Supplementary Material

Incineration Characteristics of Several Typical Industrial Polymeric Wastes: Kinetics and Products distribution

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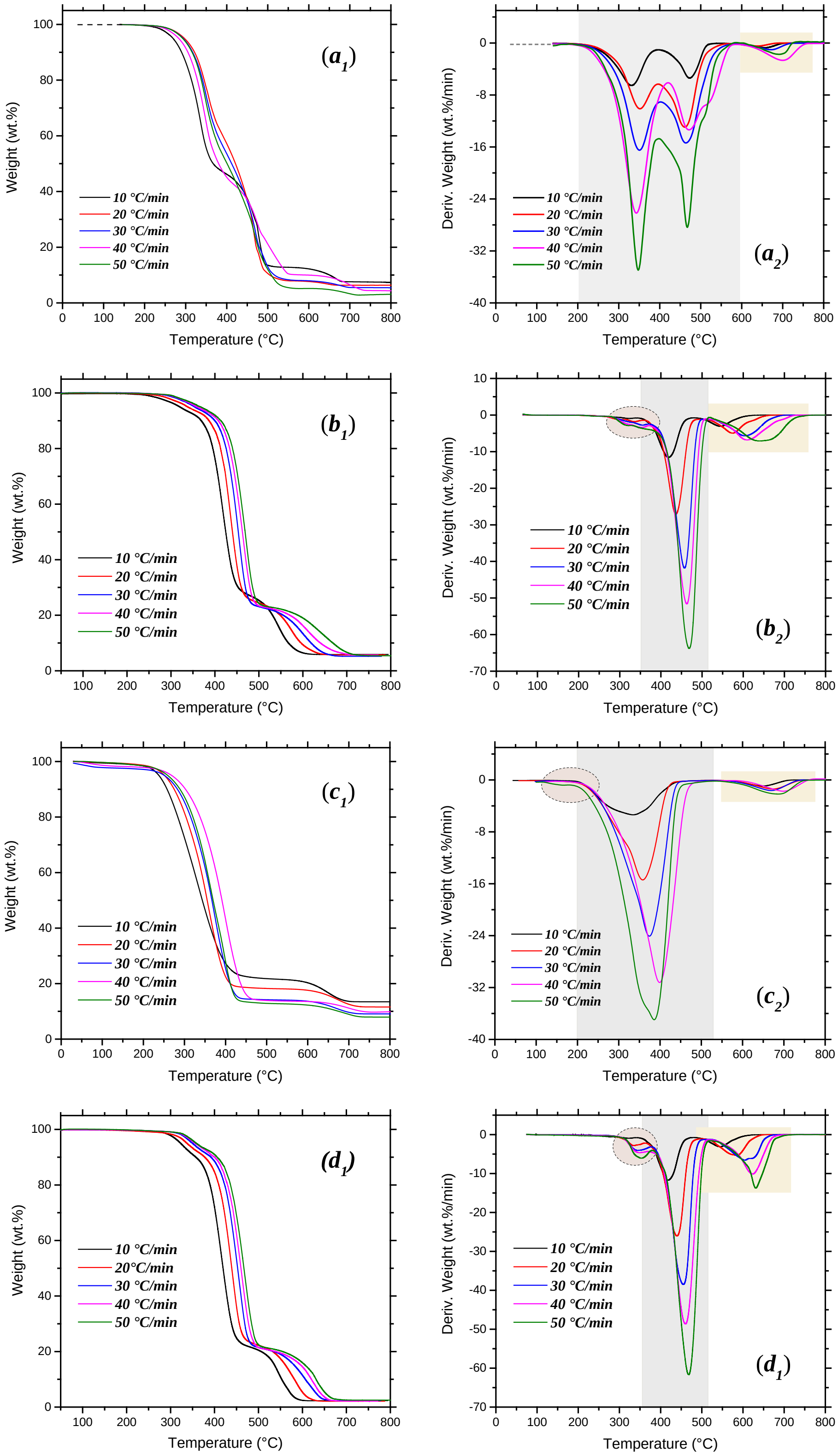

Figure S1. Thermogravimetric analysis (TG and DTG curves) of four kinds of industrial polymeric wastes: rubber (a_1 & a_2), leather (b_1 & b_2), plastic (c_1 & c_2) and cloth (d_1 & d_2) .

Table S1. Conventional combustion parameter of four polymeric waste polymers at different heating rates.

Sample	***β*** (°C/min)	t_i (min)	T_i (°C)	M_i wt.%	t_{max} (min)	T_{max} (°C)	DTG_{max} (%/min)	t_b (min)	T_b (°C)	M_b (wt.%)	DTG_{mean} (%/min)	M_f (wt.%)
Rubber	10	25.2	282	91.9	30.1	331	6.5	65.4	684	7.91	2.09	7.43
	20	13.7	303	93.8	16.1	352	10.1	31.8	665	6.47	4.82	6.36
	30	9.1	302	93.2	10.7	350	16.5	22.4	700	5.67	6.59	5.44
	40	6.7	297	91.8	7.83	343	26.2	17.6	732	4.81	8.00	4.37
	50	5.5	303	92.6	6.37	348	35.0	13.6	708	3.16	11.0	3.10
Leather	10	33.9	382	86.5	37.5	418	11.6	53.4	577	8.45	4.01	5.85
	20	18.3	402	85.7	20.0	437	27.0	28.7	610	8.22	7.47	5.70
	30	13.0	417	84.7	14.2	453	41.8	20.5	645	6.75	10.3	5.19
	40	10.1	424	85.1	11.0	462	51.6	16.1	663	7.70	13.0	5.66
	50	8.3	429	85.7	9.07	468	63.8	13.7	701	6.59	14.6	5.40
Platics	10	22.4	254	91.1	30.0	335	5.4	65.8	687	14.0	1.78	13.4
	20	13.0	289	85.7	16.4	359	15.4	34.1	711	12.1	3.49	11.6
	30	9.1	303	84.5	11.5	374	24.1	22.7	710	9.40	5.54	9.09
	40	7.4	324	84.7	9.23	399	31.2	17.6	732	10.0	7.32	9.86
	50	5.5	305	85.8	7.10	385	37.0	13.9	726	8.10	9.23	7.92
Cloth	10	33.2	381	86.6	37.4	417	12.0	53.6	579	3.79	4.05	2.33
	20	18.3	401	84.2	20.1	439	25.1	28.7	611	3.64	7.69	2.11
	30	12.9	413	84.6	14.3	455	38.5	20.5	643	3.18	10.6	2.34
	40	10.0	419	84.9	11.0	461	49.5	15.8	652	3.32	14.0	2.16
	50	8.3	426	84.8	9.08	468	61.8	12.9	659	4.05	17.4	2.50

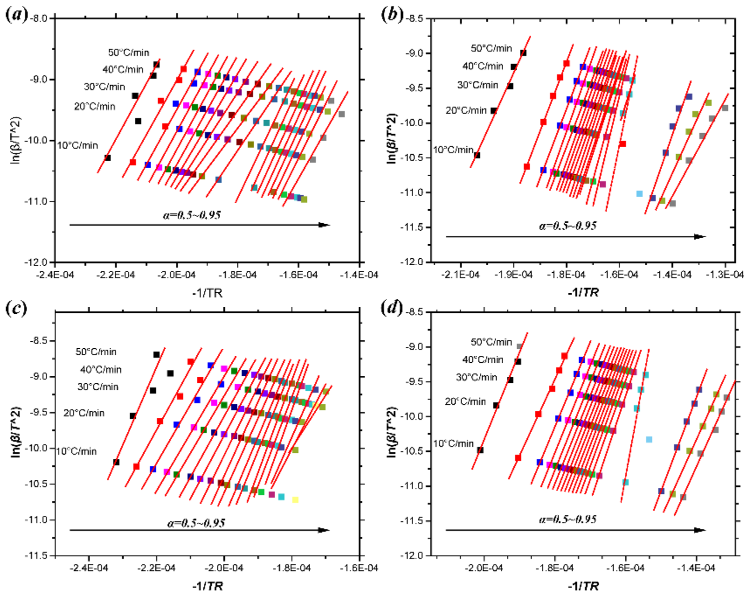

Figure S2. KAS fitting results for incineration of typical polymeric wastes: (a) rubber, (b) leather, (c) plastics and (d) cloth.

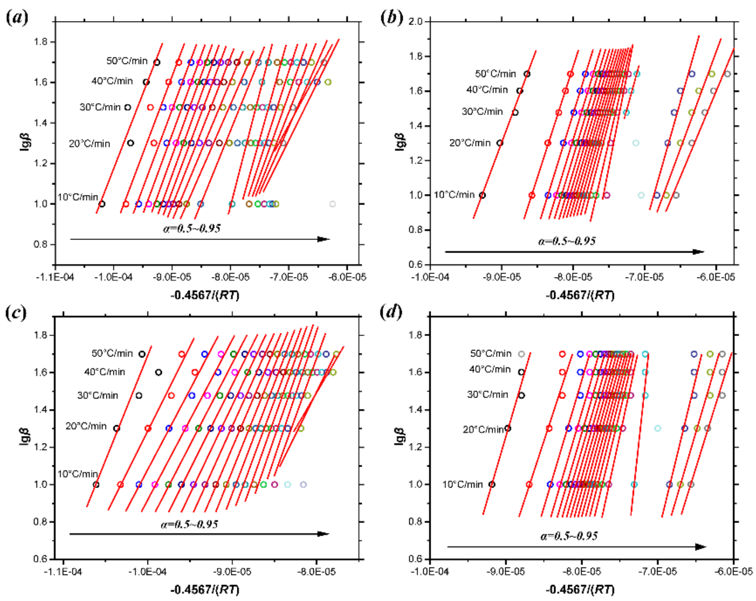

Figure S3. FWO fitting results for incineration of typical polymeric wastes: (a) rubber, (b) leather, (c) plastics and (d) cloth.

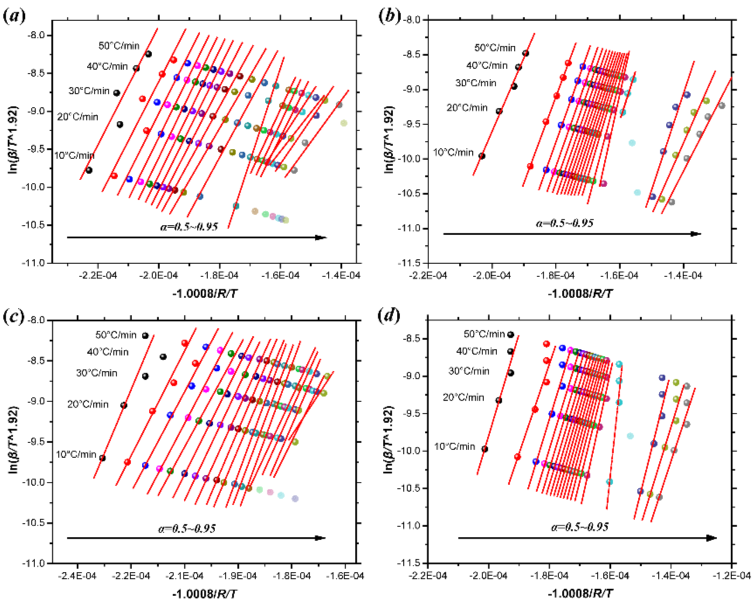

Figure S4. STK fitting results for incineration of typical polymeric wastes: (a) rubber, (b) leather, (c) plastics and (d) cloth.

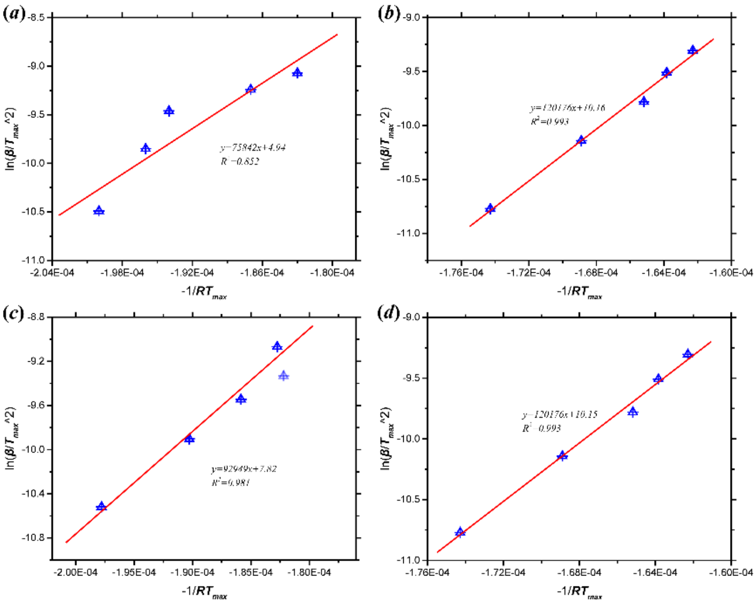

Figure S5. Kissinger fitting results for incineration of typical polymeric wastes: (a) rubber, (b) leather, (c) plastics and (d) cloth.

Table S2. E_a and R^2 values of the polymeric wastes according to DAEM, FWO, Starink, and Kissinger.

α	**Waste rubber** (kJ/mol)						**Waste leather** (kJ/mol)						**Waste plastic**(kJ/mol)						**Waste cloth** (kJ/mol)					
	DAEM		**FWO**		**STK**		**DAEM**		**FWO**		**STK**		**DAEM**		**FWO**		**STK**		**DAEM**		**FWO**		**STK**	
	E_a	R^2	E_a	R^2	E_a	R^2	E_a	R^2	E_a	R^2	E_a	R^2	E_a	R^2	E_a	R^2	E_a	R^2	E_a	R^2	E_a	R^2	E_a	R^2
0.05	87.9	0.896	88.9	0.896	88.2	0.896	104.1	0.983	110.3	0.993	106.1	0.991	108.8	0.929	112.3	0.935	104.7	0.896	125.4	0.993	138.7	0.962	136.0	0.956
0.10	82.5	0.886	88.4	0.886	82.9	0.887	124.4	0.999	127.8	0.999	123.7	0.999	86.0	0.976	90.5	0.975	86.3	0.975	109.7	0.998	123.9	0.960	119.8	0.953
0.15	82.1	0.887	87.4	0.887	82.4	0.888	124.5	0.999	132.8	0.999	128.7	0.999	81.8	0.987	85.7	0.983	82.5	0.988	122.1	0.998	136.5	0.959	132.8	0.953
0.20	86.1	0.884	91.0	0.884	86.5	0.885	134.7	0.994	134.8	0.999	130.7	0.999	80.0	0.974	85.6	0.986	83.5	0.990	125.4	0.996	137.8	0.958	134.0	0.952
0.25	85.4	0.880	91.3	0.880	85.8	0.881	124.5	0.999	136.4	0.999	132.3	0.999	80.1	0.974	87.3	0.987	80.6	0.976	126.5	0.997	139.8	0.957	135.9	0.951
0.30	81.4	0.873	88.0	0.873	81.8	0.875	134.8	0.994	138.4	0.999	134.2	0.999	85.2	0.977	90.2	0.990	88.4	0.993	126.7	0.997	140.0	0.957	136.1	0.951
0.35	78.0	0.863	84.3	0.863	78.4	0.864	134.8	0.994	139.4	0.999	135.2	0.998	88.4	0.993	94.9	0.989	92.8	0.981	128.2	0.997	142.0	0.956	138.1	0.950
0.40	68.9	0.846	75.3	0.846	69.3	0.848	134.9	0.994	140.7	0.997	136.5	0.997	95.9	0.995	100.2	0.992	96.6	0.995	129.0	0.998	143.9	0.957	140.0	0.951
0.45	60.7	0.833	68.4	0.833	61.1	0.835	134.9	0.994	142.1	0.997	137.9	0.996	103.3	0.998	106.1	0.992	103.6	0.998	130.1	0.999	146.6	0.958	142.8	0.952
0.50	58.5	0.830	66.4	0.830	58.9	0.832	143.9	0.996	144.1	0.995	140.0	0.994	103.8	0.998	112.8	0.994	104.3	0.998	131.5	0.999	148.9	0.959	145.1	0.953
0.55	64.9	0.871	72.3	0.871	65.3	0.872	144.1	0.996	147.2	0.994	143.1	0.993	111.7	0.996	118.6	0.995	119.5	0.992	133.8	0.999	151.3	0.960	147.6	0.953
0.60	89.6	0.755	97.0	0.993	90.0	0.824	144.4	0.996	151.5	0.992	147.6	0.991	116.0	0.975	122.7	0.988	116.7	0.974	135.9	0.999	156.2	0.960	152.7	0.954
0.65	93.8	0.801	100.6	0.845	94.2	0.845	146.7	0.978	157.7	0.99	154.1	0.988	128.8	0.966	128.4	0.973	120.8	0.985	138.8	0.999	161.0	0.961	157.6	0.955
0.70	85.2	0.823	92.8	0.751	85.7	0.834	173.1	0.974	177.9	0.982	175.2	0.98	124.0	0.914	131.4	0.934	93.8	0.816	142.5	0.999	167.8	0.961	164.8	0.955
0.75	84.9	0.830	93.9	0.842	85.3	0.855	197.5	0.880	210.2	0.918	209.0	0.909	131.8	0.816	135.8	0.841	97.9	0.711	152.2	0.998	186.4	0.955	184.2	0.949
0.80	83.2	0.826	91.3	0.824	83.6	0.872	153.3	0.989	148.4	0.984	143.7	0.981	131.0	0.678	125.8	0.807	102.2	0.790	278.3	0.989	372.2	0.961	379.0	0.959
0.85	83.2	0.812	92.1	0.832	83.7	0.836	137.5	0.963	145.0	0.942	139.0	0.93	116.4	0.755	91.6	0.744	88.8	0.764	134.8	0.998	166.7	0.958	162.1	0.951
0.90	73.0	0.781	82.1	0.841	73.5	0.792	104.5	0.964	111.6	0.967	103.5	0.958	73.7	0.889	77.1	0.896	67.4	0.824	112.1	0.997	138.0	0.962	131.6	0.954
0.95	71.4	0.834	80.0	0.951	71.9	0.812	87.0	0.963	98.5	0.969	89.4	0.957	—	—	—	—	—	—	112.7	0.992	130.4	0.961	123.2	0.953
Average	79.0	0.843	85.9	0.865	79.4	0.854	136.0	0.982	141.8	0.985	137.4	0.982	102.6	0.933	105.4	0.945	96.1	0.925	136.6	0.997	159.4	0.959	156.0	0.953
Kissinger	***Ea***=75.842, R^2=0.8520						***Ea***=121.43, R^2=0.9957						***Ea***=92.9, R^2=0.9812						***Ea***=120.175, R^2=0.9926					

Table S3. Thermodynamic parameters for the polymaric wastes combustions using FWO at 20 K/min.

α	Waste rubber				Waste leather				Waste plastic				Waste cloth			
	A (s^{-1})	***ΔH***(kJ/mol)	***ΔG***(kJ/mol)	***ΔS***(J/mol/K)	***A*** (s^{-1})	***ΔH***(kJ/mol)	***ΔG***(kJ/mol)	***ΔS***(J/mol/K)	***A*** (s^{-1})	***ΔH***(kJ/mol)	***ΔG***(kJ/mol)	***ΔS***(J/mol/K)	***A*** (s^{-1})	***ΔH***(kJ/mol)	***ΔG***(kJ/mol)	***ΔS***(J/mol/K)
0.05	2.45×10^{5}	84.2	181.3	-155.4	1.14×10^{6}	105.2	207.0	-0.143	2.17×10^{7}	107.9	182.3	-117.7	1.66×10^{8}	133.7	206.2	-102.0
0.10	2.20×10^{5}	83.5	181.4	-156.6	2.55×10^{7}	122.3	206.1	-0.118	2.74×10^{5}	85.9	183.4	-154.3	1.20×10^{7}	118.5	206.9	-124.2
0.15	1.79×10^{5}	82.3	181.4	-158.5	6.19×10^{7}	127.2	205.9	-0.111	1.04×10^{5}	81.0	183.7	-162.5	1.11×10^{8}	130.9	206.3	-105.9
0.20	3.73×10^{5}	85.8	181.2	-152.6	8.93×10^{7}	129.1	205.8	-0.108	1.02×10^{5}	80.8	183.7	-162.8	1.40×10^{8}	132.1	206.3	-104.2
0.25	3.98×10^{5}	86.1	181.2	-152.2	1.18×10^{8}	130.7	205.7	-0.106	1.43×10^{5}	82.4	183.6	-160.1	1.99×10^{8}	134.1	206.2	-101.3
0.30	2.05×10^{5}	82.7	181.4	-157.8	1.67×10^{8}	132.6	205.6	-0.103	2.60×10^{5}	85.3	183.4	-155.3	2.08×10^{8}	134.3	206.2	-101.0
0.35	9.63×10^{4}	79.0	181.6	-164.2	2.00×10^{8}	133.6	205.6	-0.101	6.59×10^{5}	89.9	183.2	-147.7	2.92×10^{8}	136.1	206.1	-98.3
0.40	1.53×10^{4}	69.9	182.2	-179.7	2.50×10^{8}	134.8	205.5	-0.100	1.93×10^{6}	95.1	182.9	-138.8	4.11×10^{8}	138.1	206.0	-95.5
0.45	3.64×10^{3}	62.8	182.7	-191.8	3.20×10^{8}	136.2	205.5	-0.098	6.26×10^{6}	101.0	182.6	-129.2	6.63×10^{8}	140.7	205.9	-91.5
0.50	2.41×10^{3}	60.7	182.8	-195.4	4.57×10^{8}	138.2	205.4	-0.095	2.39×10^{7}	107.6	182.3	-118.1	9.86×10^{8}	143.0	205.8	-88.3
0.55	8.25×10^{3}	66.5	182.4	-185.4	7.86×10^{8}	141.2	205.3	-0.090	7.62×10^{7}	113.4	182.0	-108.6	1.49×10^{9}	145.3	205.7	-84.9
0.60	1.27×10^{6}	91.1	180.9	-143.7	1.68×10^{9}	145.5	205.1	-0.084	1.70×10^{8}	117.4	181.8	-101.9	3.58×10^{9}	150.2	205.5	-77.7
0.65	2.62×10^{6}	94.6	180.7	-137.7	5.02×10^{9}	151.7	204.9	-0.075	5.29×10^{8}	123.1	181.6	-92.6	8.19×10^{9}	154.9	205.4	-70.8
0.70	5.39×10^{5}	86.7	181.1	-151.0	1.74×10^{11}	171.8	204.1	-0.046	9.59×10^{8}	126.1	181.5	-87.7	2.73×10^{10}	161.8	205.1	-60.9
0.75	6.75×10^{5}	87.8	181.0	-149.2	4.91×10^{13}	204.1	203.2	0.001	2.28×10^{9}	130.4	181.3	-80.6	6.98×10^{11}	180.3	204.5	-34.0
0.80	3.98×10^{5}	85.1	181.2	-153.7	9.71×10^{8}	141.9	205.2	-0.089	3.18×10^{8}	120.4	181.7	-97.0	6.01×10^{25}	365.7	200.4	232.2
0.85	4.75×10^{5}	85.9	181.1	-152.3	5.35×10^{8}	138.1	205.4	-0.095	3.42×10^{5}	86.1	183.4	-153.9	2.26×10^{10}	159.9	205.2	-63.6
0.90	6.14×10^{4}	75.8	181.7	-169.5	1.44×10^{6}	104.6	206.9	-0.144	1.84×10^{4}	71.6	184.3	-178.4	1.46×10^{8}	131.0	206.3	-105.7
0.95	3.99×10^{4}	73.6	181.9	-173.3	1.39×10^{5}	91.3	207.6	-0.164	——	——	——	——	3.80×10^{7}	123.2	206.6	-117.1
Average	4.12×10^{5}	80.2	181.5	-162.114	2.59×10^{12}	135.8	205.6	-0.10	2.44×10^{8}	100.3	182.7	-130.4	3.16×10^{24}	153.4	205.6	-73.4

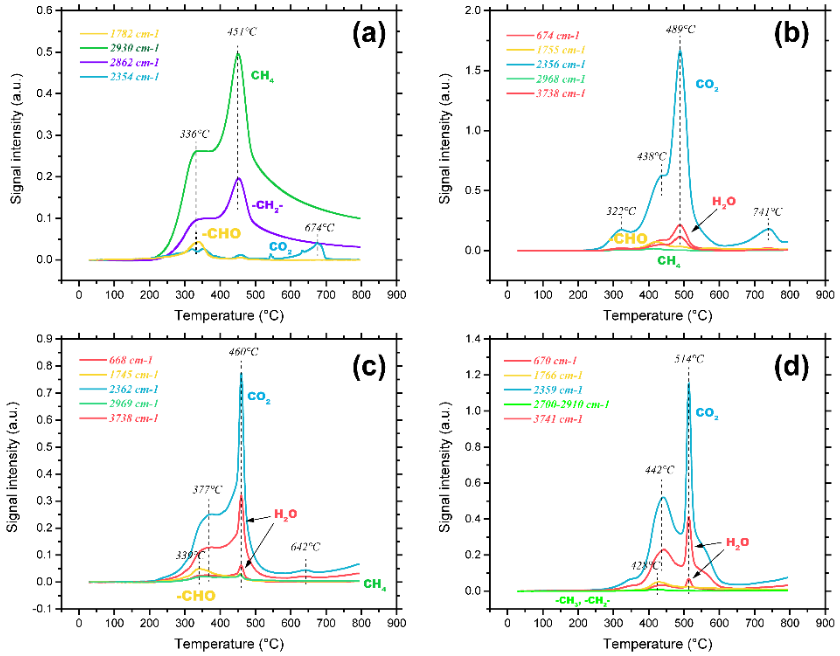

Figure S6. The intensity evolution of main infrared absorption peaks with temperature.

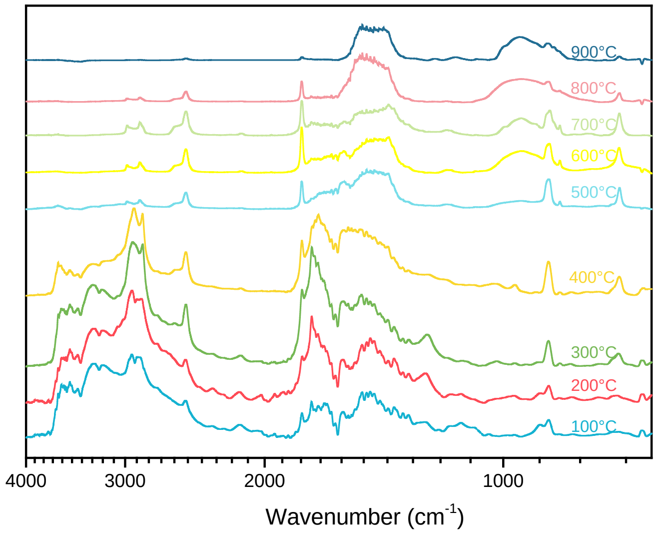

Figure S7. FTIR spectra of residual phase of waste rubber at different combustion temperature.

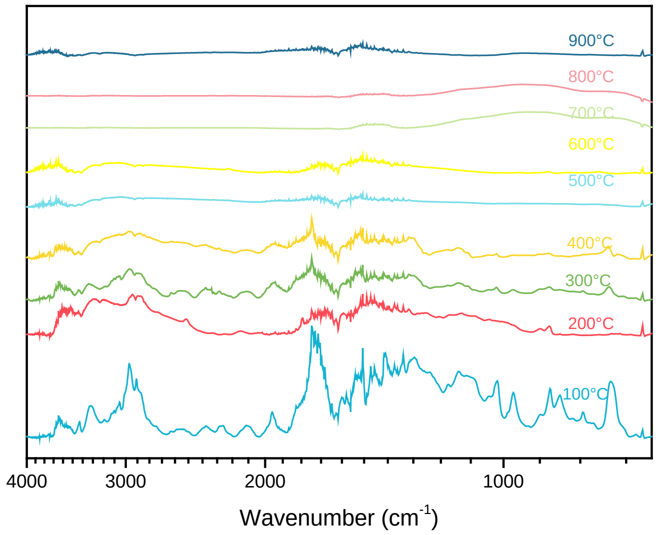

Figure S8. FTIR spectra of residual phase of waste leather at different combustion temperature.

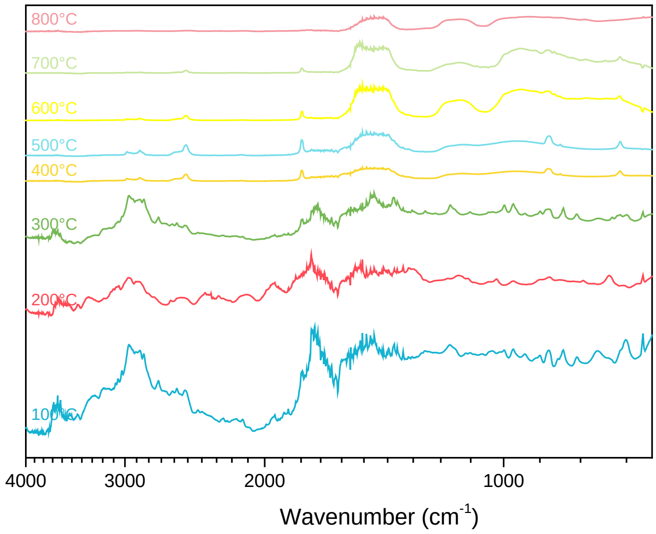

Figure S9. FTIR spectra of residual phase of waste at different combustion temperature.

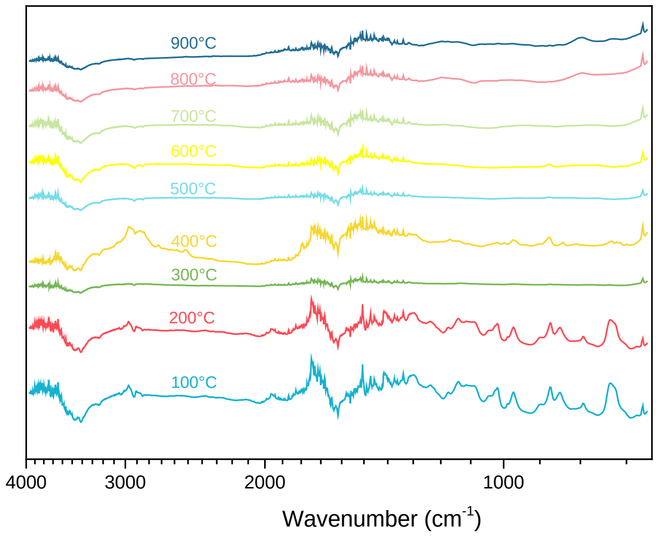

Figure S10. FTIR spectra of residual phase of waste cloth at different combustion temperature.