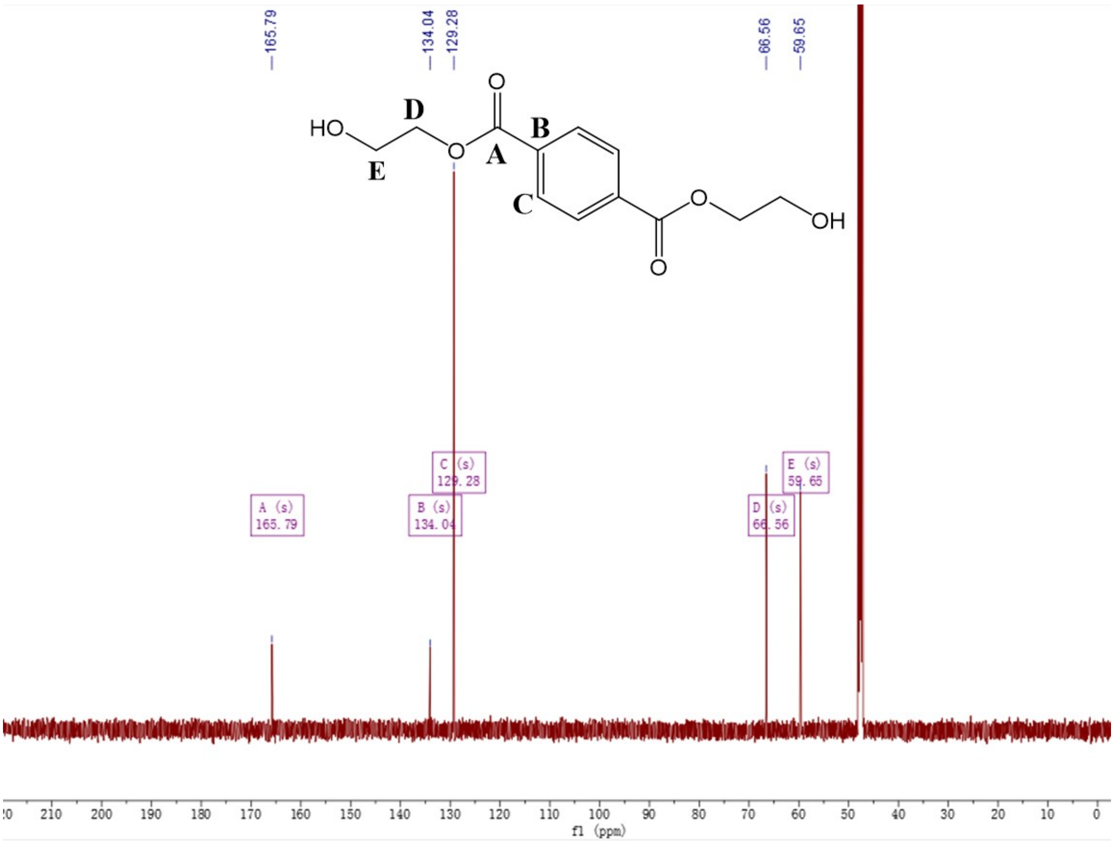


Fig. S10 The ^{13}C NMR (151 MHz, *d4*-methanol) of recovered BHET.

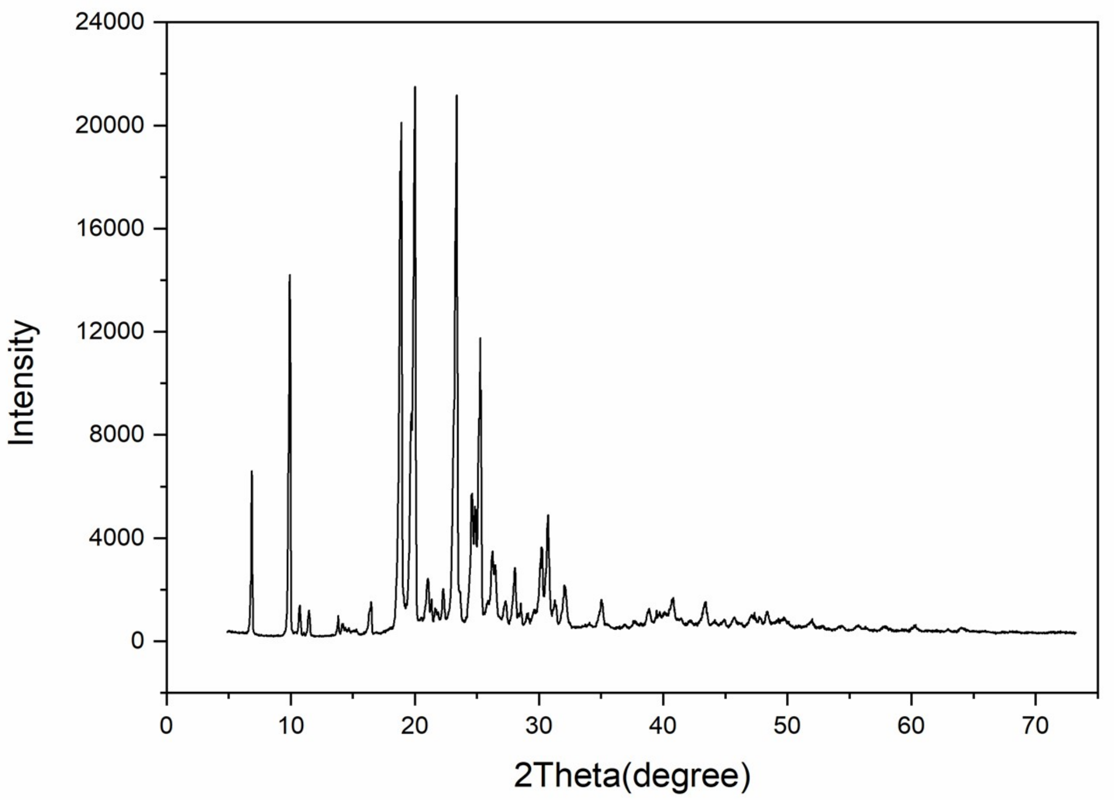


Fig. S11 The X-ray diffraction (XRD) spectrum of recovered BHET. X-ray diffraction (XRD) pattern of BHET was recorded in the range $2\theta = 5\text{-}75°$ using an X-ray Powder diffractometer (Bruker D8 Discover) with Cu Kα radiation ($k = 0.154$ nm). The instrument was operated at 40 kV and 40 mA. The spectra were recorded at a scanning rate of 2° θ/min.

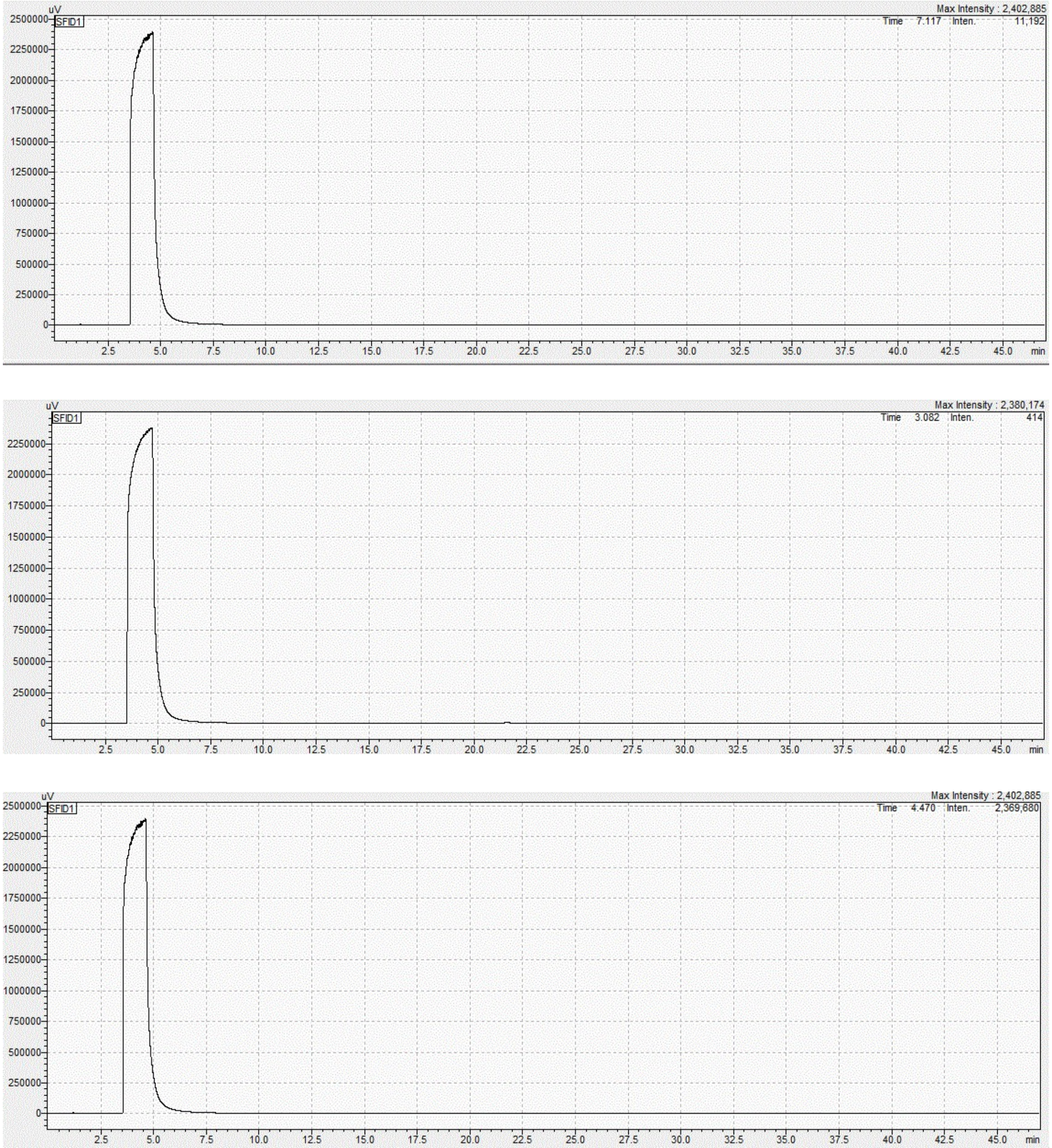


Fig. S12 The gas chromatography (GC) spectra of fresh ethylene glycol, ethylene glycol that was distilled after 6 recycles of glycolysis reaction and ethylene glycol, which was distilled after decolorization of sample 1. The characterization conditions: InertCap CHRAMIX, 30m×0.25mm, df = 2.5μm, nitrogen gas as a mobile phase at a column pressure of 5 psi. The injector and the FID temperatures were 275 ^{o}C. The column oven temperature procedure: 90 ^{o}C for 15min, 5 ^{o}C /min to 150 ^{o}C for 20 minutes.

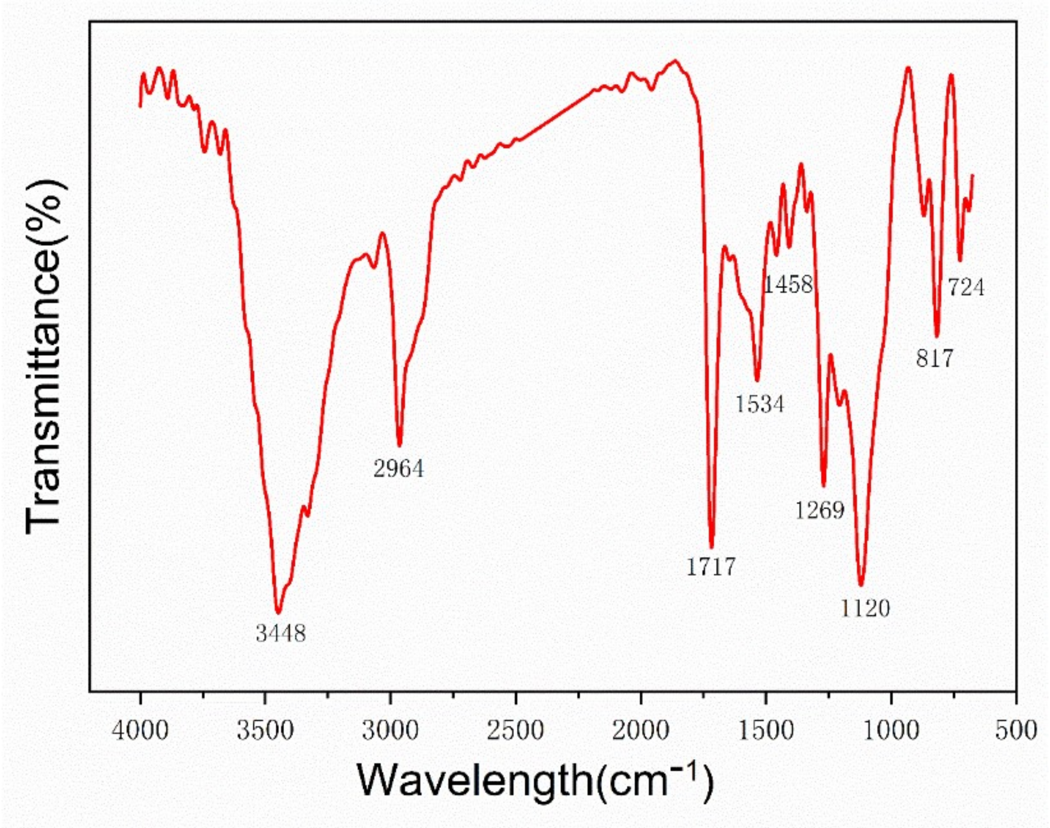
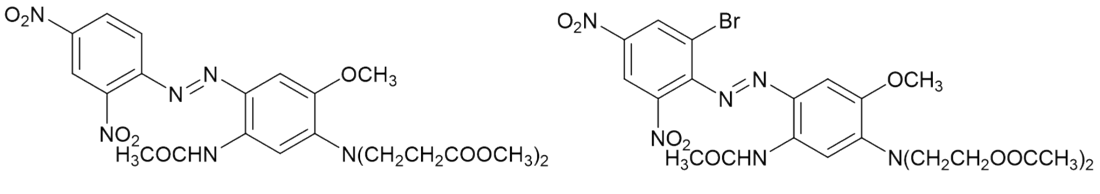


Fig. S13 The Fourier Transform Infrared Spectroscopy (FT-IR) spectra of recovered dye from textile **Sample 1**. The 1717 cm^{-1} peak corresponds to the C=O stretching and the signals at 1269 and 1120 cm^{-1} are the corresponding C-O-C asymmetric and symmetric stretching vibrations. 1534 cm^{-1} was assigned to N=O stretching vibration of the nitro group. The peaks at 724, 817, 1450-1600 cm^{-1} were attributed to substituted aryl groups. The potential molecule structures of this recovered dye were shown in **Fig. S14**.



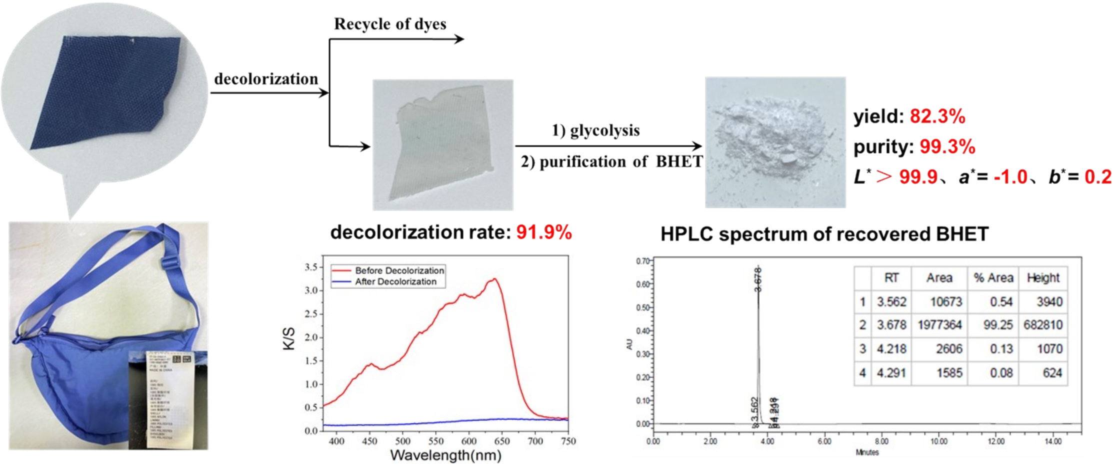
Dispersol Navy Blue 2R-PC

Resolin Blue GLS

Fig. S14 The potential molecule structure of the recovered dye from textile **Sample 1**.

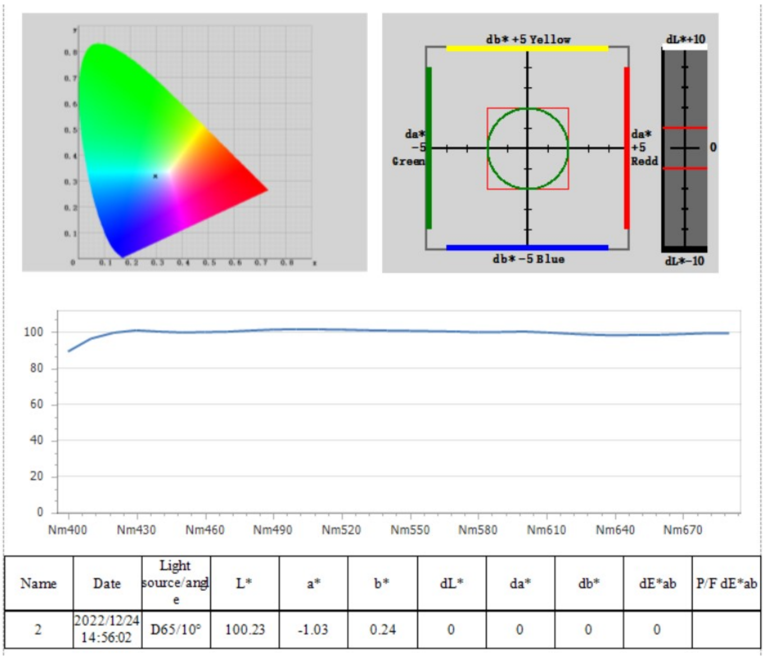
3.2 Sample 2

Composition： 100% Polyester



	RT	Area	% Area	Height
1	3.562	10673	0.54	3940
2	3.678	1977364	99.25	682810
3	4.218	2606	0.13	1070
4	4.291	1585	0.08	624

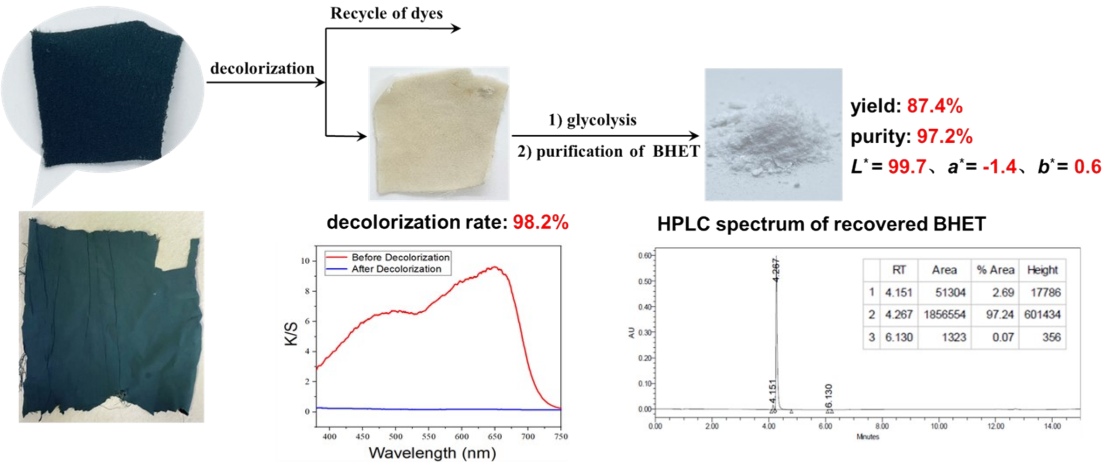
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
2	2022/12/24 14:56:02	D65/10°	100.23	-1.03	0.24	0	0	0	0	

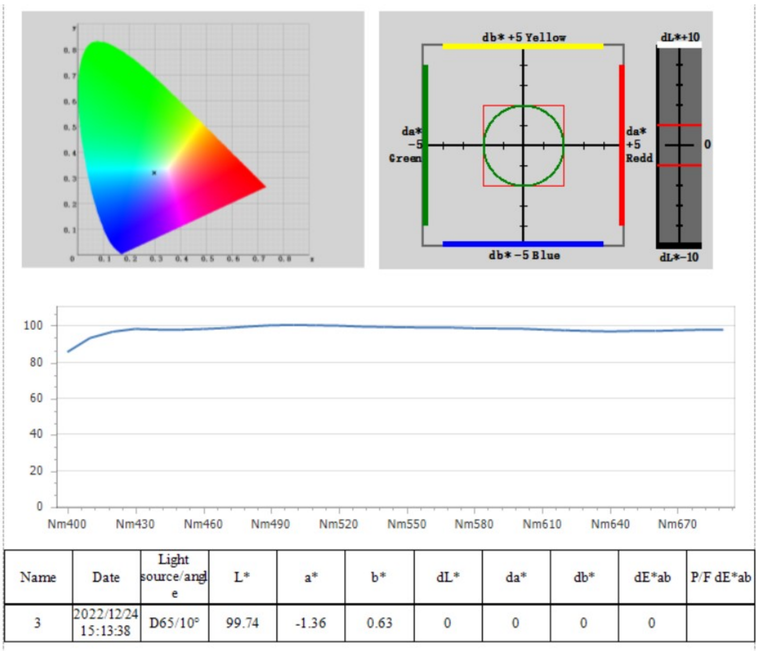
3.3 Sample 3

Composition： 85% Polyester、15% Spandex



	RT	Area	% Area	Height
1	4.151	51304	2.69	17786
2	4.267	1856554	97.24	601434
3	6.130	1323	0.07	356

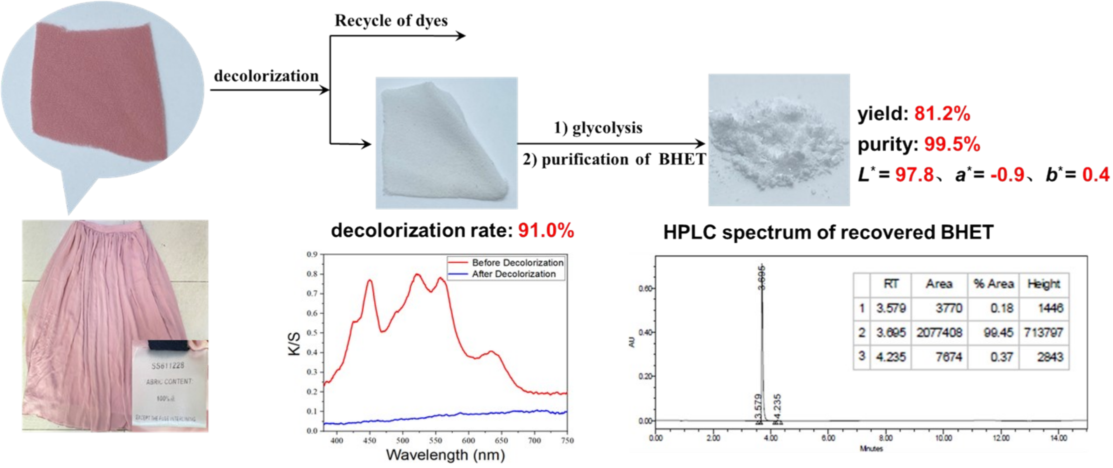
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
3	2022/12/24 15:13:38	D65/10°	99.74	-1.36	0.63	0	0	0	0	

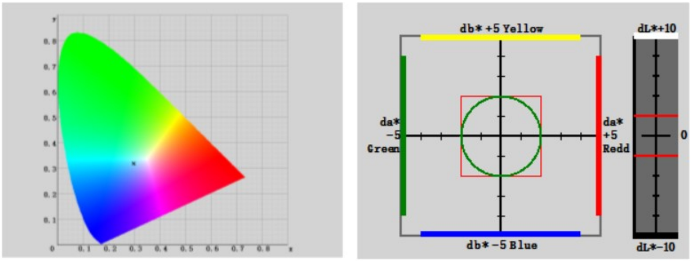
3.4 Sample 4

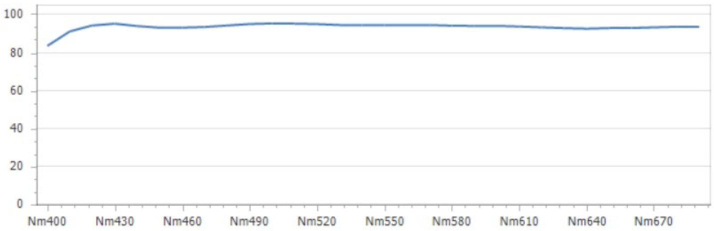
Composition: 100% Polyester



	RT	Area	% Area	Height
1	3.579	3770	0.18	1446
2	3.695	2077408	99.45	713797
3	4.235	7674	0.37	2843

Chromaticity of recovered BHET:

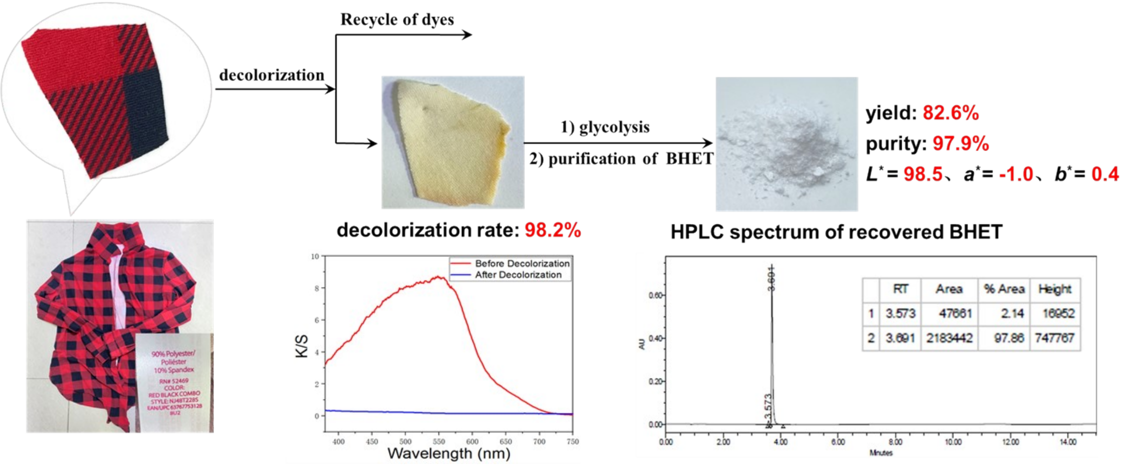




Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
4	2022/12/24 15:15:19	D65/10°	97.78	-0.86	0.4	0	0	0	0	

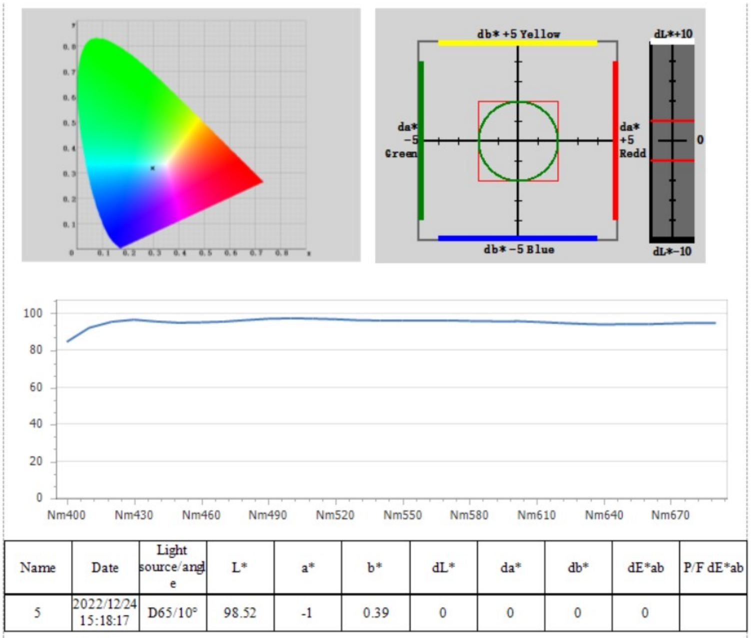
3.5 Sample 5

Composition： 90% Polyester、10% Spandex



	RT	Area	% Area	Height
1	3.573	47661	2.14	16952
2	3.691	2183442	97.86	747767

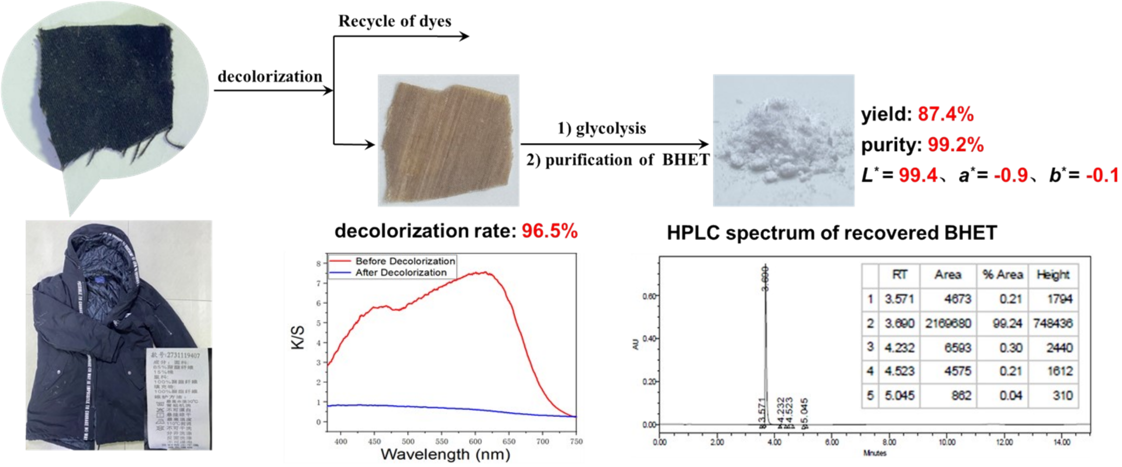
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
5	2022/12/24 15:18:17	D65/10°	98.52	-1	0.39	0	0	0	0	

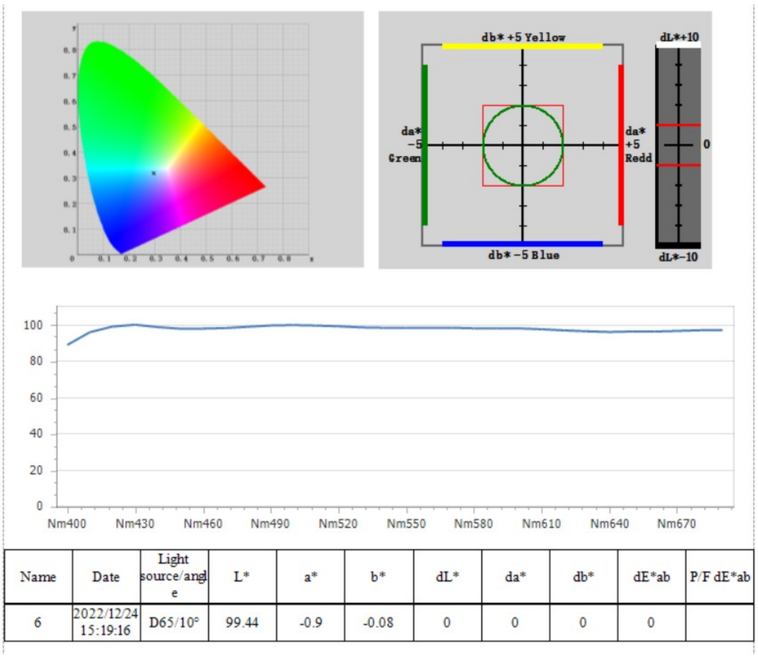
3.6 Sample 6

Composition： 85% Polyester、15% Cotton



	RT	Area	% Area	Height
1	3.571	4673	0.21	1794
2	3.690	2169680	99.24	748436
3	4.232	6593	0.30	2440
4	4.523	4575	0.21	1612
5	5.045	862	0.04	310

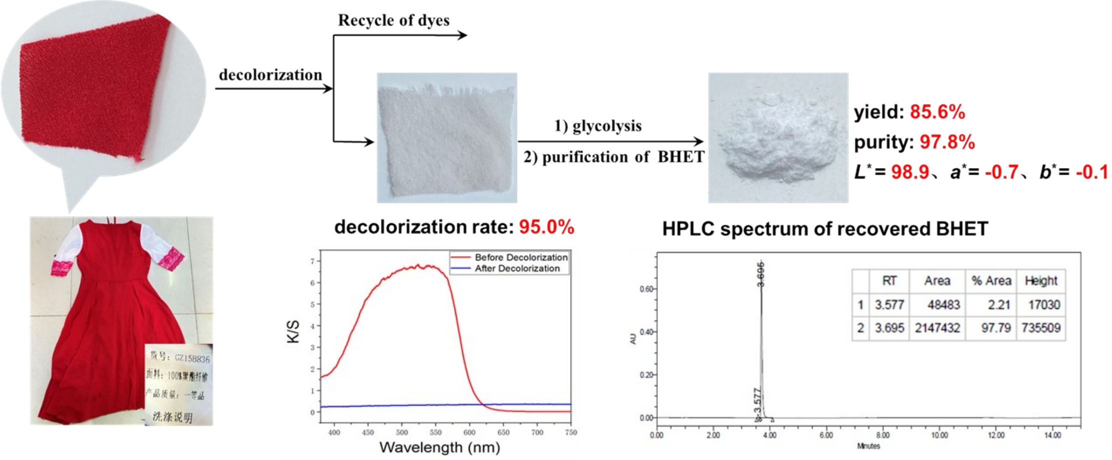
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
6	2022/12/24 15:19:16	D65/10°	99.44	-0.9	-0.08	0	0	0	0	

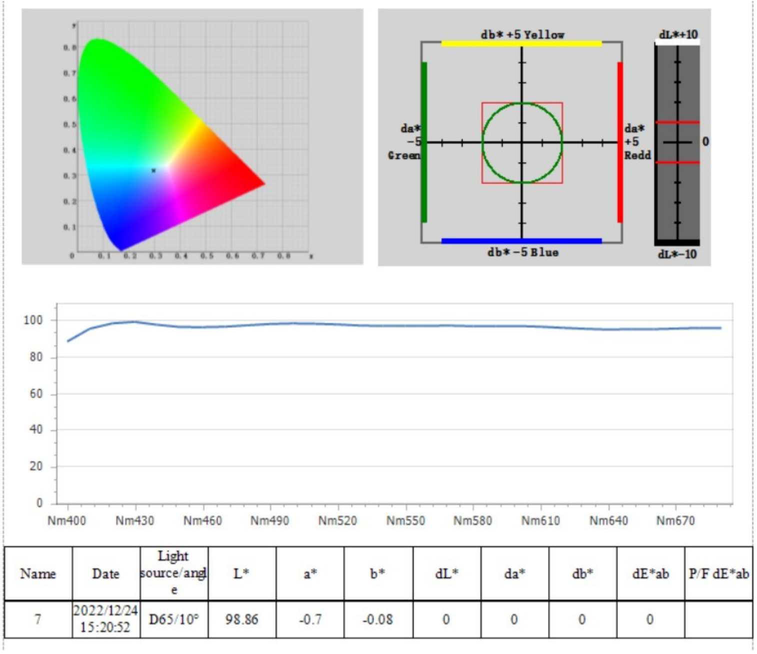
3.7 Sample 7

Composition： 100% Polyester



	RT	Area	% Area	Height
1	3.577	48483	2.21	17030
2	3.695	2147432	97.79	735509

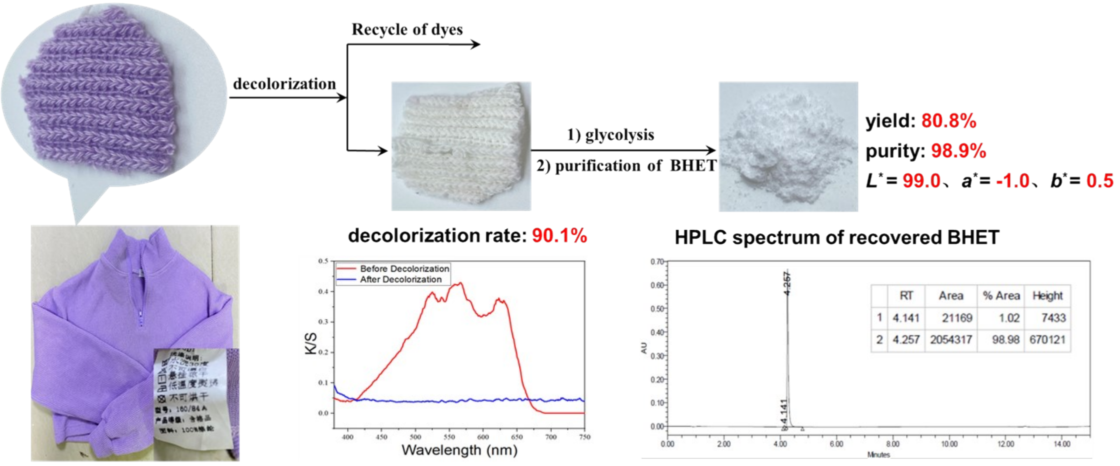
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
7	2022/12/24 15:20:52	D65/10°	98.86	-0.7	-0.08	0	0	0	0	

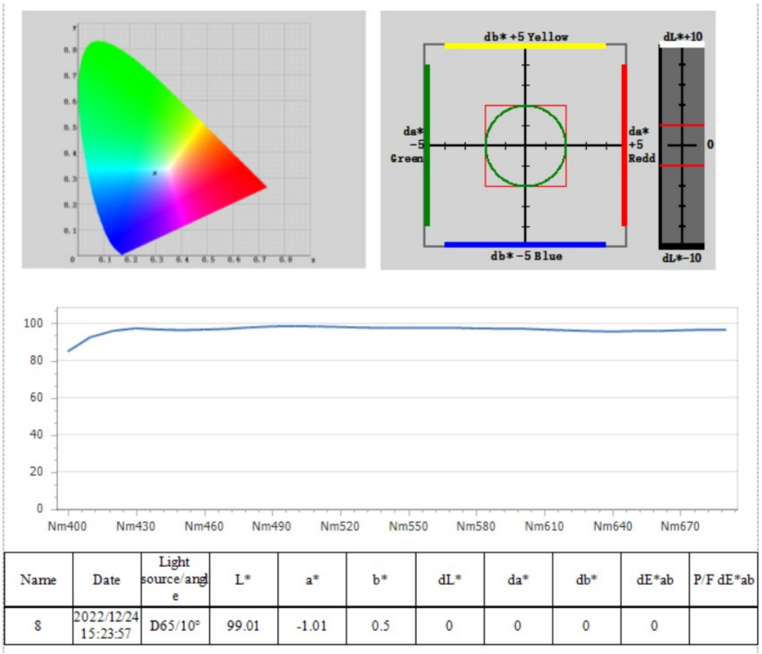
3.8 Sample 8

Composition： 100% Polyester



	RT	Area	% Area	Height
1	4.141	21169	1.02	7433
2	4.257	2054317	98.98	670121

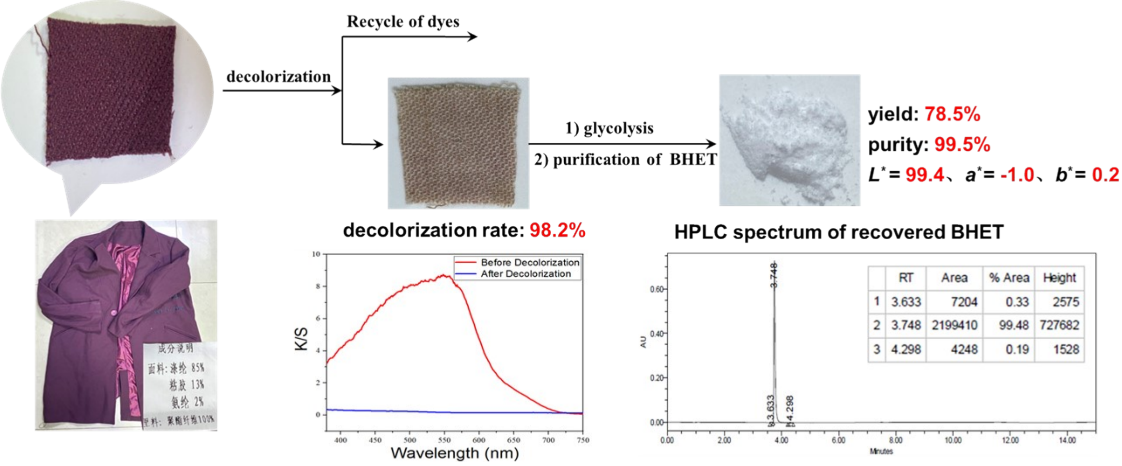
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
8	2022/12/24 15:23:57	D65/10°	99.01	-1.01	0.5	0	0	0	0	

3.9 Sample 9

Composition： 85% Polyester、13% Viscose、2% Spandex



yield: 78.5%

purity: 99.5%

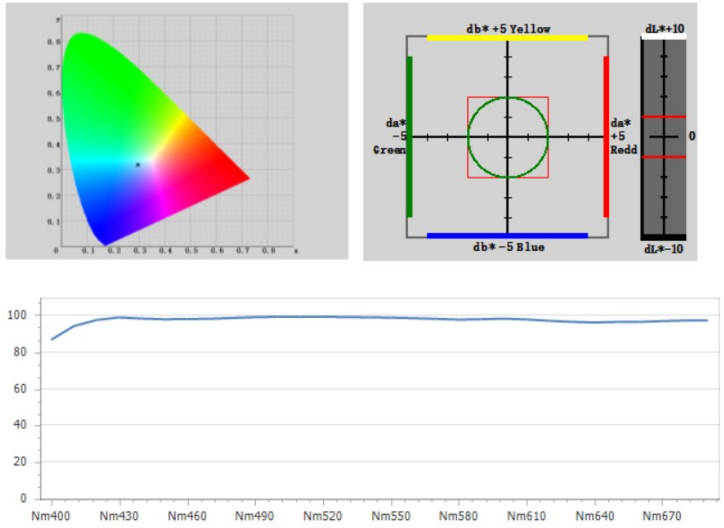
L^* = 99.4、a^* = -1.0、b^* = 0.2

decolorization rate: 98.2%

HPLC spectrum of recovered BHET

	RT	Area	% Area	Height
1	3.633	7204	0.33	2575
2	3.748	2199410	99.48	727682
3	4.298	4248	0.19	1528

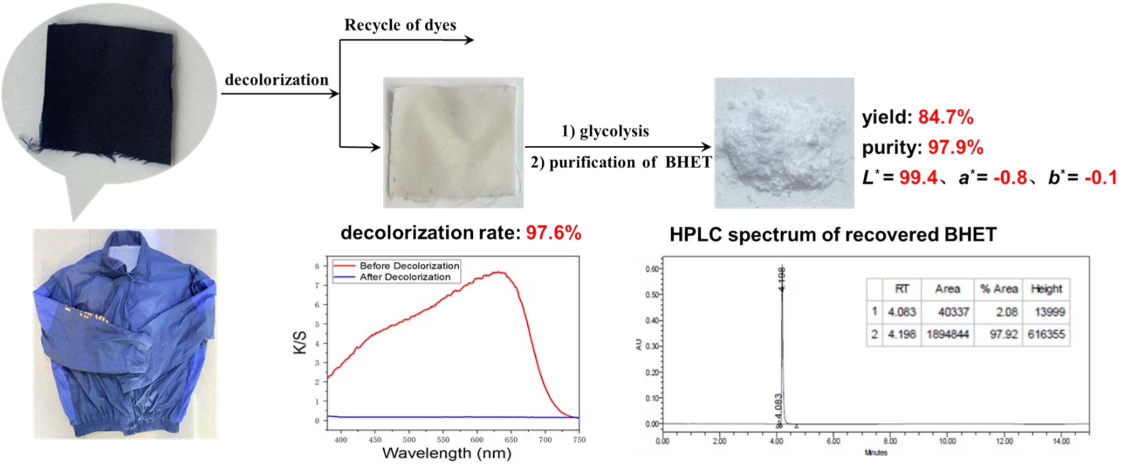
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
9	2022/12/24 15:23:00	D65/10°	99.41	-1	0.22	0	0	0	0	

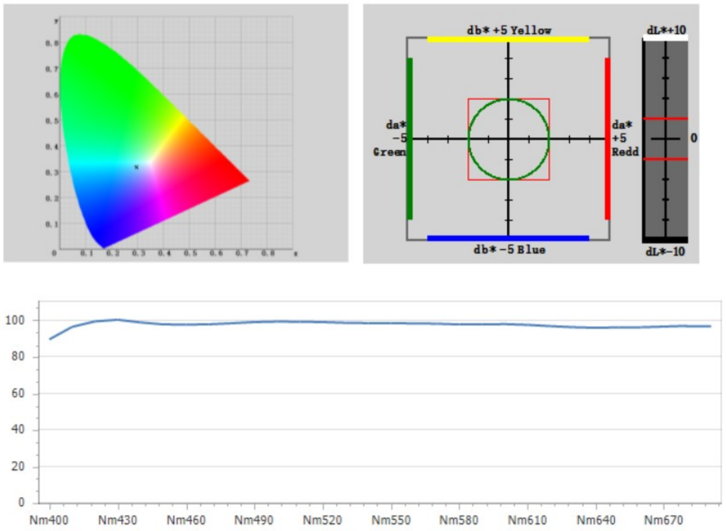
3.10 Sample 10

Composition： 100% Polyester



	RT	Area	% Area	Height
1	4.083	40337	2.08	13999
2	4.198	1894844	97.92	616355

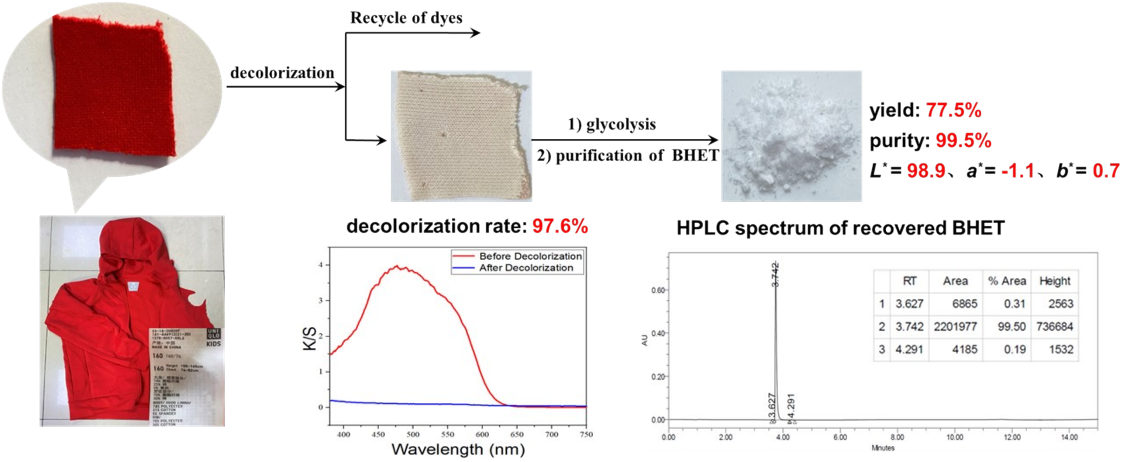
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
10	2022/12/24 15:22:01	D65/10°	99.35	-0.83	-0.13	0	0	0	0	

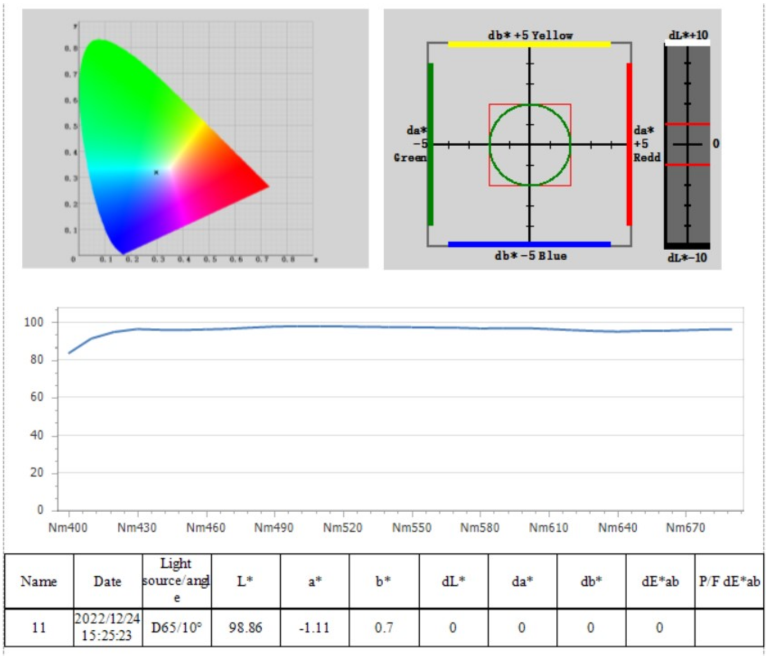
3.11 Sample 11

Composition：74% Polyester、21% Cotton、5% Spandex



	RT	Area	% Area	Height
1	3.627	6865	0.31	2563
2	3.742	2201977	99.50	736684
3	4.291	4185	0.19	1532

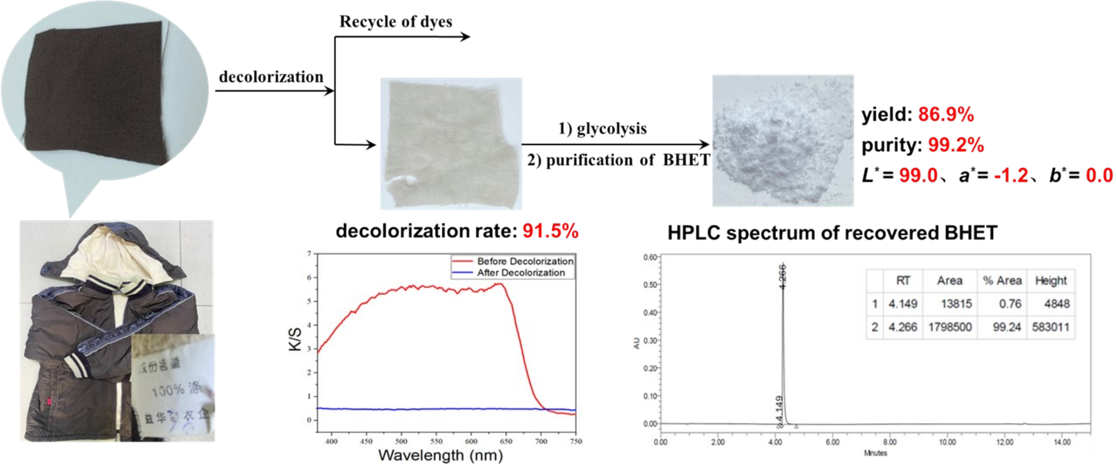
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
11	2022/12/24 15:25:23	D65/10°	98.86	-1.11	0.7	0	0	0	0	

3.12 Sample 12

Composition: 100% Polyester

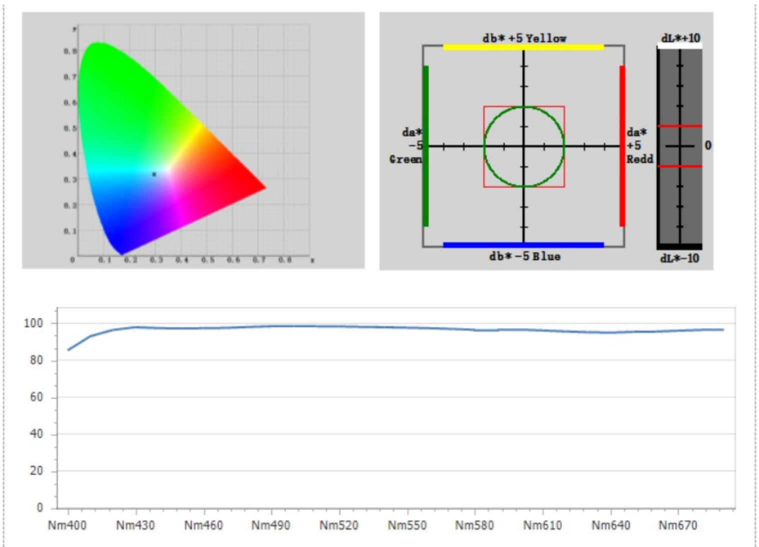


decolorization rate: 91.5%

HPLC spectrum of recovered BHET

	RT	Area	% Area	Height
1	4.149	13815	0.76	4848
2	4.266	1798500	99.24	583011

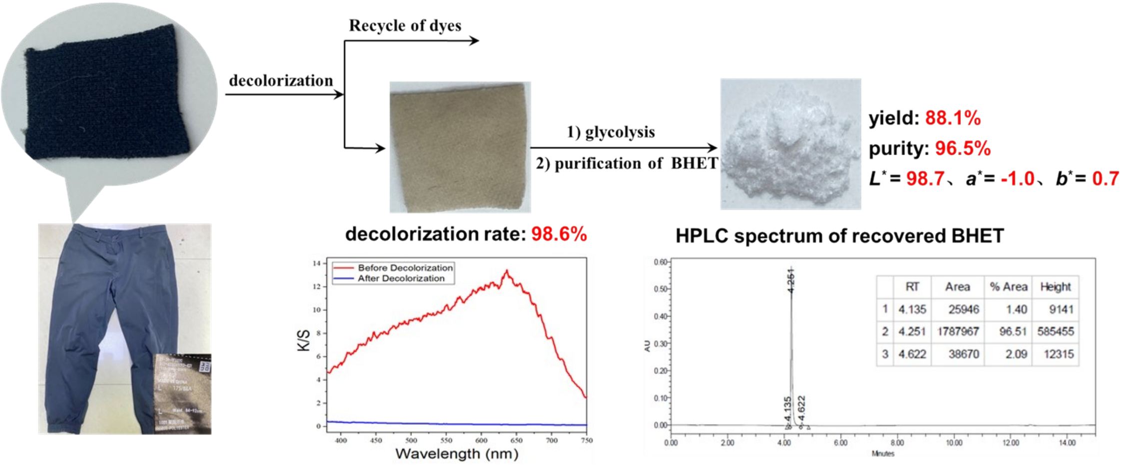
Chromaticity of recovered BHET:



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
12	2022/12/24 15:26:13	D65/10°	98.99	-1.21	0	0	0	0	0	

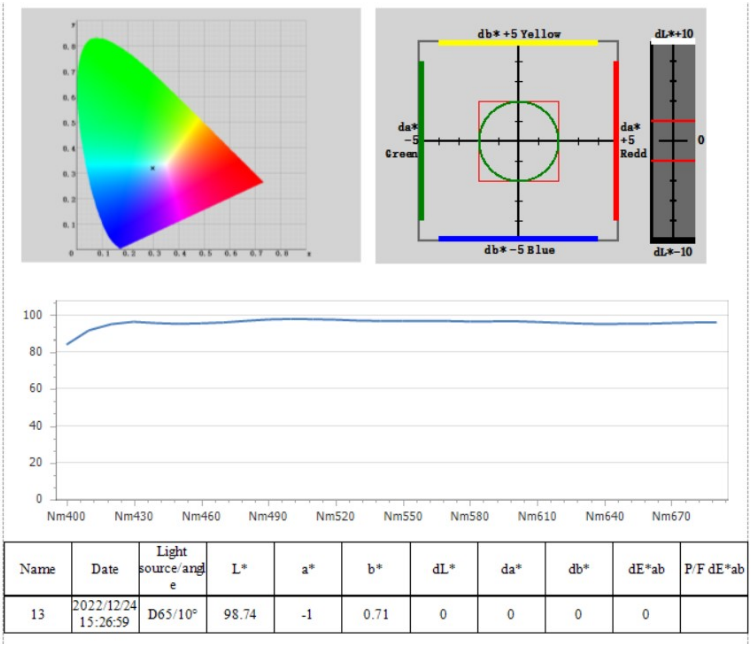
3.13 Sample 13

Composition： 100% Polyester



	RT	Area	% Area	Height
1	4.135	25946	1.40	9141
2	4.251	1787967	96.51	585455
3	4.622	38670	2.09	12315

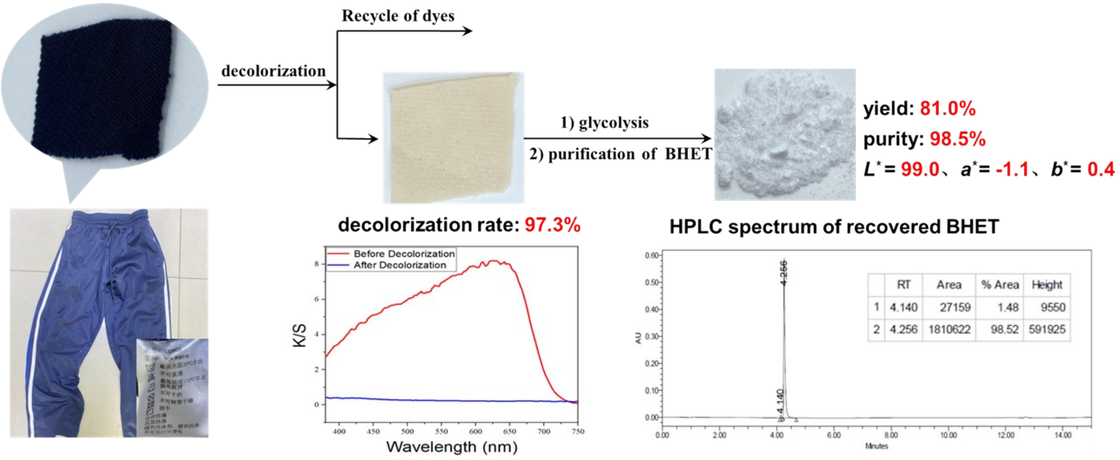
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
13	2022/12/24 15:26:59	D65/10°	98.74	-1	0.71	0	0	0	0	

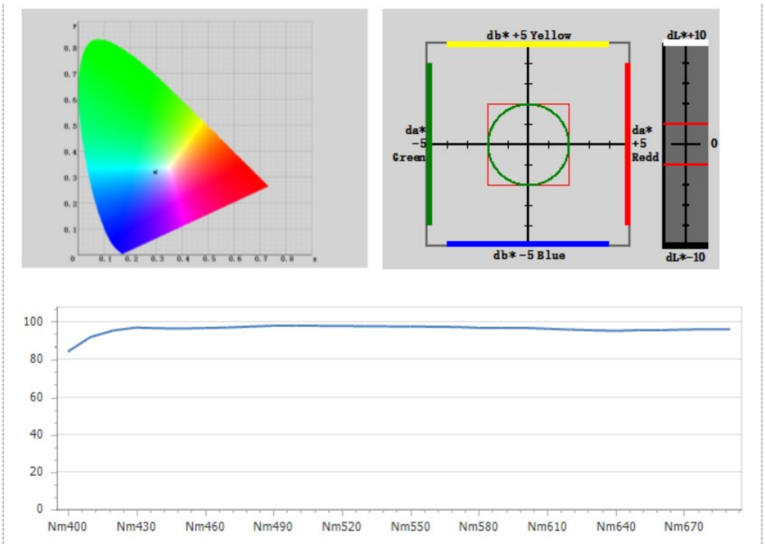
3.14 Sample 14

Composition： 100% Polyester



	RT	Area	% Area	Height
1	4.140	27159	1.48	9550
2	4.256	1810622	98.52	591925

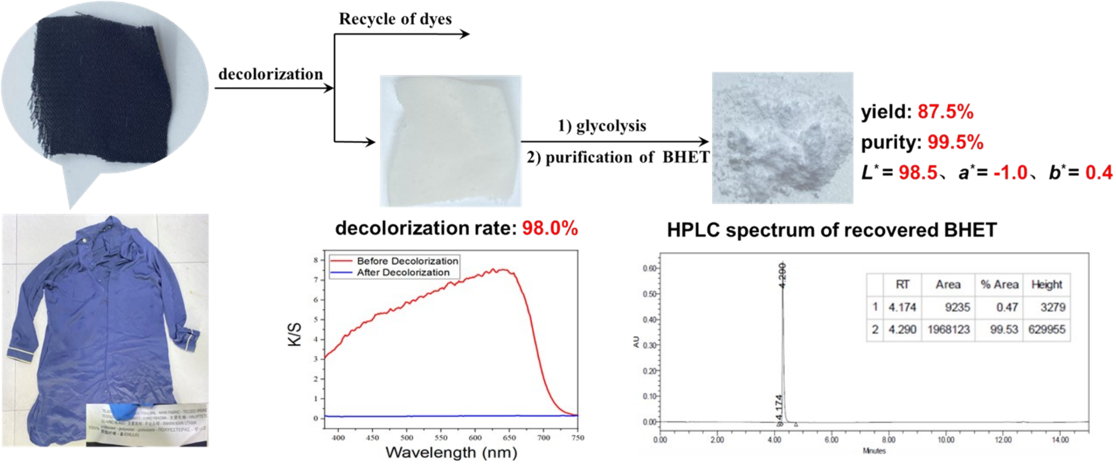
Chromaticity of recovered BHET：



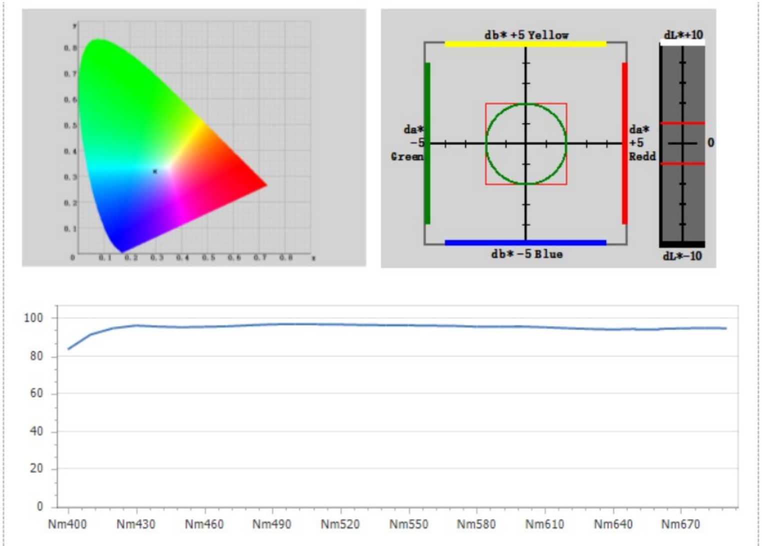
Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
14	2022/12/24 15:29:09	D65/10°	98.97	-1.06	0.44	0	0	0	0	

3.15 Sample 15

Composition： 100% Polyester



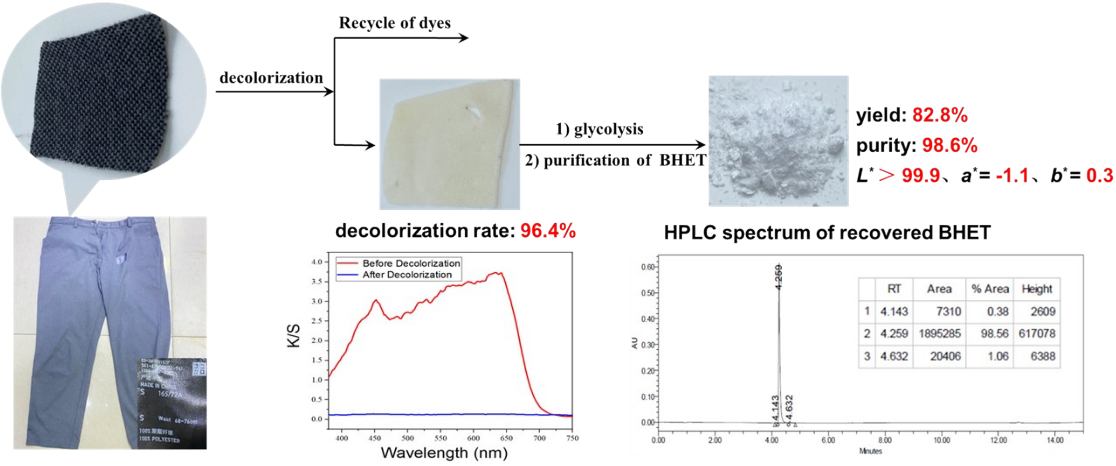
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
15	2022/12/24 15:29:59	D65/10°	98.46	-1.01	0.35	0	0	0	0	

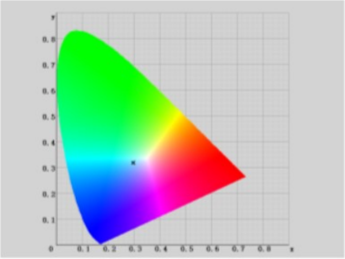
3.16 Sample 16

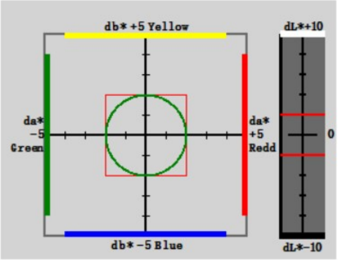
Composition: 100% Polyester

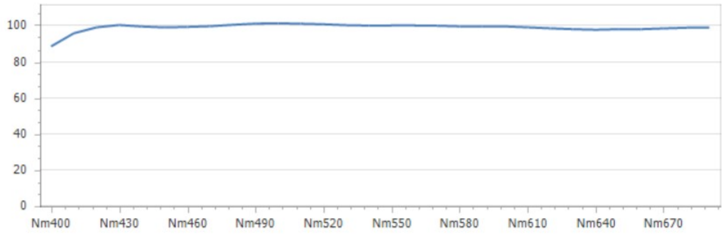


	RT	Area	% Area	Height
1	4.143	7310	0.38	2609
2	4.259	1895285	98.56	617078
3	4.632	20406	1.06	6388

Chromaticity of recovered BHET:



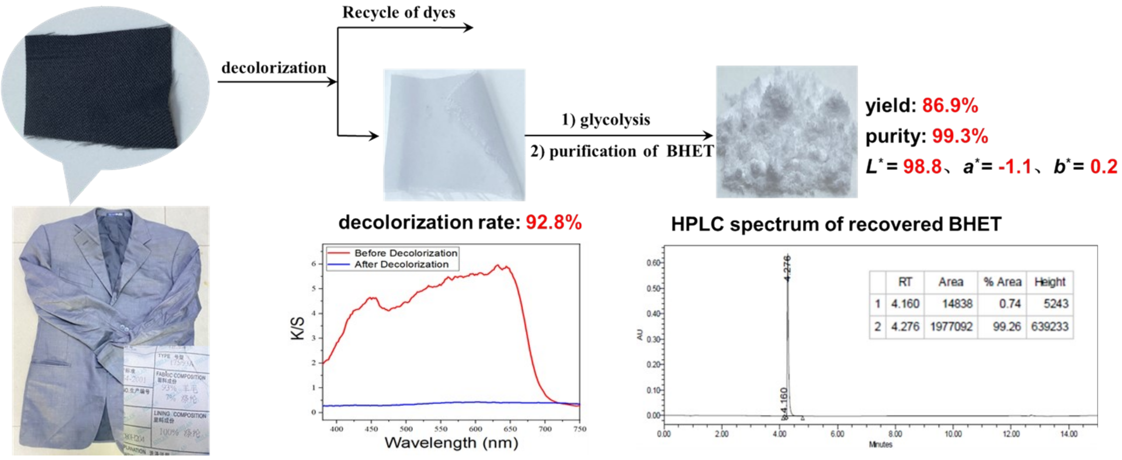




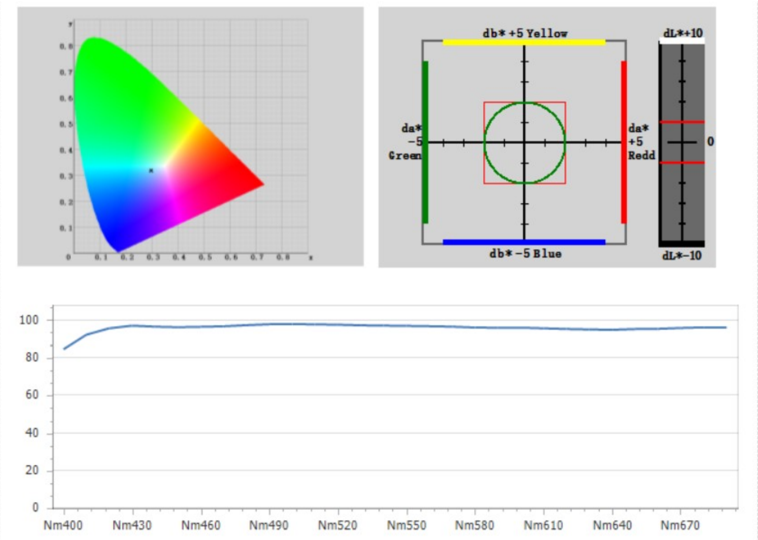
Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
16	2022/12/24 15:31:15	D65/10°	99.98	-1.06	0.29	0	0	0	0	

3.17 Sample 17

Composition： 100% Polyester



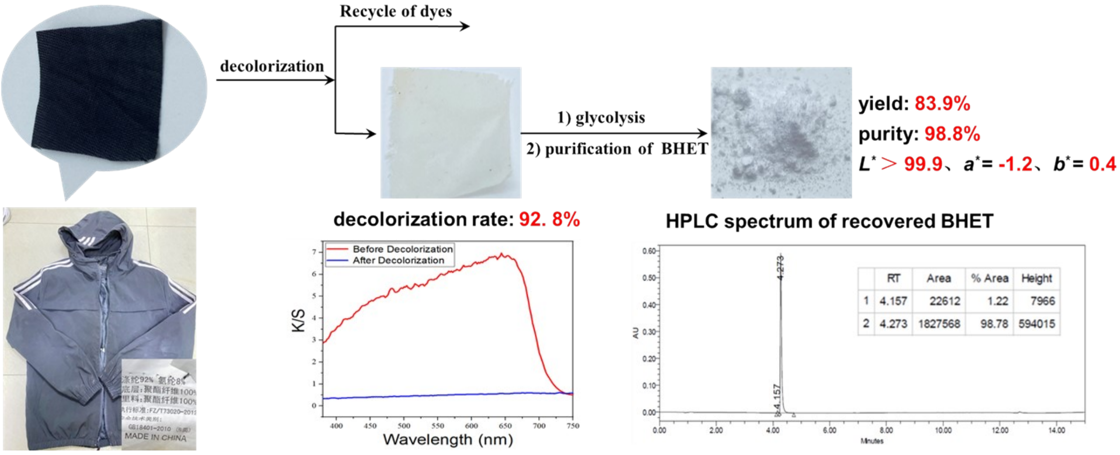
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
17	2022/12/24 15:31:59	D65/10°	98.75	-1.11	0.17	0	0	0	0	

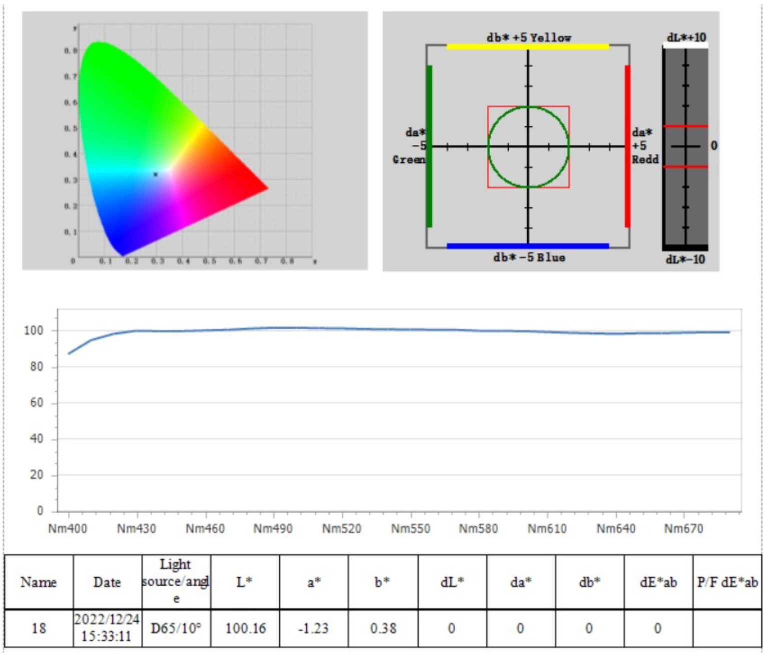
3.18 Sample 18

Composition： 92% Polyester、8% Spandex



	RT	Area	% Area	Height
1	4.157	22612	1.22	7966
2	4.273	1827568	98.78	594015

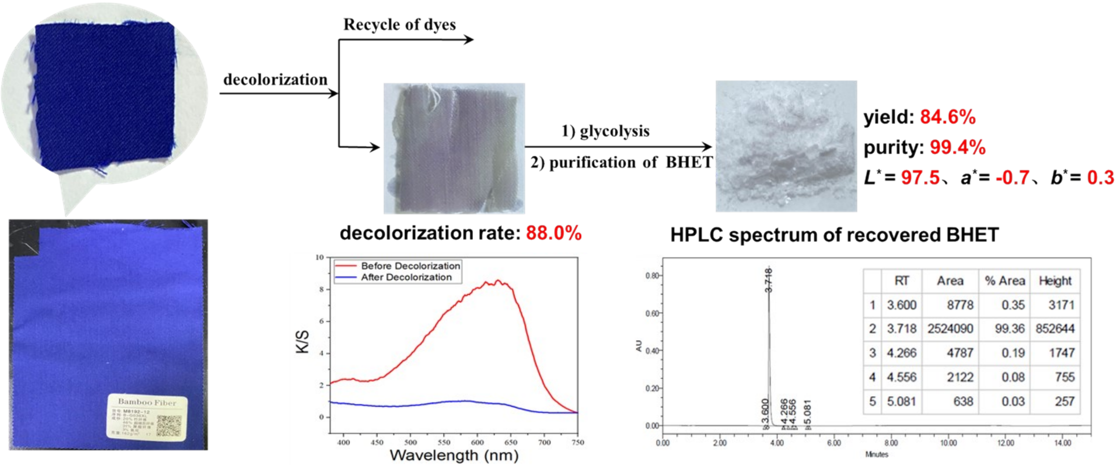
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
18	2022/12/24 15:33:11	D65/10°	100.16	-1.23	0.38	0	0	0	0	

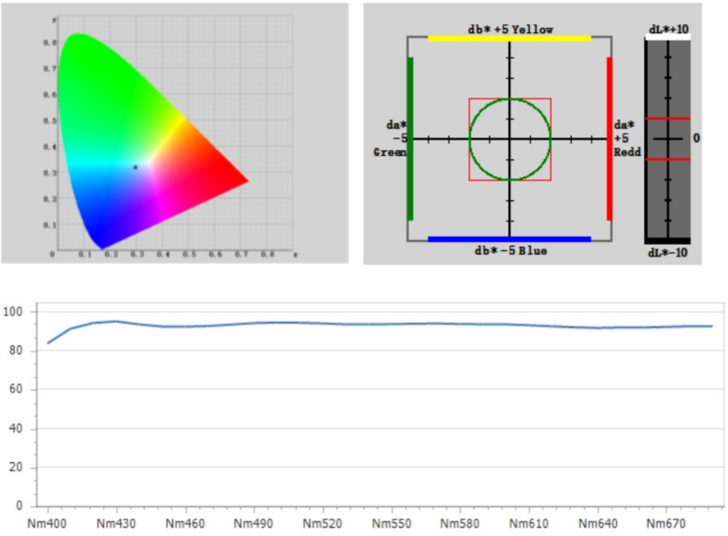
3.19 Sample 19

Composition： 31% Polyester、46% Polypropylene、20% Bamboo Fiber、3%Spandex



	RT	Area	% Area	Height
1	3.600	8778	0.35	3171
2	3.718	2524090	99.36	852644
3	4.266	4787	0.19	1747
4	4.556	2122	0.08	755
5	5.081	638	0.03	257

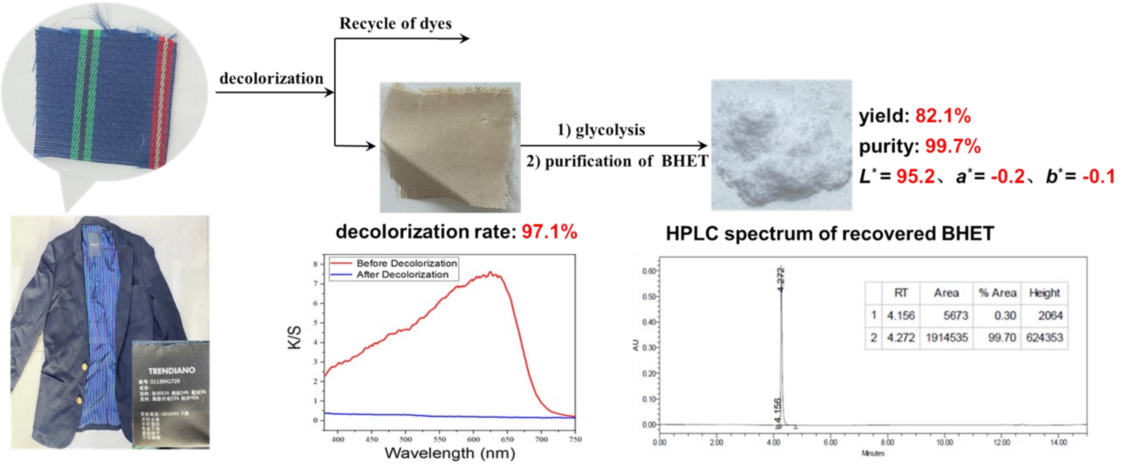
Chromaticity of recovered BHET：



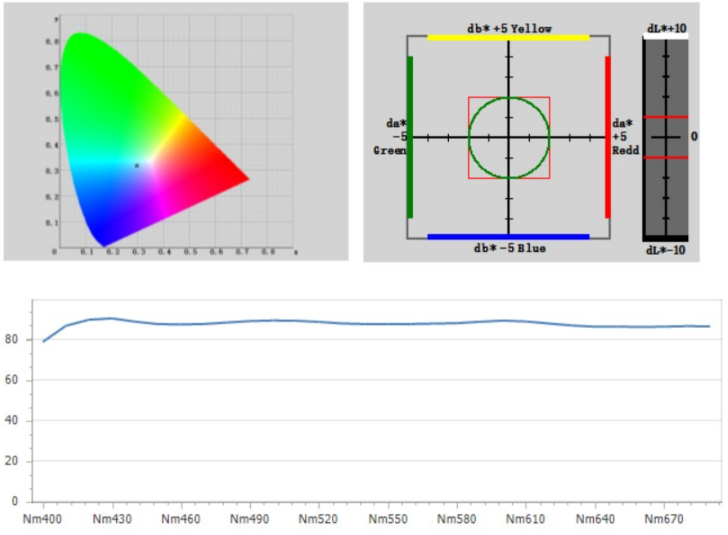
Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
19	2022/12/24 15:33:56	D65/10°	97.46	-0.67	0.28	0	0	0	0	

3.20 Sample 20

Composition： 55% Polyester、45% Viscose



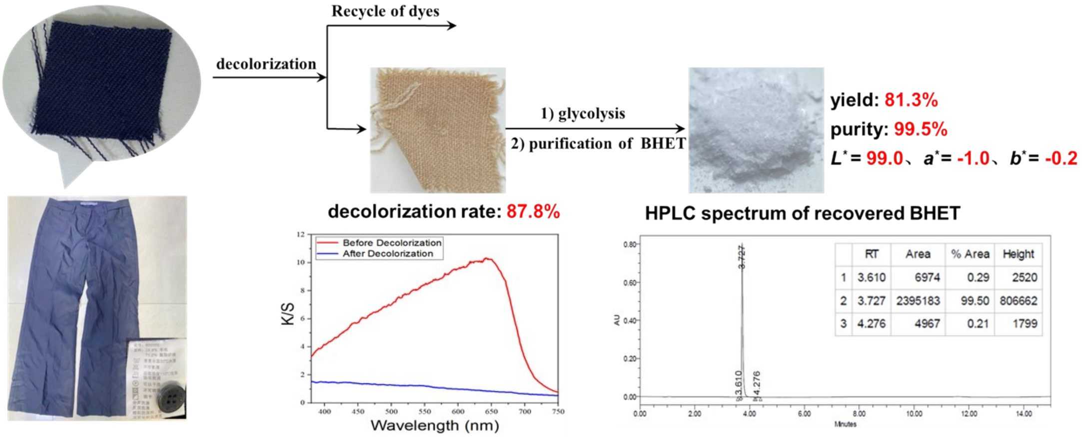
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
20	2022/12/24 15:35:48	D65/10°	95.2	-0.21	-0.13	0	0	0	0	

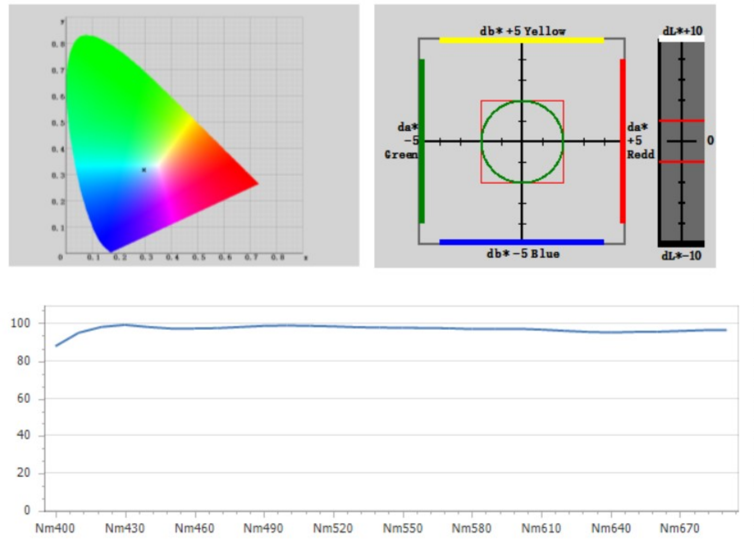
3.21 Sample 21

Composition： 71.2% Polyester、28.8% Wool



	RT	Area	% Area	Height
1	3.610	6974	0.29	2520
2	3.727	2395183	99.50	806662
3	4.276	4967	0.21	1799

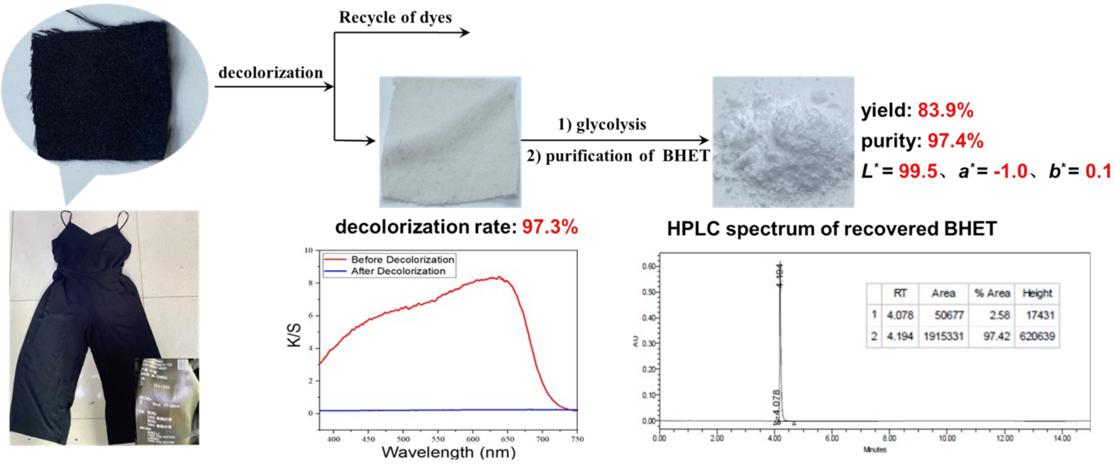
Chromaticity of recovered BHET：



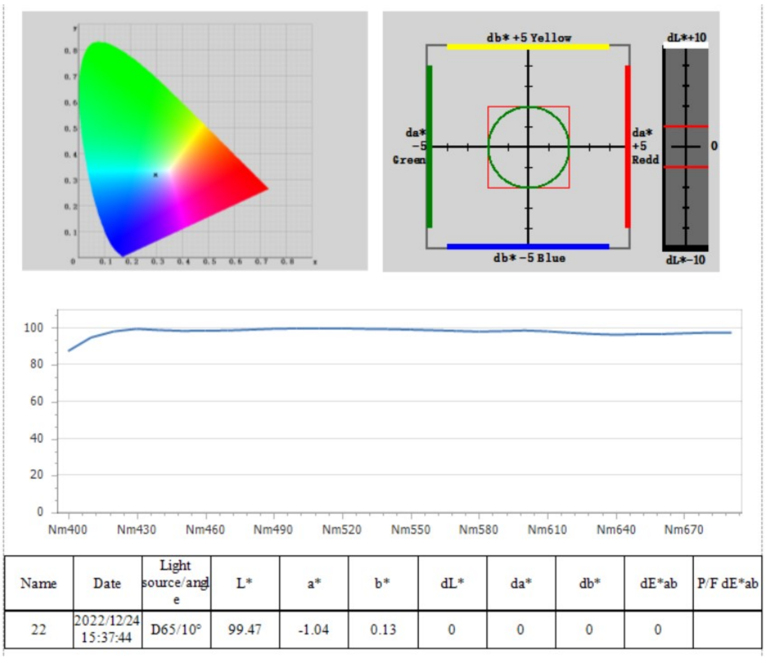
Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
21	2022/12/24 15:36:45	D65/10°	99.04	-0.95	-0.15	0	0	0	0	

3.22 Sample 22

Composition： 100% Polyester



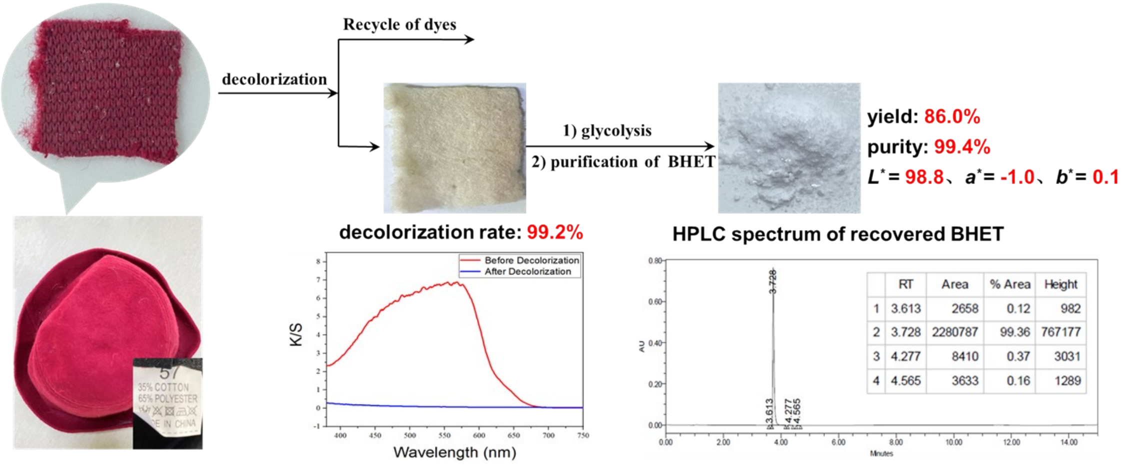
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
22	2022/12/24 15:37:44	D65/10°	99.47	-1.04	0.13	0	0	0	0	

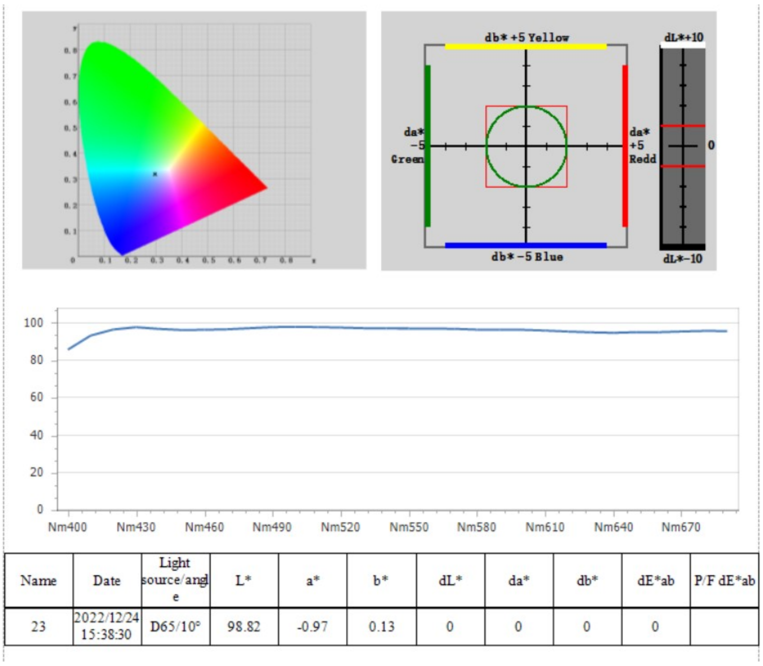
3.23 Sample 23

Composition: 65% Polyester、35% Cotton



	RT	Area	% Area	Height
1	3.613	2658	0.12	982
2	3.728	2280787	99.36	767177
3	4.277	8410	0.37	3031
4	4.565	3633	0.16	1289

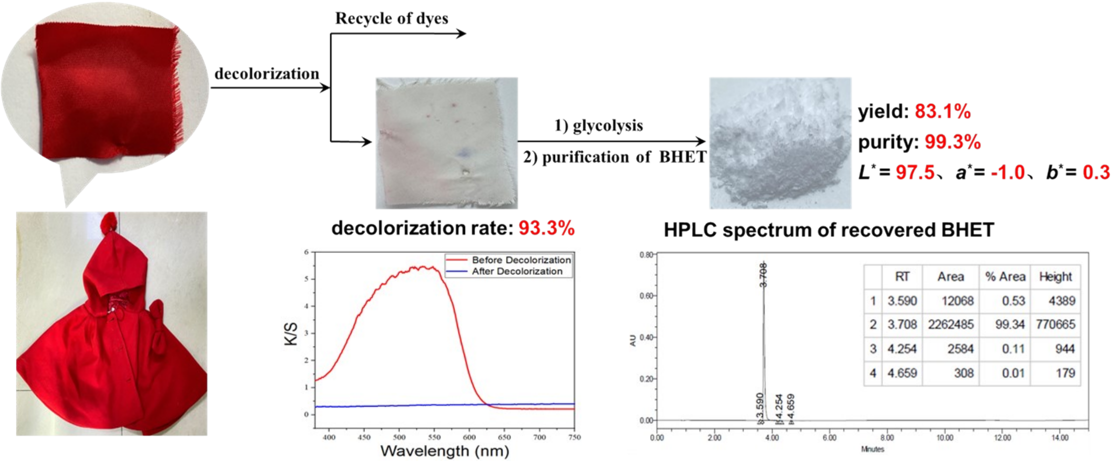
Chromaticity of recovered BHET:



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
23	2022/12/24 15:38:30	D65/10°	98.82	-0.97	0.13	0	0	0	0	

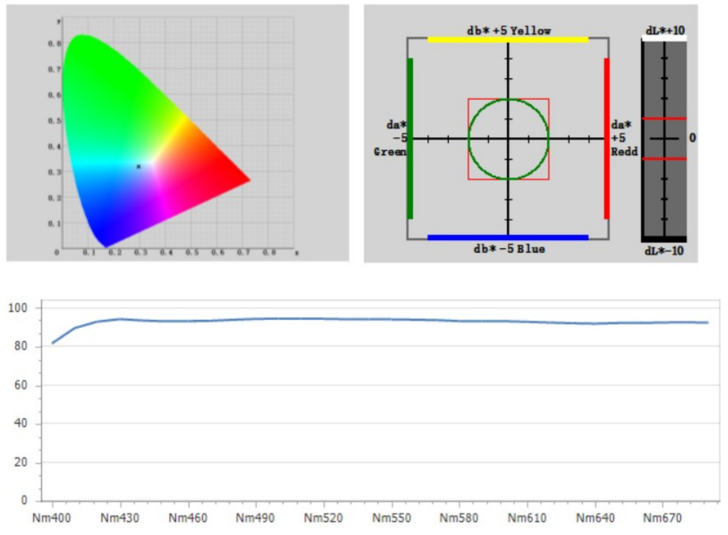
3.24 Sample 24

Composition： 100% Polyester



	RT	Area	% Area	Height
1	3.590	12068	0.53	4389
2	3.708	2262485	99.34	770665
3	4.254	2584	0.11	944
4	4.659	308	0.01	179

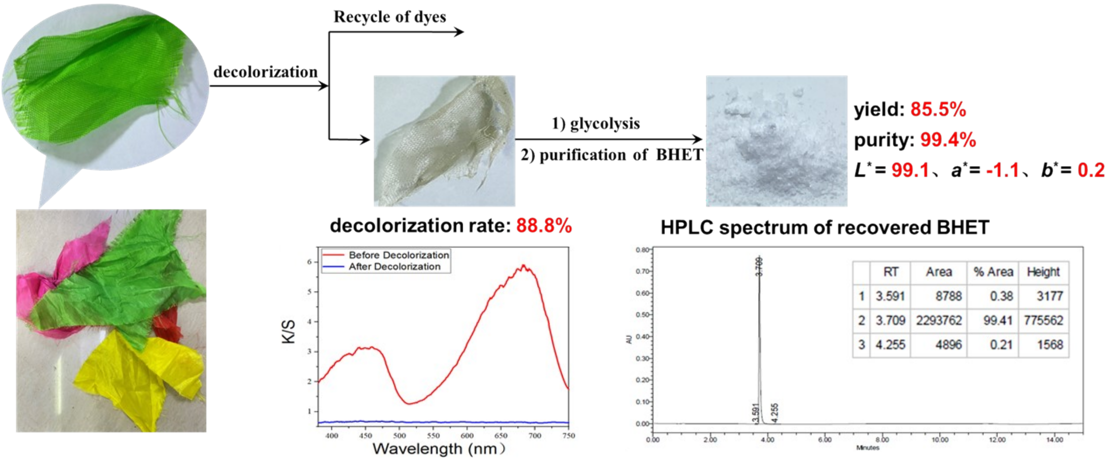
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
24	2022/12/24 15:39:10	D65/10°	97.53	-0.98	0.26	0	0	0	0	

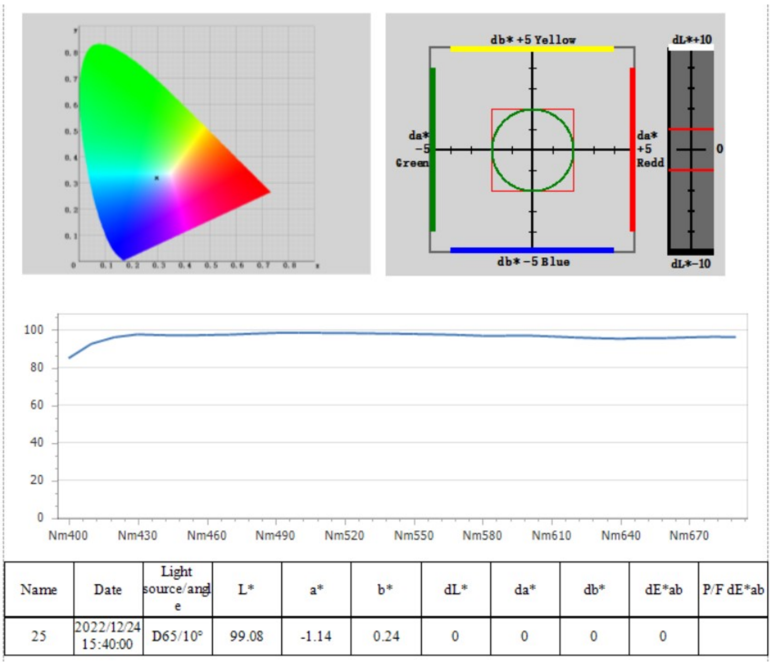
3.25 Sample 25

Composition： 100% Polyester



	RT	Area	% Area	Height
1	3.591	8788	0.38	3177
2	3.709	2293762	99.41	775562
3	4.255	4896	0.21	1568

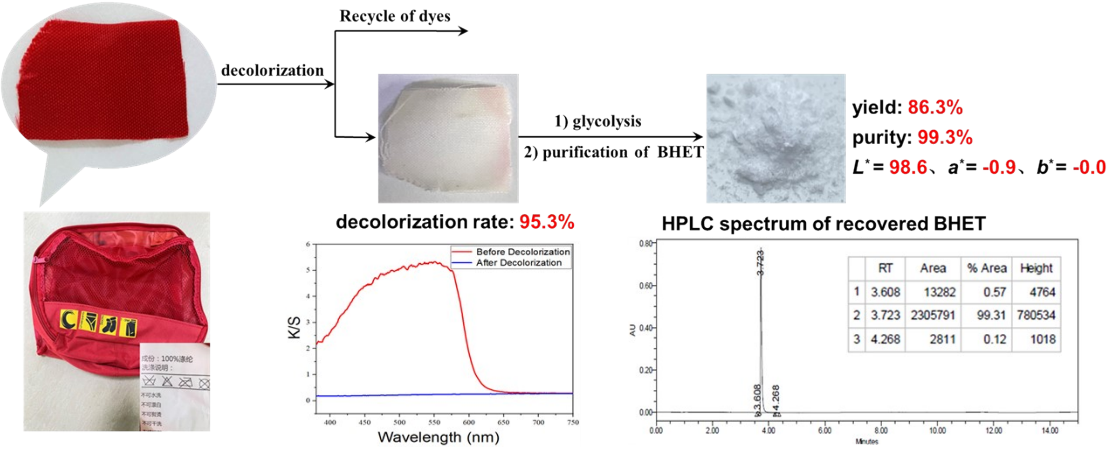
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
25	2022/12/24 15:40:00	D65/10°	99.08	-1.14	0.24	0	0	0	0	

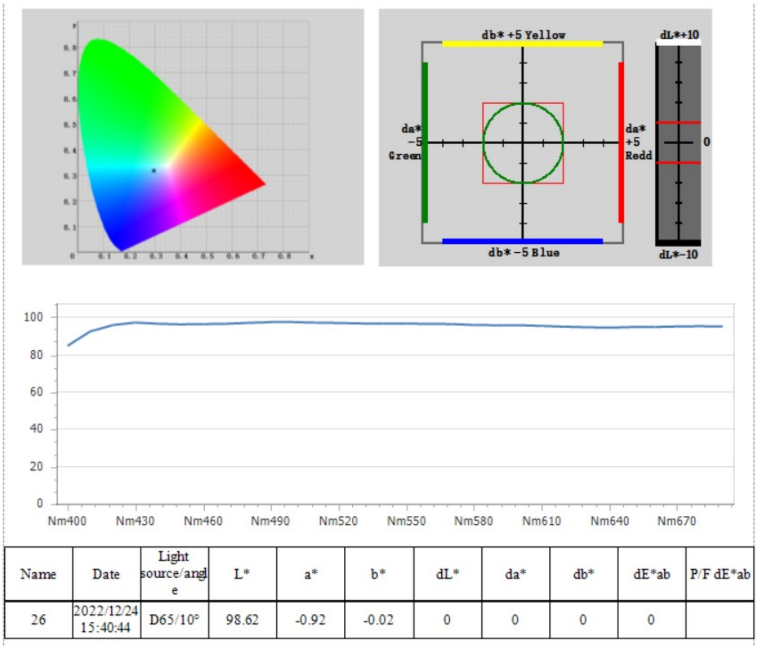
3.26 Sample 26

Composition: 100% Polyester



	RT	Area	% Area	Height
1	3.608	13282	0.57	4764
2	3.723	2305791	99.31	780534
3	4.268	2811	0.12	1018

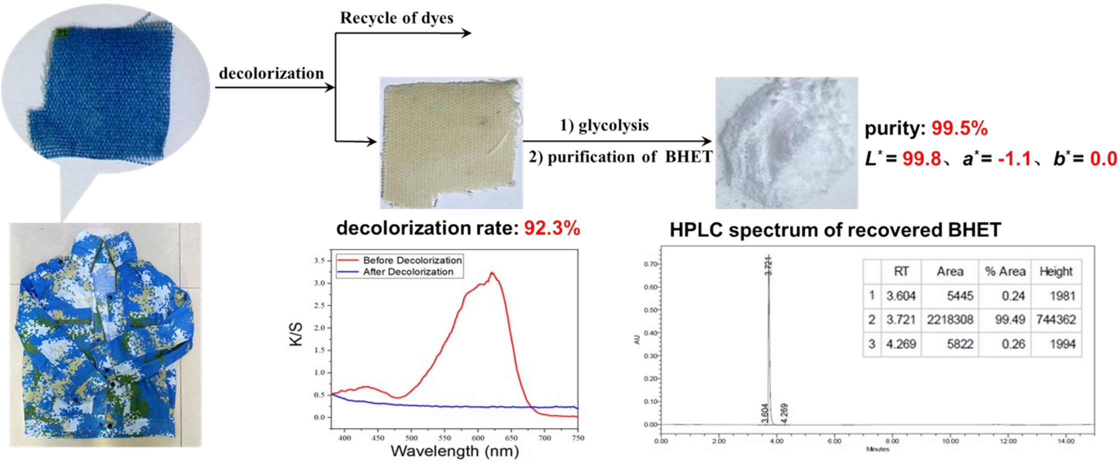
Chromaticity of recovered BHET:



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
26	2022/12/24 15:40:44	D65/10°	98.62	-0.92	-0.02	0	0	0	0	

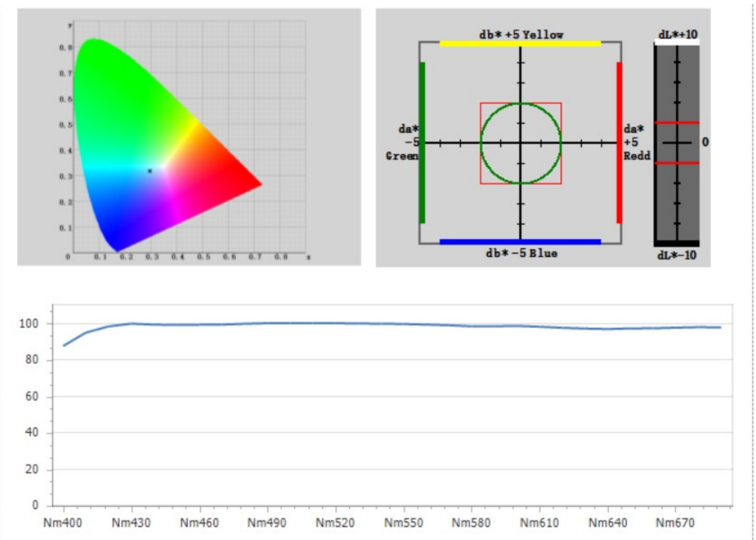
3.27 Sample 27

Composition： Unknown



	RT	Area	% Area	Height
1	3.604	5445	0.24	1981
2	3.721	2218308	99.49	744362
3	4.269	5822	0.26	1994

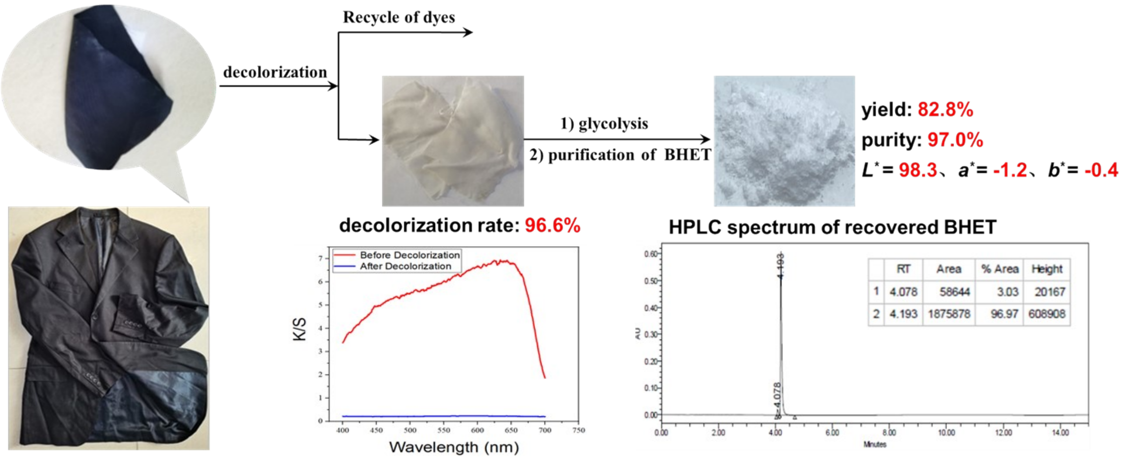
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
27	2022/12/24 15:41:31	D65/10°	99.75	-1.11	0.02	0	0	0	0	

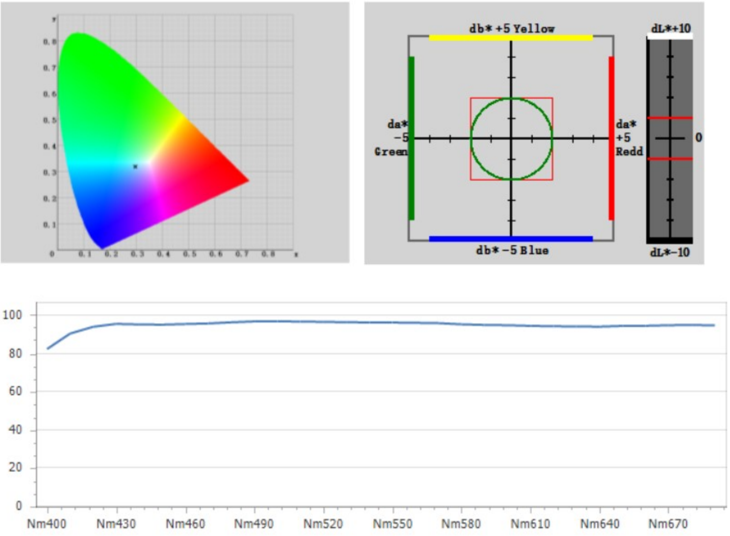
3.28 Sample 28

Composition: 100% Polyester



	RT	Area	% Area	Height
1	4.078	58644	3.03	20167
2	4.193	1875878	96.97	608908

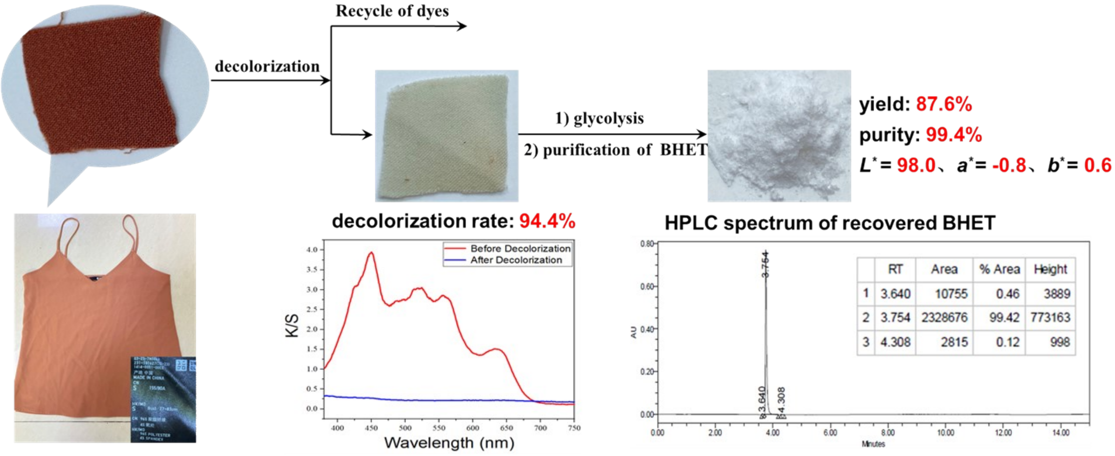
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
28	2022/12/24 15:42:13	D65/10°	98.33	-1.24	0.39	0	0	0	0	

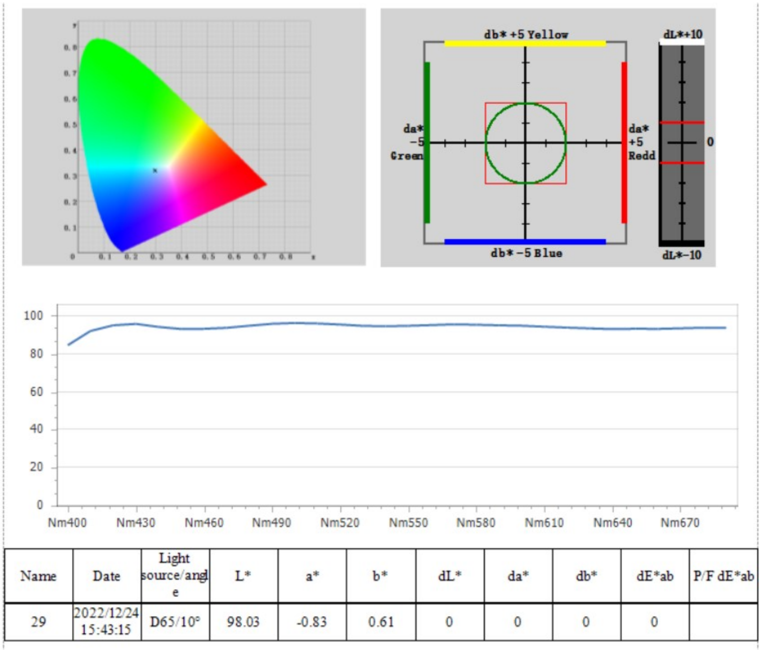
3.29 Sample 29

Composition： 96% Polyester、4% Spandex



	RT	Area	% Area	Height
1	3.640	10755	0.46	3889
2	3.754	2328676	99.42	773163
3	4.308	2815	0.12	998

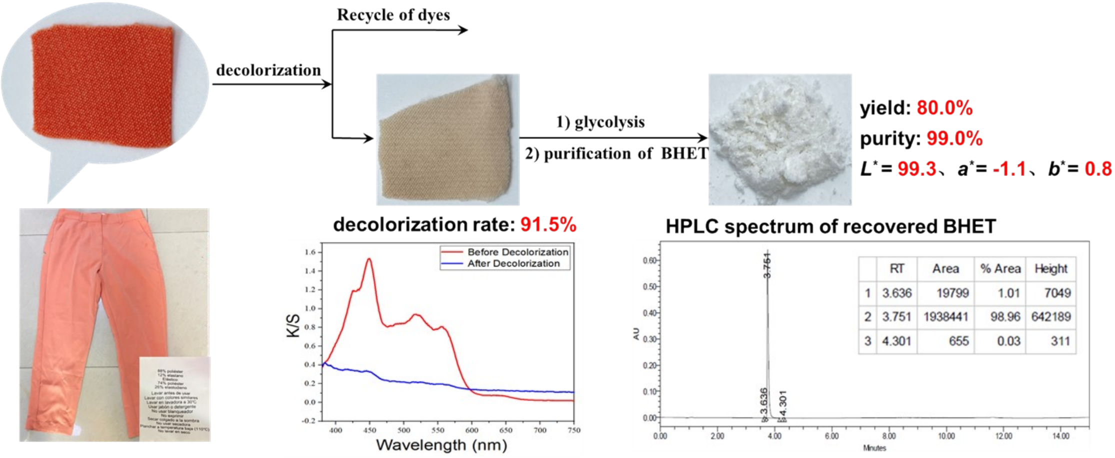
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
29	2022/12/24 15:43:15	D65/10°	98.03	-0.83	0.61	0	0	0	0	

3.30 Sample 30

Composition: 88% Polyester、12% Spandex



yield: 80.0%

purity: 99.0%

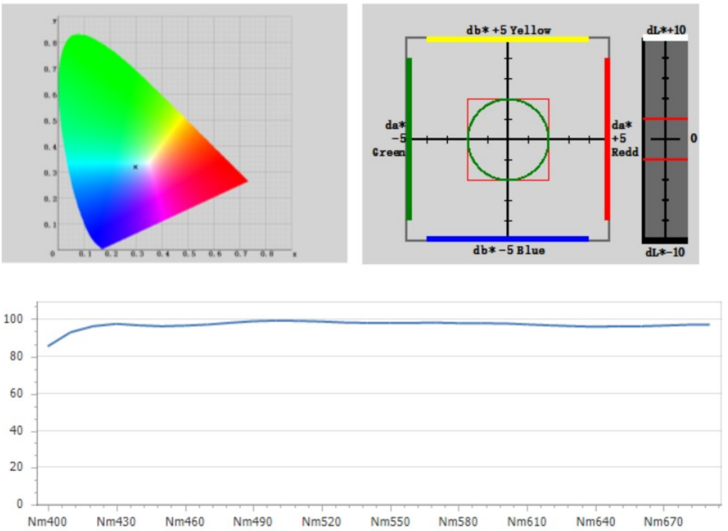
L^* = 99.3、a^* = -1.1、b^* = 0.8

decolorization rate: 91.5%

HPLC spectrum of recovered BHET

	RT	Area	% Area	Height
1	3.636	19799	1.01	7049
2	3.751	1938441	98.96	642189
3	4.301	655	0.03	311

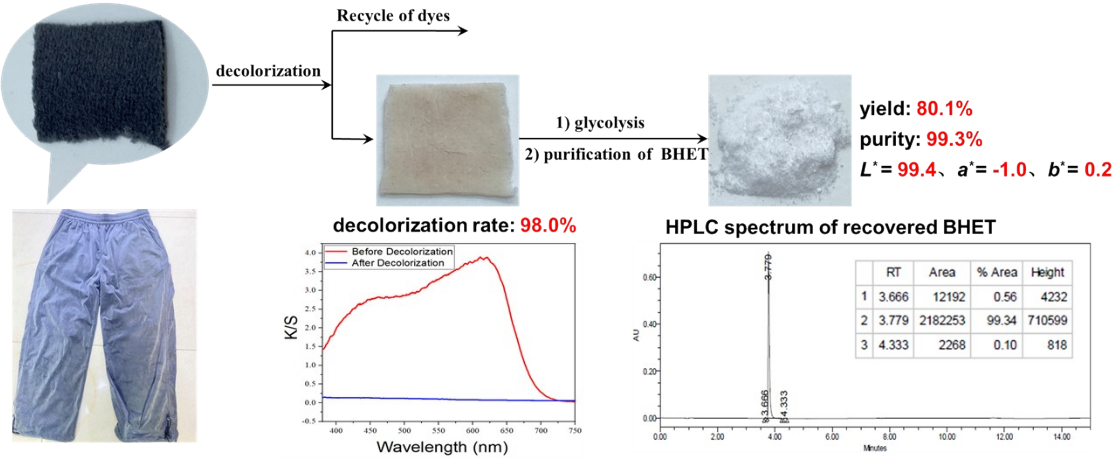
Chromaticity of recovered BHET:



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
30	2022/12/24 15:44:20	D65/10°	99.29	-1.13	0.78	0	0	0	0	

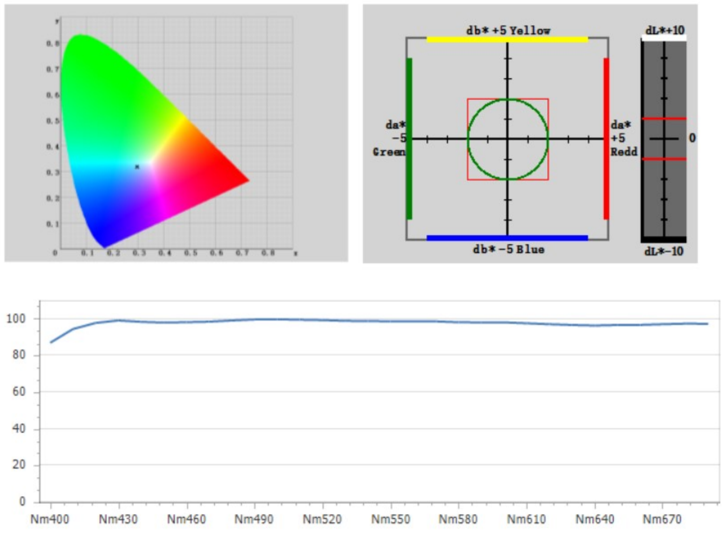
3.31 Sample 31

Composition: 100% Polyester



	RT	Area	% Area	Height
1	3.666	12192	0.56	4232
2	3.779	2182253	99.34	710599
3	4.333	2268	0.10	818

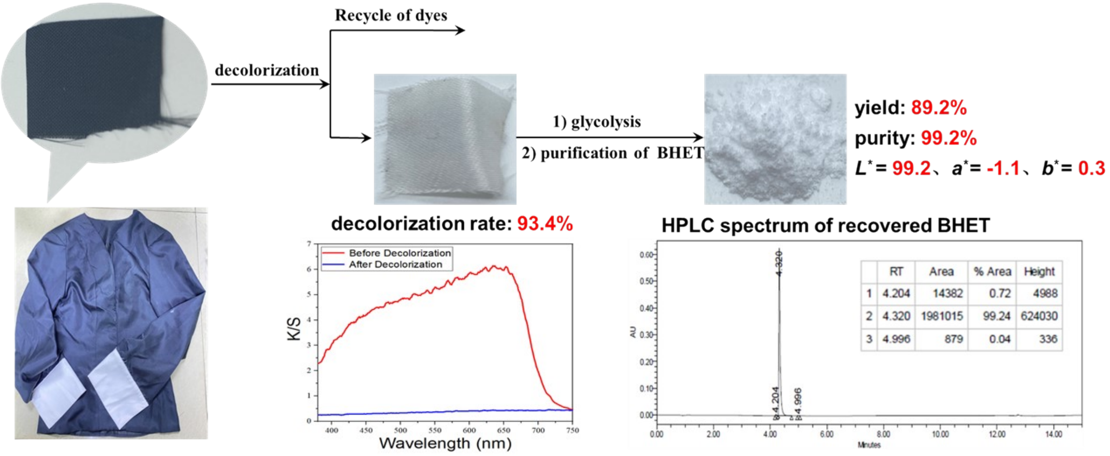
Chromaticity of recovered BHET:



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
31	2022/12/24 15:45:09	D65/10°	99.41	-1.04	0.17	0	0	0	0	

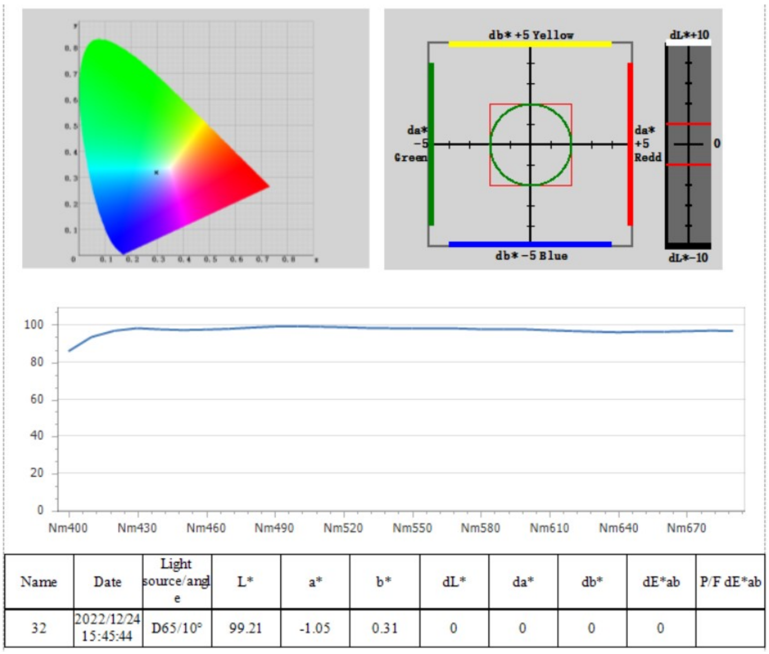
3.32 Sample 32

Composition： 100% Polyester



	RT	Area	% Area	Height
1	4.204	14382	0.72	4988
2	4.320	1981015	99.24	624030
3	4.996	879	0.04	336

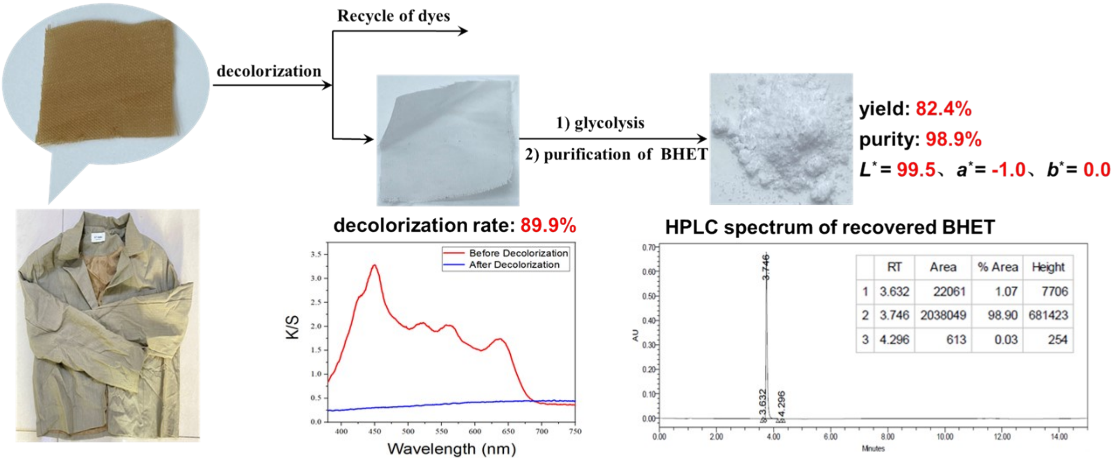
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
32	2022/12/24 15:45:44	D65/10°	99.21	-1.05	0.31	0	0	0	0	

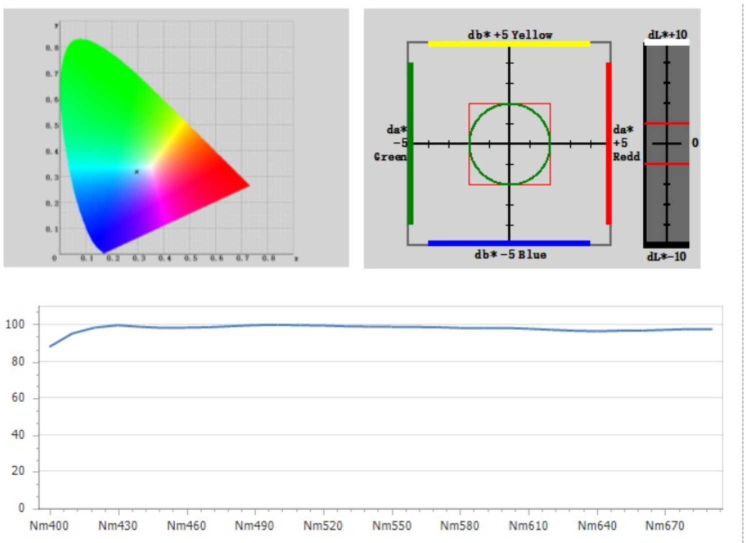
3.33 Sample 33

Composition： 100% Polyester



	RT	Area	% Area	Height
1	3.632	22061	1.07	7706
2	3.746	2038049	98.90	681423
3	4.296	613	0.03	254

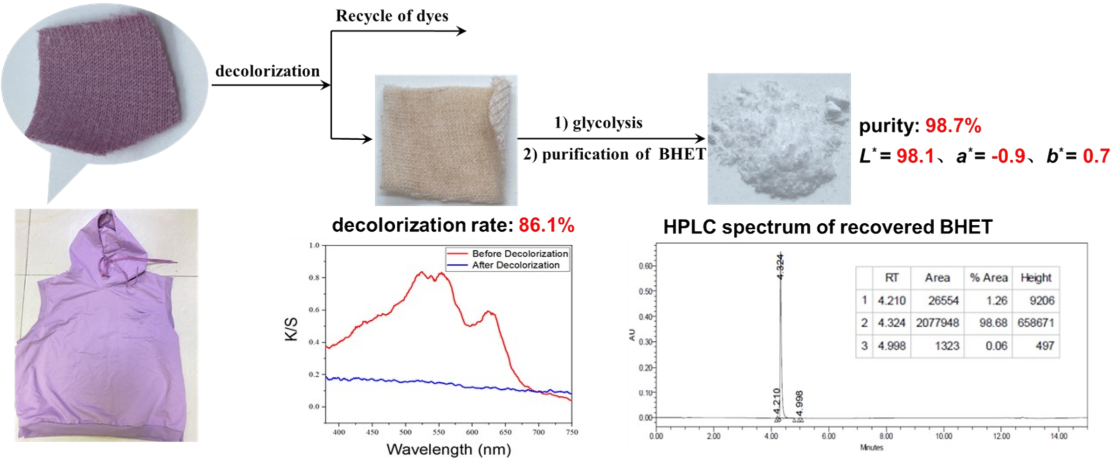
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
33	2022/12/24 15:46:54	D65/10°	99.52	-0.99	0.04	0	0	0	0	

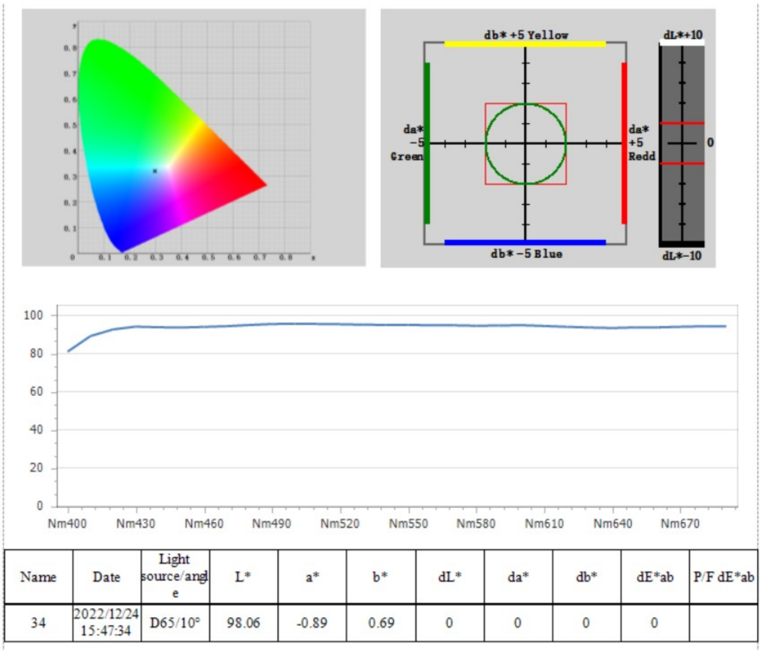
3.34 Sample 34

Composition： Unknown



	RT	Area	% Area	Height
1	4.210	26554	1.26	9206
2	4.324	2077948	98.68	658671
3	4.998	1323	0.06	497

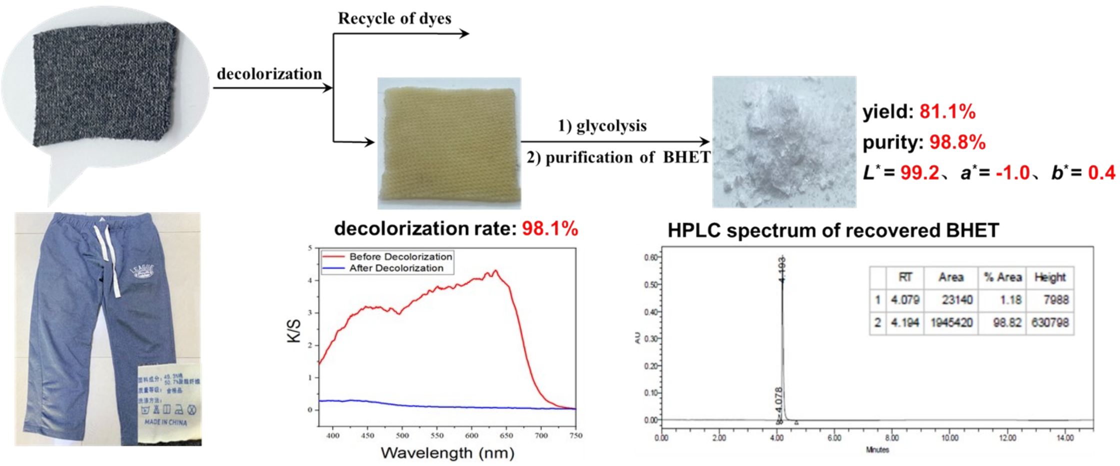
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
34	2022/12/24 15:47:34	D65/10°	98.06	-0.89	0.69	0	0	0	0	

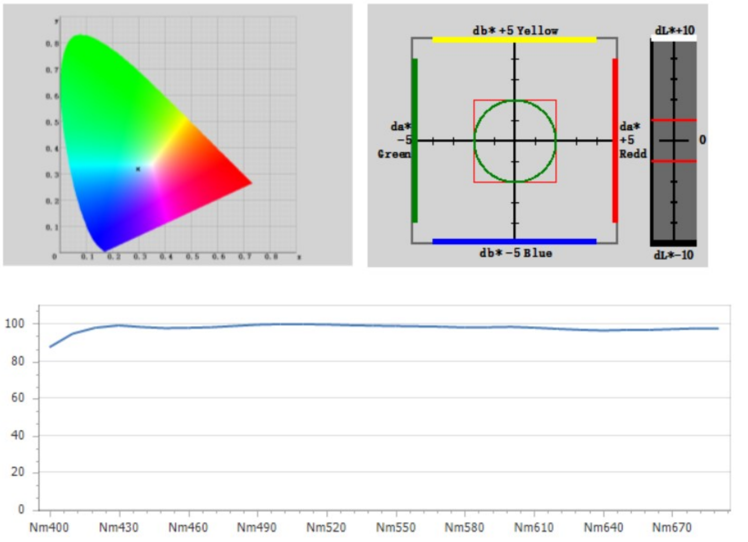
3.35 Sample 35

Composition： 50.7% Polyester、49.3% Cotton



	RT	Area	% Area	Height
1	4.079	23140	1.18	7988
2	4.194	1945420	98.82	630798

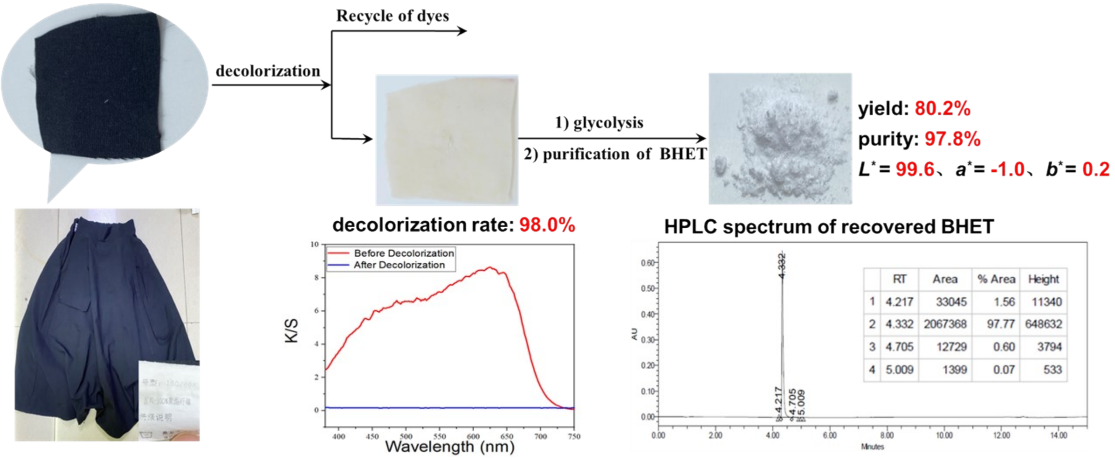
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
35	2022/12/24 15:48:10	D65/10°	99.54	-1.1	0.35	0	0	0	0	

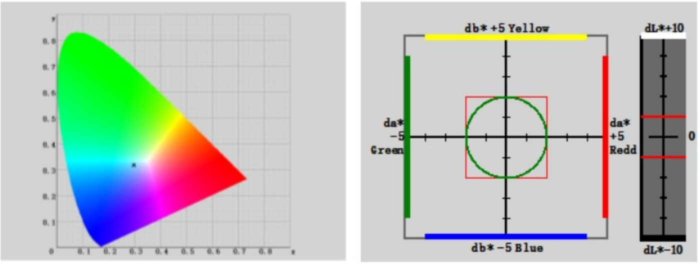
3.36 Sample 36

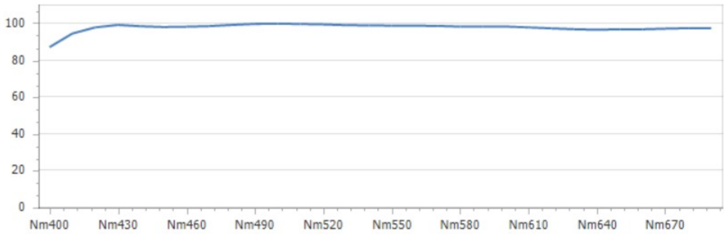
Composition： 100% Polyester



	RT	Area	% Area	Height
1	4.217	33045	1.56	11340
2	4.332	2067368	97.77	648632
3	4.705	12729	0.60	3794
4	5.009	1399	0.07	533

Chromaticity of recovered BHET：

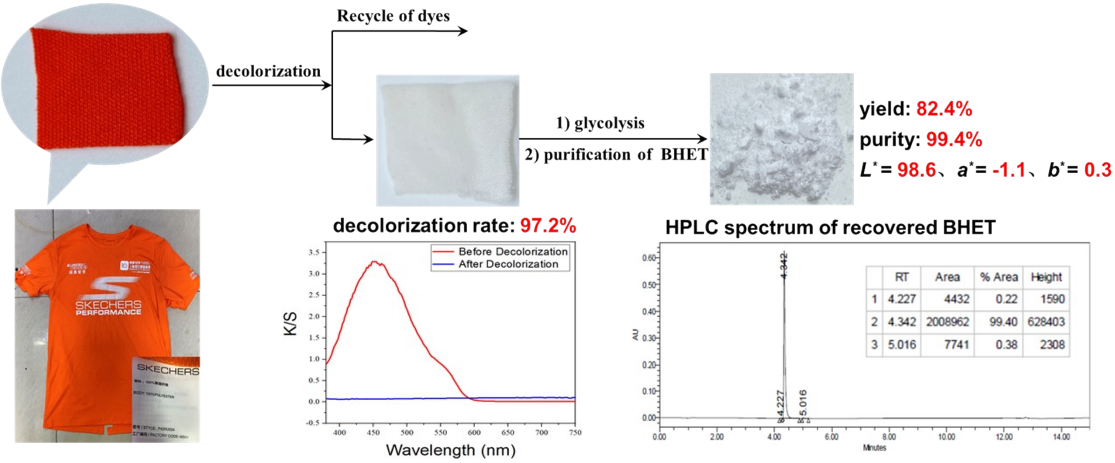




Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
36	2022/12/24 15:49:08	D65/10°	99.57	-1.02	0.21	0	0	0	0	

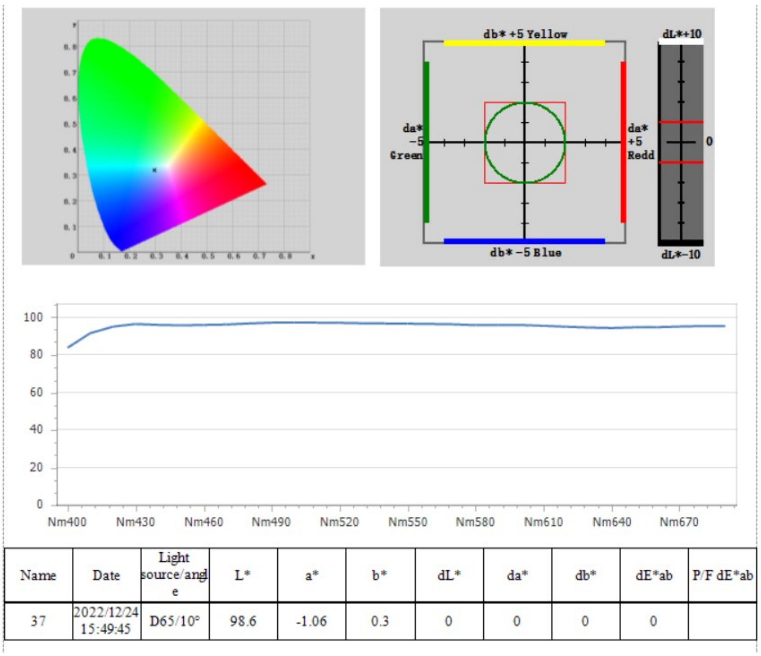
3.37 Sample 37

Composition： 100% Polyester



	RT	Area	% Area	Height
1	4.227	4432	0.22	1590
2	4.342	2008962	99.40	628403
3	5.016	7741	0.38	2308

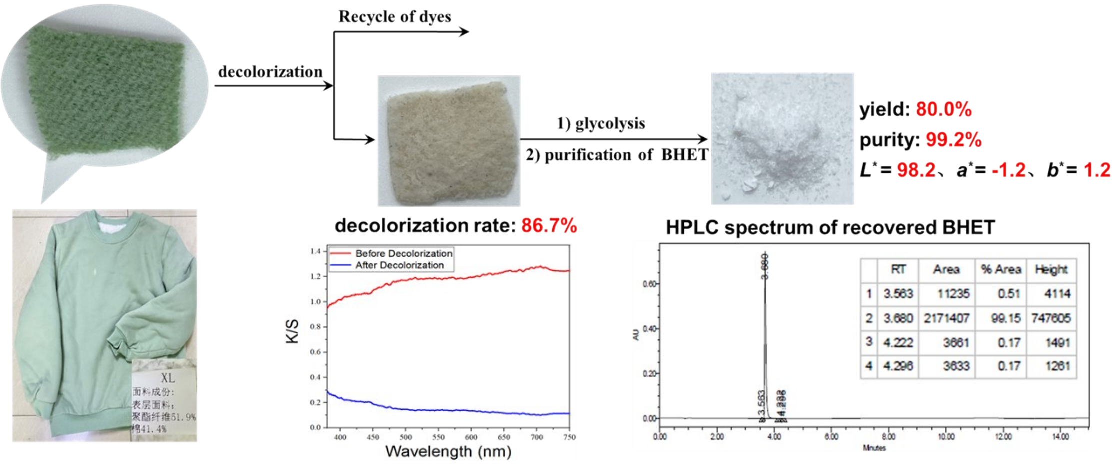
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
37	2022/12/24 15:49:45	D65/10°	98.6	-1.06	0.3	0	0	0	0	

3.38 Sample 38

Composition： 51.9% Polyester、48.1% Cotton



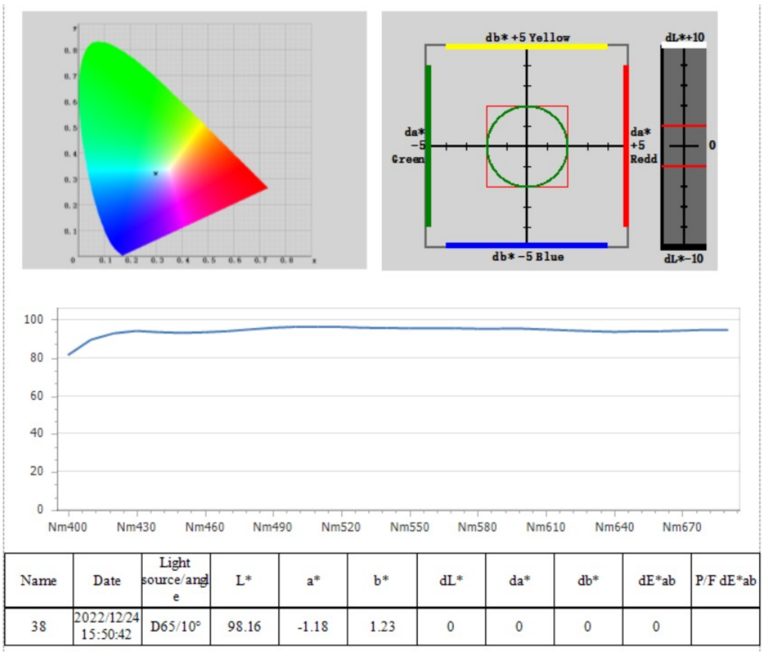
yield: 80.0%
purity: 99.2%
L^* = 98.2、a^* = -1.2、b^* = 1.2

decolorization rate: 86.7%

HPLC spectrum of recovered BHET

	RT	Area	% Area	Height
1	3.563	11235	0.51	4114
2	3.680	2171407	99.15	747605
3	4.222	3661	0.17	1491
4	4.296	3633	0.17	1261

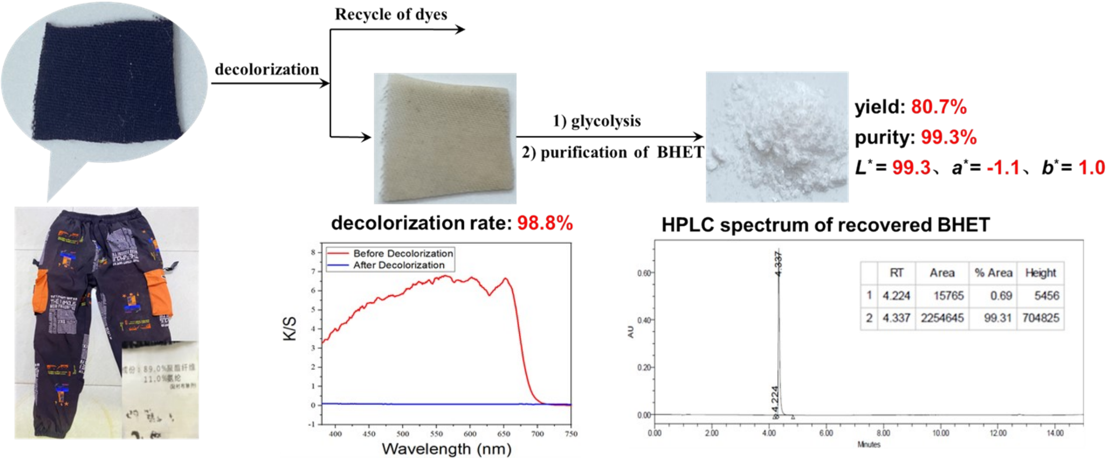
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
38	2022/12/24 15:50:42	D65/10°	98.16	-1.18	1.23	0	0	0	0	

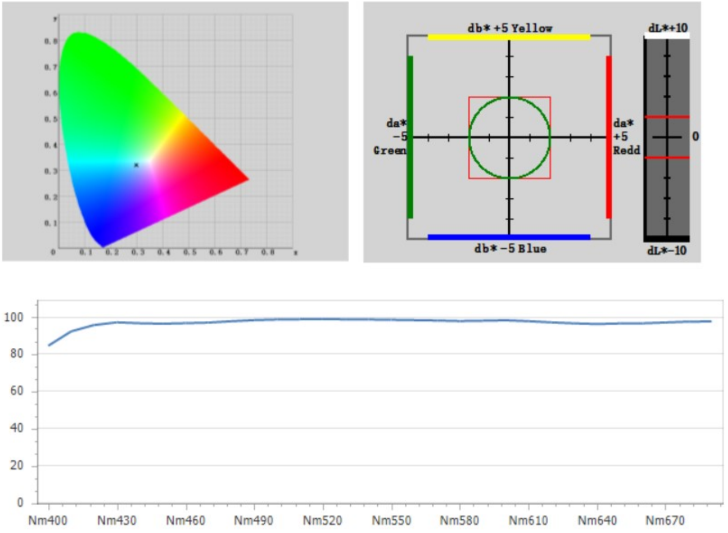
3.39 Sample 39

Composition： 89% Polyester、11% Spandex



	RT	Area	% Area	Height
1	4.224	15765	0.69	5456
2	4.337	2254645	99.31	704825

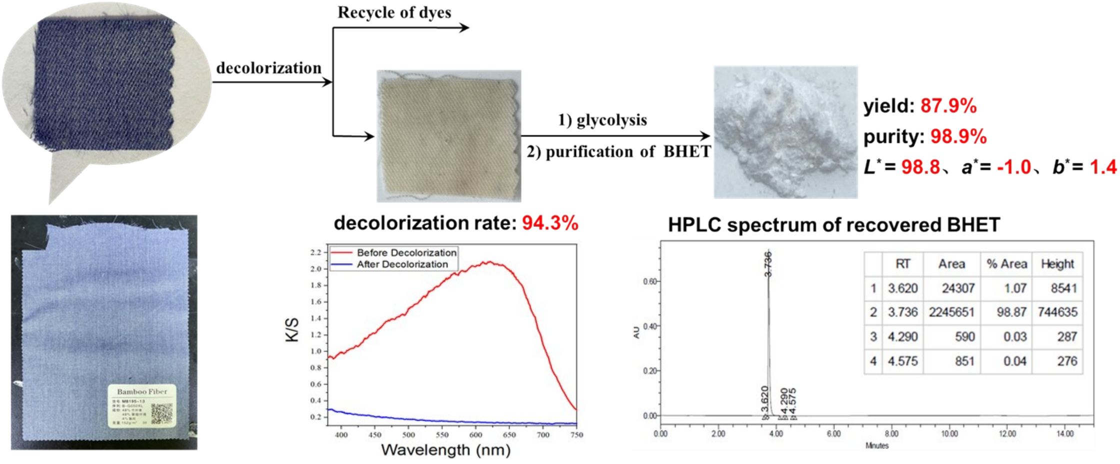
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
39	2022/12/24 15:51:28	D65/10°	99.31	-1.07	1.01	0	0	0	0	

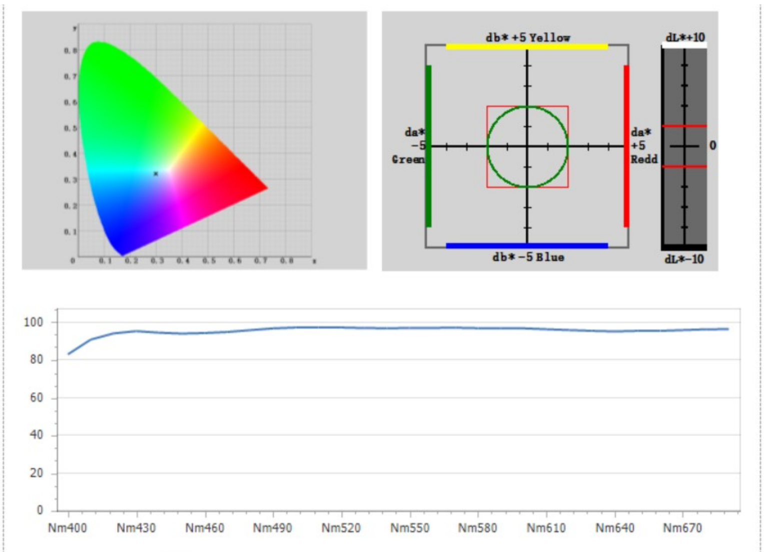
3.40 Sample 40

Composition：48% Polyester、48% Bamboo Fiber、4%Spandex



	RT	Area	% Area	Height
1	3.620	24307	1.07	8541
2	3.736	2245651	98.87	744635
3	4.290	590	0.03	287
4	4.575	851	0.04	276

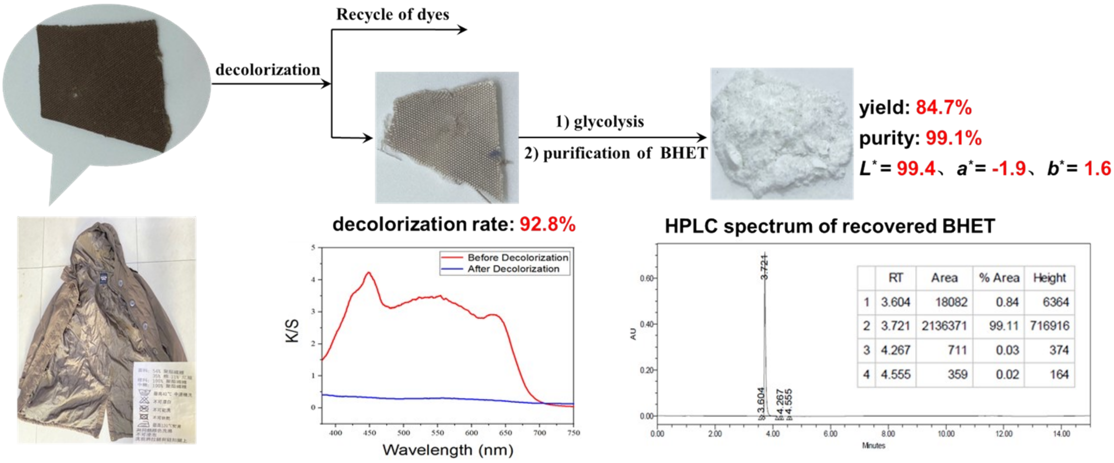
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
40	2022/12/24 15:52:10	D65/10°	98.77	-1.03	1.44	0	0	0	0	

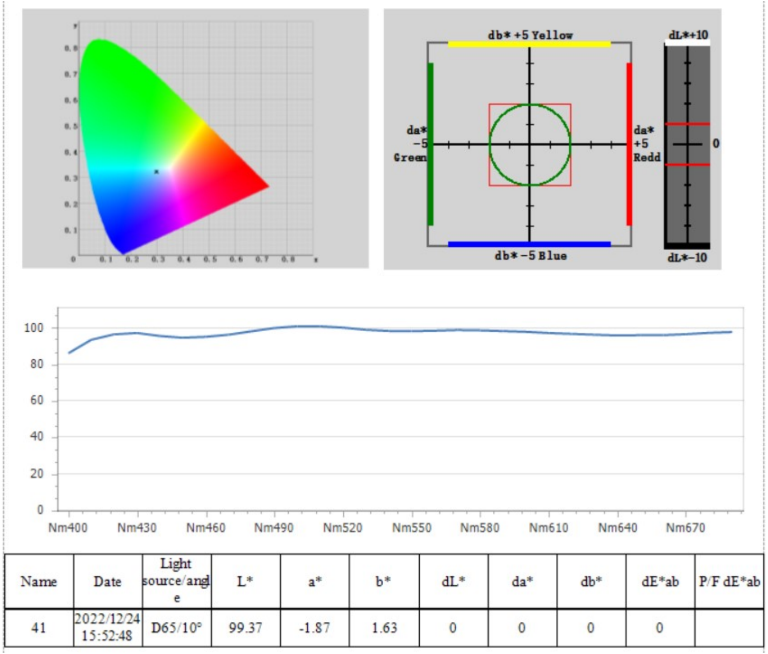
3.41 Sample 41

Composition： 54% Polyester、35% Cotton、11% Nylon



	RT	Area	% Area	Height
1	3.604	18082	0.84	6364
2	3.721	2136371	99.11	716916
3	4.267	711	0.03	374
4	4.555	359	0.02	164

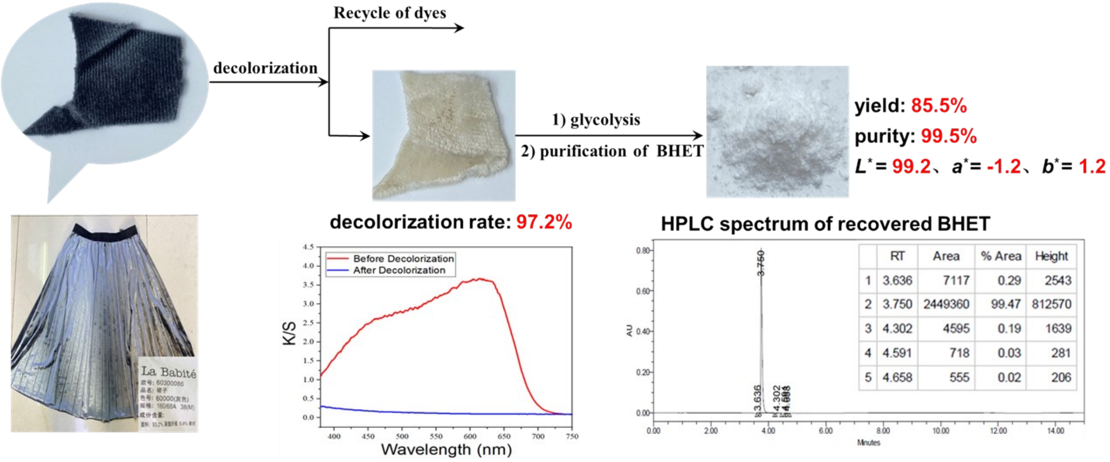
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
41	2022/12/24 15:52:48	D65/10°	99.37	-1.87	1.63	0	0	0	0	

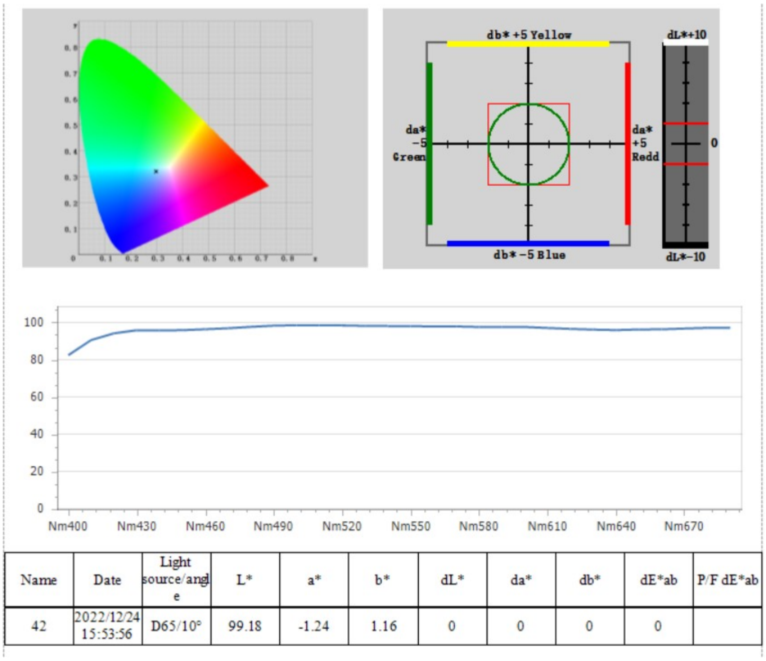
3.42 Sample 42

Composition：93.2% Polyester、6.8% Spandex



	RT	Area	% Area	Height
1	3.636	7117	0.29	2543
2	3.750	2449360	99.47	812570
3	4.302	4595	0.19	1639
4	4.591	718	0.03	281
5	4.658	555	0.02	206

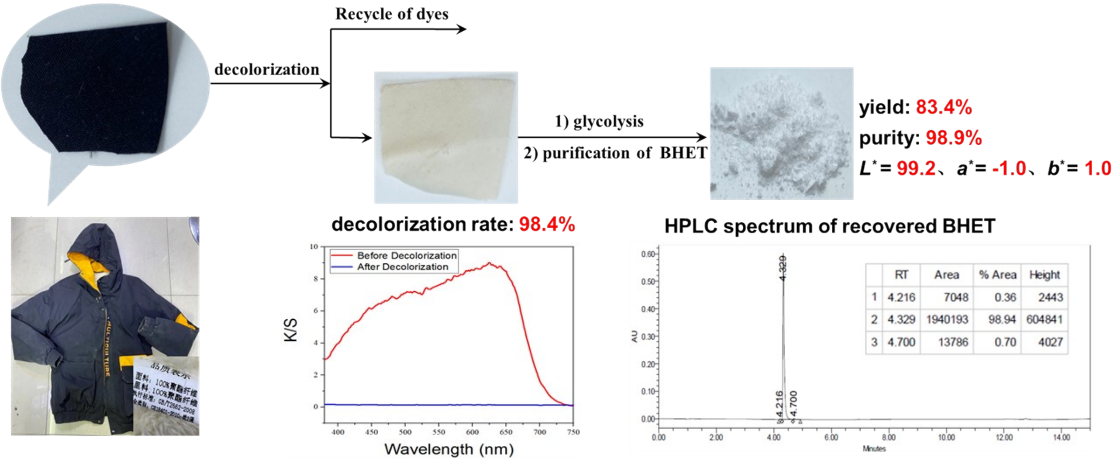
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
42	2022/12/24 15:53:56	D65/10°	99.18	-1.24	1.16	0	0	0	0	

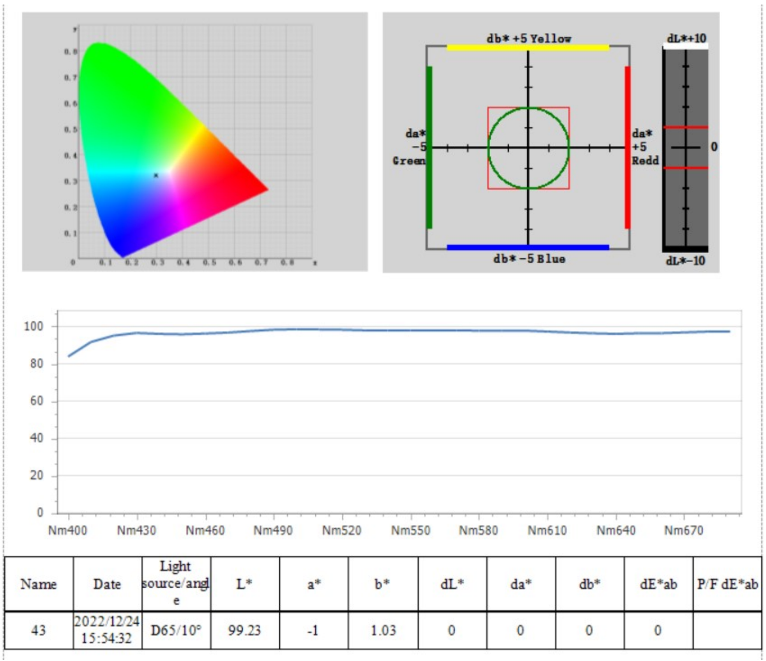
3.43 Sample 43

Composition： 100% Polyester



	RT	Area	% Area	Height
1	4.216	7048	0.36	2443
2	4.329	1940193	98.94	604841
3	4.700	13786	0.70	4027

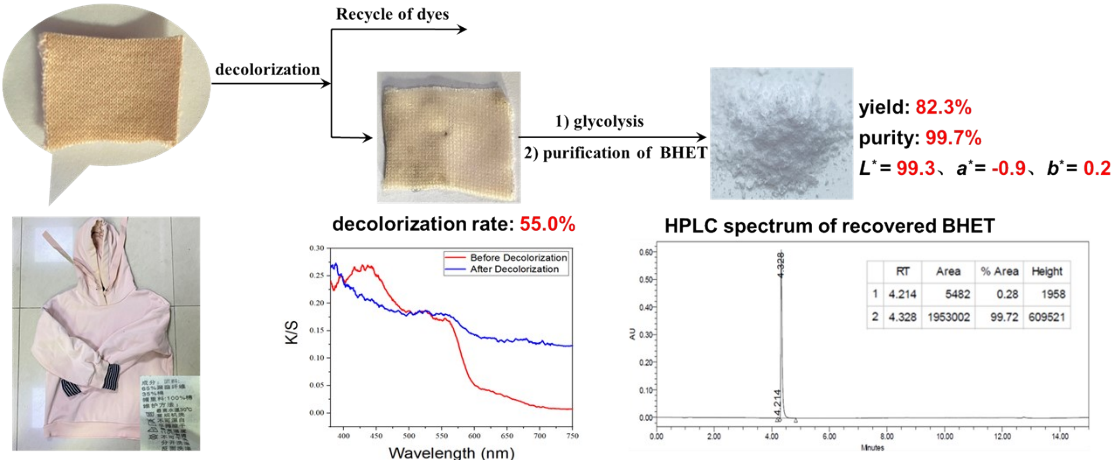
Chromaticity of recovered BHET：



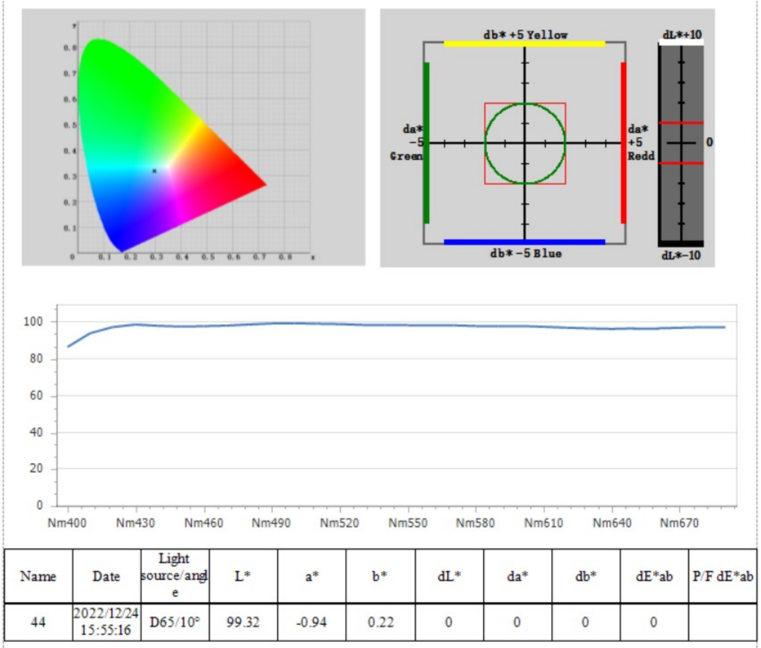
Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
43	2022/12/24 15:54:32	D65/10°	99.23	-1	1.03	0	0	0	0	

3.44 Sample 44

Composition： 65% Polyester、35% Cotton



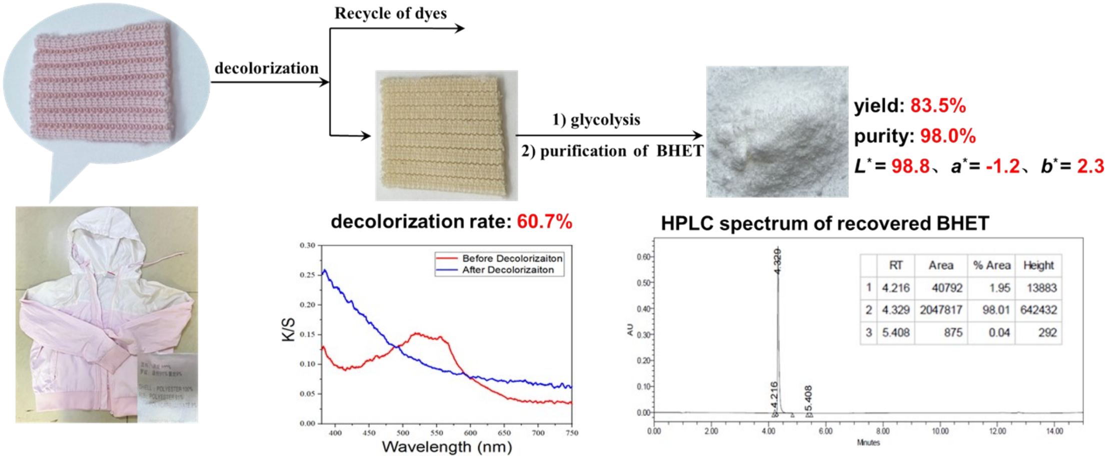
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
44	2022/12/24 15:55:16	D65/10°	99.32	-0.94	0.22	0	0	0	0	

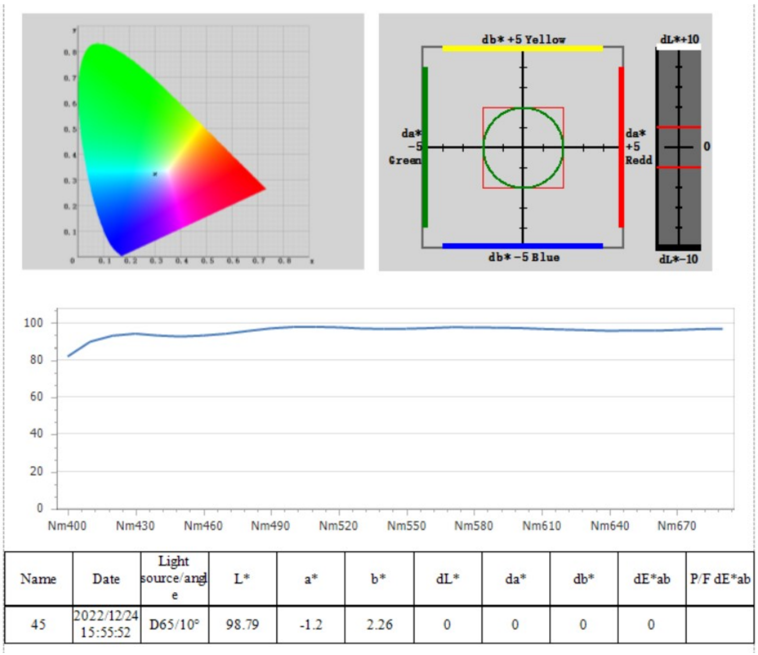
3.45 Sample 45

Composition：91% Polyester、9% Spandex



	RT	Area	% Area	Height
1	4.216	40792	1.95	13883
2	4.329	2047817	98.01	642432
3	5.408	875	0.04	292

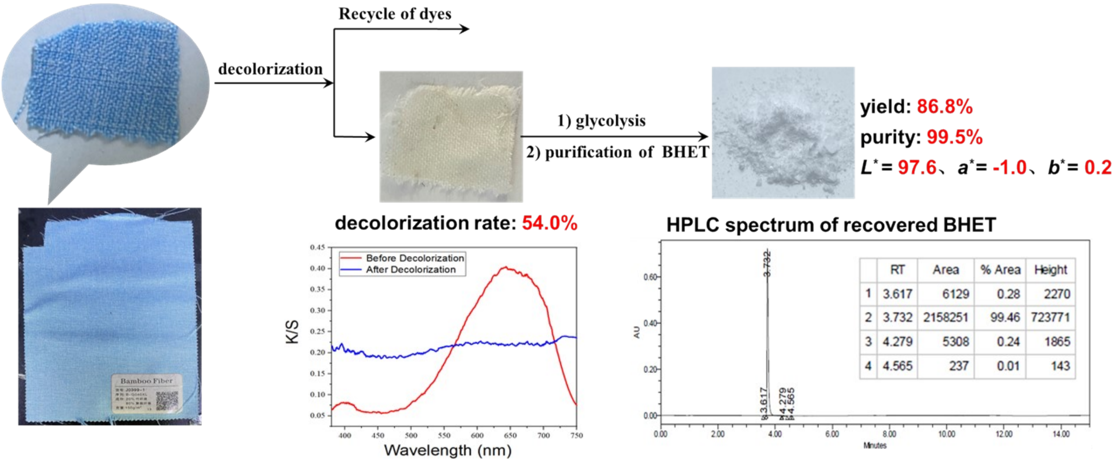
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
45	2022/12/24 15:55:52	D65/10°	98.79	-1.2	2.26	0	0	0	0	

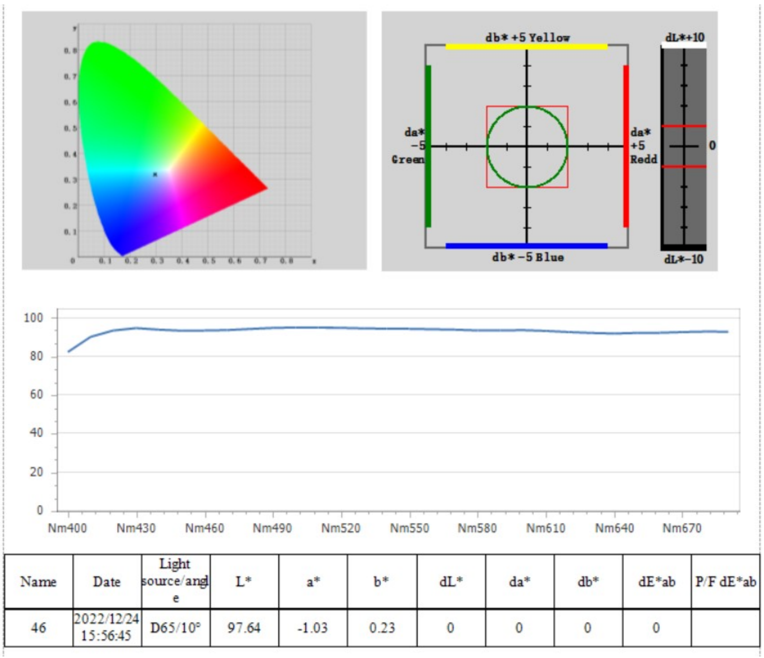
3.46 Sample 46

Composition： 80% Polyester、20% Bamboo Fiber



	RT	Area	% Area	Height
1	3.617	6129	0.28	2270
2	3.732	2158251	99.46	723771
3	4.279	5308	0.24	1865
4	4.565	237	0.01	143

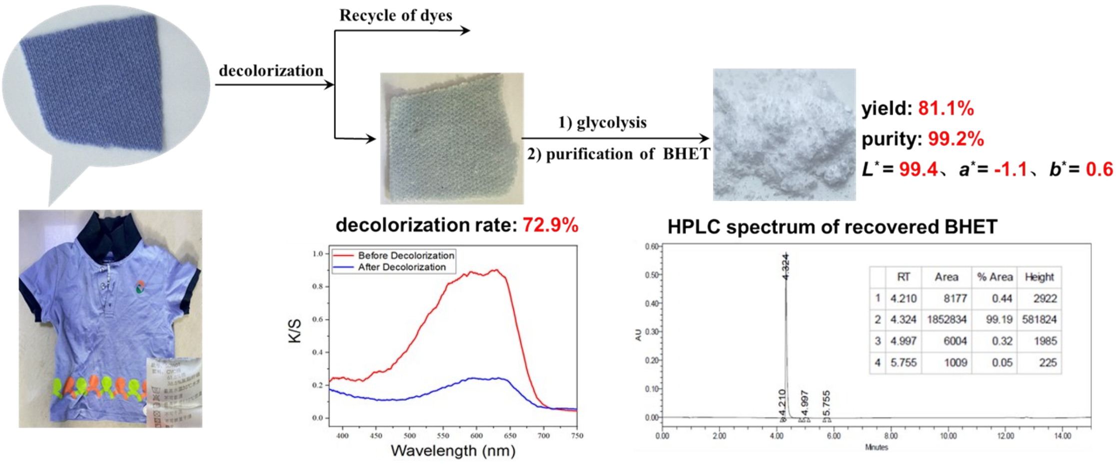
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
46	2022/12/24 15:56:45	D65/10°	97.64	-1.03	0.23	0	0	0	0	

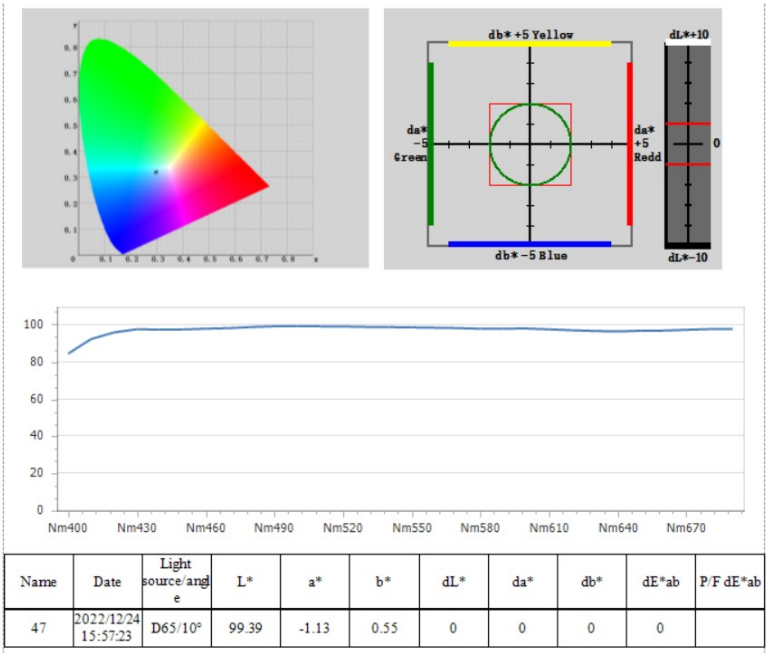
3.47 Sample 47

Composition： 38.5% Polyester、61.5% Bamboo Fiber



	RT	Area	% Area	Height
1	4.210	8177	0.44	2922
2	4.324	1852834	99.19	581824
3	4.997	6004	0.32	1985
4	5.755	1009	0.05	225

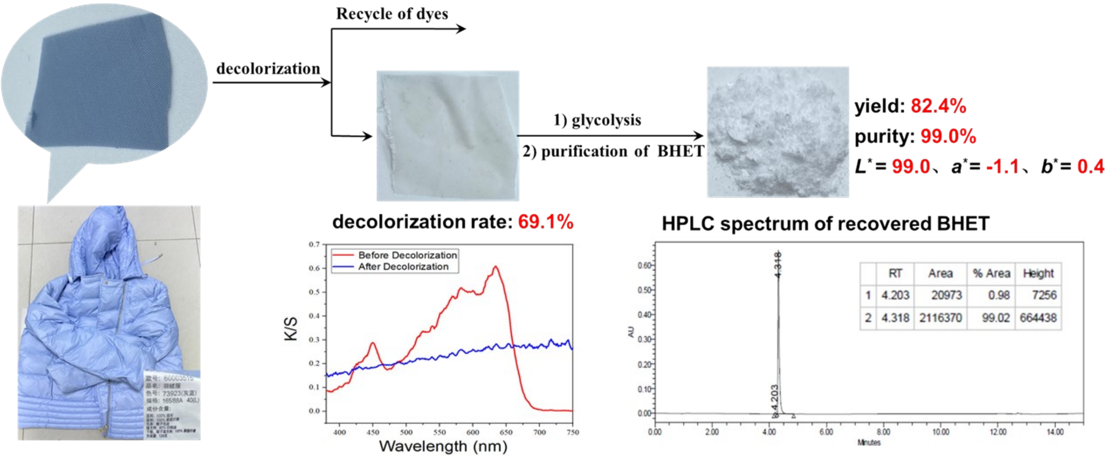
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
47	2022/12/24 15:57:23	D65/10°	99.39	-1.13	0.55	0	0	0	0	

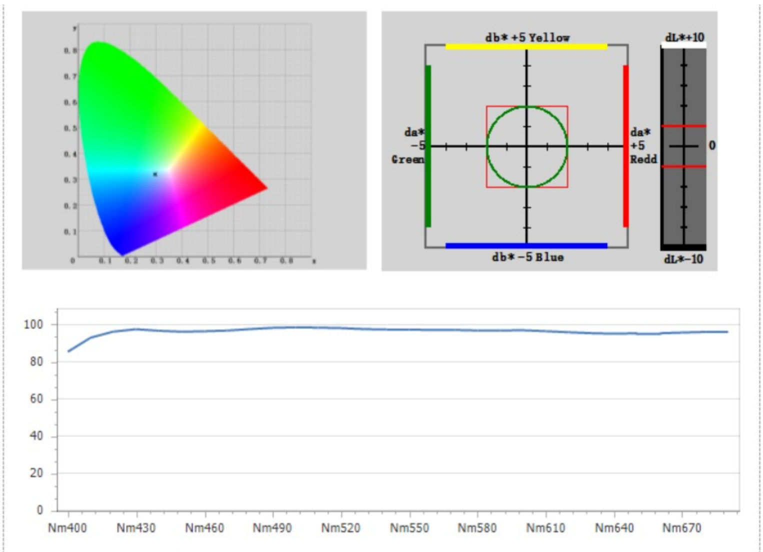
3.48 Sample 48

Composition： 100% Polyester



	RT	Area	% Area	Height
1	4.203	20973	0.98	7256
2	4.318	2116370	99.02	664438

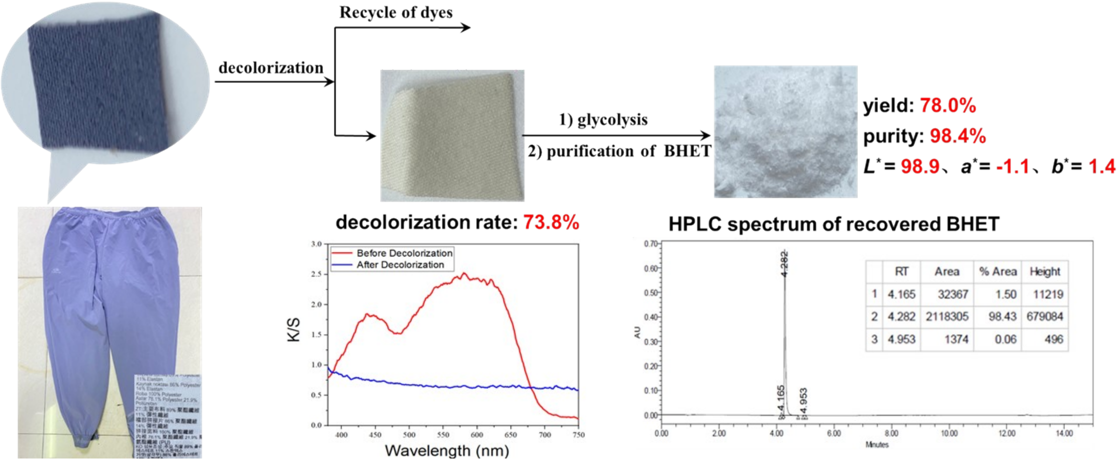
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
48	2022/12/24 15:58:01	D65/10°	98.97	-1.08	0.39	0	0	0	0	

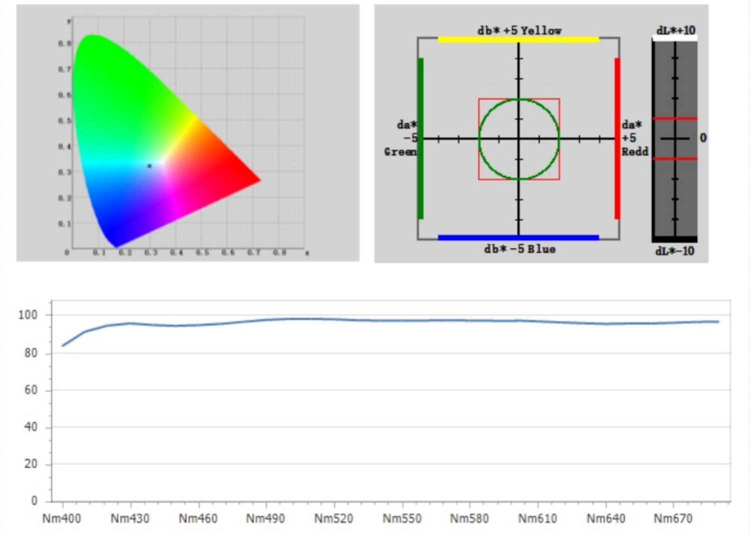
3.49 Sample 49

Composition：89% Polyester、11%Spandex



	RT	Area	% Area	Height
1	4.165	32367	1.50	11219
2	4.282	2118305	98.43	679084
3	4.953	1374	0.06	496

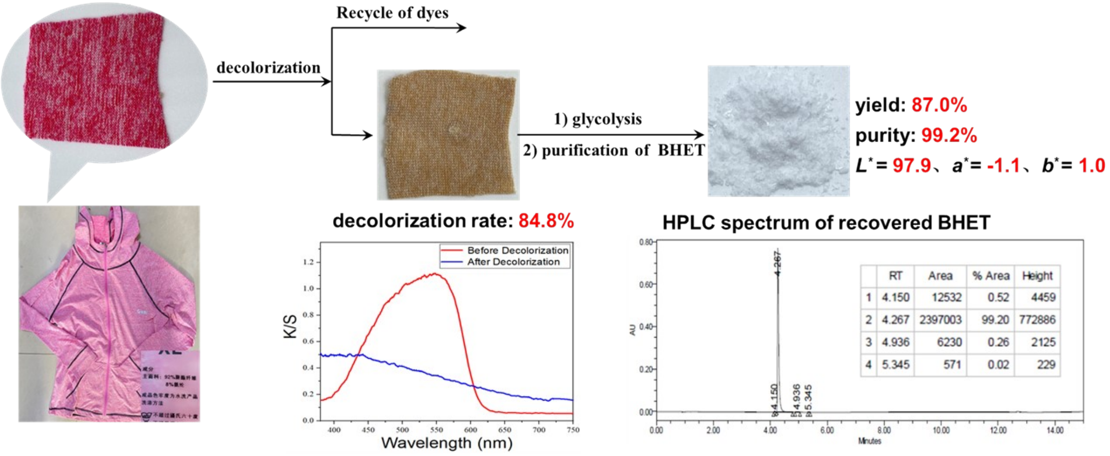
Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
49	2022/12/24 15:58:49	D65/10°	98.94	-1.14	1.42	0	0	0	0	

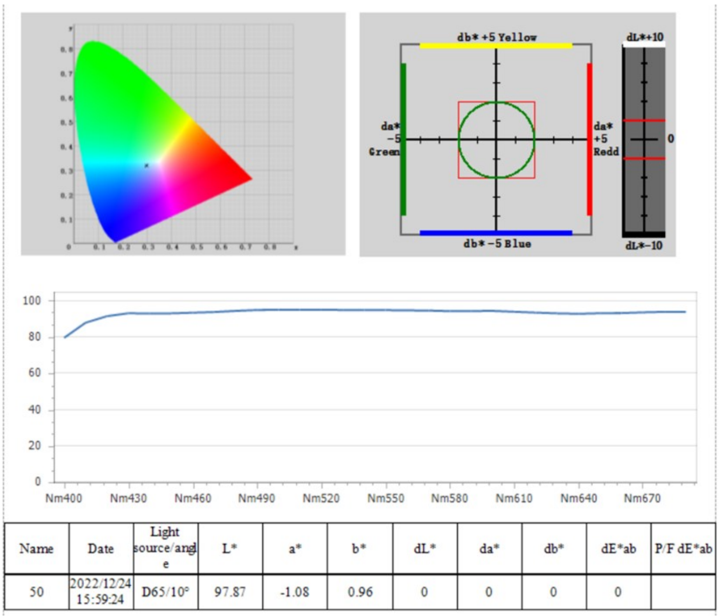
3.50 Sample 50

Composition：92% Polyester、8%Spandex



	RT	Area	% Area	Height
1	4.150	12532	0.52	4459
2	4.267	2397003	99.20	772886
3	4.936	6230	0.26	2125
4	5.345	571	0.02	229

Chromaticity of recovered BHET：



Name	Date	Light source/angle	L*	a*	b*	dL*	da*	db*	dE*ab	P/F dE*ab
50	2022/12/24 15:59:24	D65/10°	97.87	-1.08	0.96	0	0	0	0	

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