Supplementary material

Harnessing Waste-to-Energy Potential from Plastic Waste Co-Incineration

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Table S1.
Values of TG/DTG/DSC/MS for PA6

Material	DSC (the characteristic peaks)	TG	DTG (the characteristic peaks)	MS (m/z=44) (the characteristic peaks; total ion current I)
PA6	Endothermic peak $T_{DSC\ peak}$ = 205 °C DSC_{peak} = – 2.17 mW/mg Exothermic peak $T_{DSC\ peak}$ = 458 °C DSC_{peak} = 12.98 mW/mg $T_{DSC\ max.\ peak}$ = 494 °C $DSC_{max\ peak}$ = 16.15mW/mg ΔDSC (Endothermic effect) = 223.5 J/g onset = 166 °C end = 223 °C ΔDSC (Exothermic effect) = 9772 J/g onset = 451 °C end = 525 °C	T = 200 °C TG = 99% T = 400 °C TG = 90% T = 600 °C TG = 3% TG = 95% T= 370 °C TG = 50% T= 446 °C	$DTG_{max\ peak}$= 18.56%/min. DTG_{peak} = 3.04 %/min.	$I_{max.\ peak}$ = $0.14 \cdot 10^{-9}$A I_{peak} = $0.06 \cdot 10^{-9}$A ΔI = $44.41 \cdot 10^{-9}$A·s onset = 311 °C end = 561 °C

Table S2.

Values of TG/DTG/DSC/MS for different mixtures of fuels

Material	DSC (the characteristic peaks)	TG	DTG (the characteristic peaks)	MS (m/z=44) (the characteristic peaks; total ion current I)
coal (C)	Exothermic peaks $T_{DSC\ max.\ peak}$ = 485 °C $DSC_{max\ peak}$ = 19.52 mW/mg ΔDSC (Exothermic effect) = 20381 J/g onset = 389 °C end = 559 °C	T = 200 °C TG = 95% T = 400 °C TG = 86% T = 600 °C TG = 25% TG = 5% T= 303 °C TG = 50% T= 489 °C	$DTG_{max.\ peak}$ = 5.53 %/min.	$I_{max.\ peak} = 0.09 \cdot 10^{-9}$A $\Delta I = 61.13 \cdot 10^{-9}$A·s onset = 210 °C end = 612 °C
C + PA6 (10%/90%)	Endothermic peaks $T_{DSC\ peak}$ = 205 °C DSC_{peak} = – 2.25 mW/mg Exothermic peaks $T_{DSC\ peak}$ = 449 °C DSC_{peak} = 12.37 mW/mg $T_{DSC\ max.\ peak}$ = 498 °C $DSC_{max\ peak}$ = 15.69 mW/mg ΔDSC (Endothermic effect)= 372.1 J/g onset = 168 °C end = 222 °C ΔDSC (Exothermic effect) = 11400 J/g onset = 392 °C end = 544 °C	T = 200 °C TG = 99% T = 400 °C TG = 88% T = 600 °C TG = 4% TG = 95% T= 368 °C TG = 50% T= 446 °C	$DTG_{max.\ peak}$ =16.34%/min. DTG_{peak} = 3.21 %/min.	$I_{max.\ peak} = 0.14 \cdot 10^{-9}$A $I_{peak} = 0.05 \cdot 10^{-9}$A $\Delta I = 44.59 \cdot 10^{-9}$A·s onset = 312 °C end = 585 °C
C + PA6 (20%/80%)	Endothermic peaks $T_{DSC\ peak}$ = 205 °C DSC_{peak} = – 2.24 mW/mg Exothermic peaks $T_{DSC\ peak}$ =435 °C DSC_{peak} = 10.13mW/mg $T_{DSC\ max.\ peak}$ = 504 °C $DSC_{max\ peak}$ = 18.49 mW/mg ΔDSC (Endothermic effect) = 285.3 J/g onset = 165 °C end = 223 °C	T = 200 °C TG = 98% T = 400 °C TG = 90% T = 600 °C TG = 7% TG = 95% T= 363 °C TG = 50% T= 446 °C	$DTG_{max.\ peak}$ =15.24%/min. DTG_{peak} = 4.51 %/min.	$I_{max.\ peak} = 0.09 \cdot 10^{-9}$A $I_{peak} = 0.06 \cdot 10^{-9}$A $\Delta I = 44.67 \cdot 10^{-9}$A·s onset = 251 °C end = 598 °C

	ΔDSC (Exothermic effect) = 11542 J/g onset = 415 °C end = 544 °C			
C + PA6 (30%/70%)	Endothermic peaks $T_{DSC\ peak}$ = 206 °C DSC_{peak} = – 2.54 mW/mg Exothermic peaks $T_{DSC\ peak}$ =446 °C DSC_{peak} =12.01 mW/mg $T_{DSC\ max.\ peak}$ = 512 °C $DSC_{max\ peak}$ = 22.04 mW/mg ΔDSC (Endothermic effect) = 510.8 J/g onset = 167 °C end = 225 °C ΔDSC (Exothermic effect) = 12608 J/g onset = 411 °C end = 545 °C	T = 200 °C TG = 98% T = 400 °C TG = 89% T = 600 °C TG = 9% TG = 95% T= 371 °C TG = 50% T= 447 °C	$DTG_{max.\ peak}$ = 14.34%/min. DTG_{peak} = 5.56 %/min.	$I_{max.\ peak} = 0.11 \cdot 10^{-9}$A $I_{peak} = 0.10 \cdot 10^{-9}$A $\Delta I = 51.20 \cdot 10^{-9}$A·s onset = 272 °C end = 587 °C

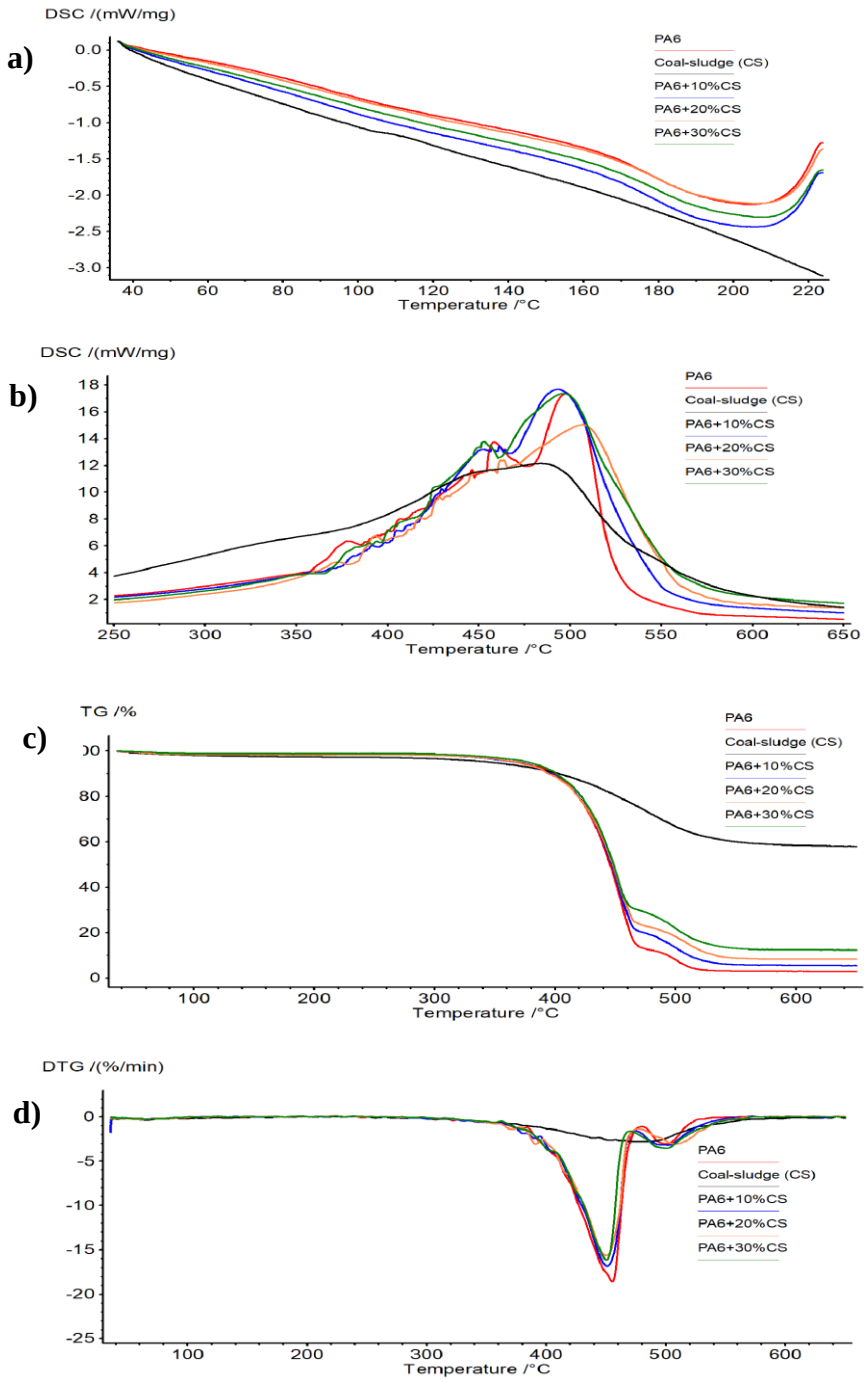

Figure S1. Thermal analysis of PA6 waste, coal sludge (CS), coal sludge + PA6 waste (10%/90%), coal sludge + PA6 waste (20%/80%), coal sludge + PA6 waste (30%/70%): DSC (endothermic peak); b) DSC (exothermic peaks); c) TG; d) DTG

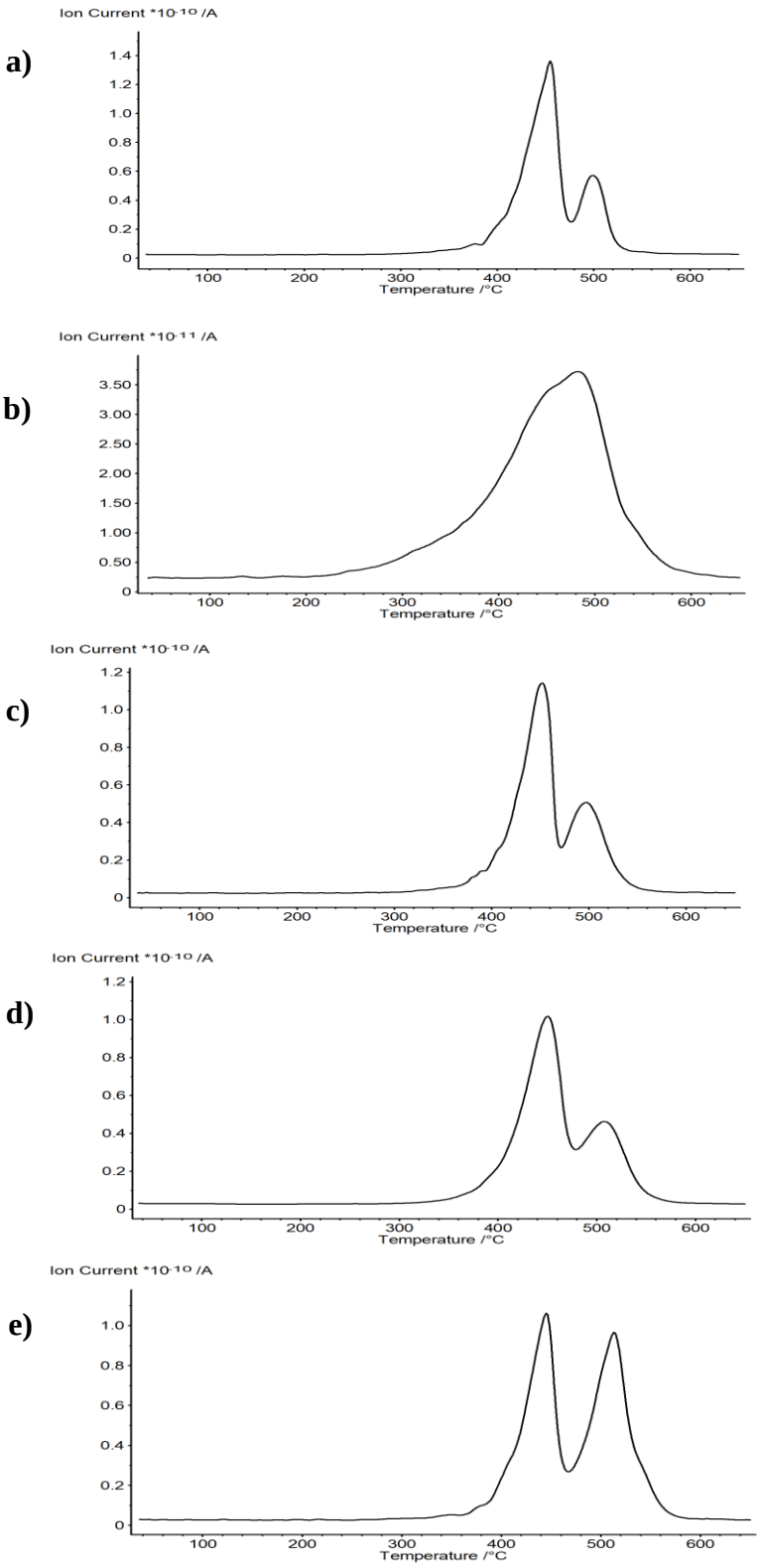

Figure S2. Thermograms MS (m/z=44) of coal sludge + PA6 waste mixture:
a) PA6 waste; b) coal sludge; c) coal sludge + PA6 waste (10%/90%); d) coal sludge + PA6 waste (20%/80%); e) coal sludge + PA6 waste (20%/80%); coal sludge + PA6 waste (30%/70%)

Table S3.

Values of TG/DTG/DSC/MS for different mixtures of fuels

Material	DSC (the characteristic peaks)	TG	DTG (the characteristic peaks)	MS (m/z=44) (the characteristic peaks; total ion current I)
coal sludge (CS)	Exothermic peaks $T_{DSC\ max.\ peak}$ = 483 °C $DSC_{max\ peak}$ = 10.48 mW/mg ΔDSC (Exothermic effect) = 11780 J/g onset = 387 °C end = 549 °C	T = 200 °C TG = 97% T = 400 °C TG = 90% T = 600 °C TG = 58% TG = 95% T= 345 °C TG = 57% T= 997 °C	$DTG_{max.\ peak}$ = 2.83 %/min.	$I_{max.\ peak} = 0.04 \cdot 10^{-9}$A $\Delta I = 28.41 \cdot 10^{-9}$A·s onset = 195 °C end = 629 °C
CS + PA6 (10%/90%)	Endothermic peaks $T_{DSC\ peak}$ = 205 °C DSC_{peak} = 2.49 mW/mg Exothermic peaks $T_{DSC\ peak}$ = 458 °C DSC_{peak} = 13.07 mW/mg $T_{DSC\ max.\ peak}$ = 494 °C $DSC_{max\ peak}$ = 16.01 mW/mg ΔDSC (Endothermic effect) = 289.4 J/g onset = 165 °C end = 223 °C ΔDSC (Exothermic effect) = 9782 J/g onset = 399 °C end = 543 °C	T = 200 °C TG = 99% T = 400 °C TG = 89% T = 600 °C TG = 6% TG = 95% T= 366 °C TG = 50% T= 447 °C	$DTG_{max.peak}$ =16.86 %/min. DTG_{peak} = 3.19 %/min.	$I_{max.\ peak} = 0.11 \cdot 10^{-9}$A $I_{peak} = 0.05 \cdot 10^{-9}$A $\Delta I = 43.95 \cdot 10^{-9}$A·s onset = 299 °C end = 596 °C
CS + PA6 (20%/80%)	Endothermic peaks $T_{DSC\ peak}$ = 205 °C DSC_{peak} = – 2.14 mW/mg Exothermic peaks $T_{DSC\ peak}$ = 462 °C DSC_{peak} = 12.05 mW/mg $T_{DSC\ max.\ peak}$ = 496 °C $DSC_{max\ peak}$ = 13.38 mW/mg ΔDSC	T = 200 °C TG = 98% T = 400 °C TG = 89% T = 600 °C TG = 8% TG = 95% T= 367 °C TG = 50% T= 448 °C	$DTG_{max.\ peak}$ =15.62%/min. DTG_{peak} =3.06 %/min.	$I_{max.\ peak} = 0.10 \cdot 10^{-9}$A $I_{peak} = 0.05 \cdot 10^{-9}$A $\Delta I = 41.84 \cdot 10^{-9}$A·s onset = 295 °C end = 599 °C

	(Endothermic effect) = 346.2 J/g onset = 169 °C end = 223.4 °C ∆DSC (Exothermic effect) = 10125 J/g onset = 684 °C end = 557 °C			
CS + PA6 (30%/70%)	Endothermic peaks $T_{DSC\ peak}$ = 206 °C DSC_{peak} = 2.37 mW/mg Exothermic peaks $T_{DSC\ peak}$ = 452 °C DSC_{peak} = 13.60 mW/mg $T_{DSC\ max.\ peak}$ = 507 °C $DSC_{max\ peak}$ = 15.41 mW/mg ∆DSC (Endothermic effect) = 308.5 J/g onset = 169 °C end = 223 °C ∆DSC (Exothermic effect) = 10645 J/g onset = 418 °C end = 551 °C	T = 200 °C TG = 99% T = 400 °C TG = 91% T = 600 °C TG = 12% TG = 95% T= 377 °C TG = 50% T= 448 °C	$DTG_{max.\ peak}$ =16.13%/min. DTG_{peak} =3.52 %/min.	$I_{max.\ peak} = 0.10 \cdot 10^{-9}$A $I_{peak} = 0.05 \cdot 10^{-9}$A $\Delta I = 40.62 \cdot 10^{-9}$A·s onset = 291 °C end = 598 °C

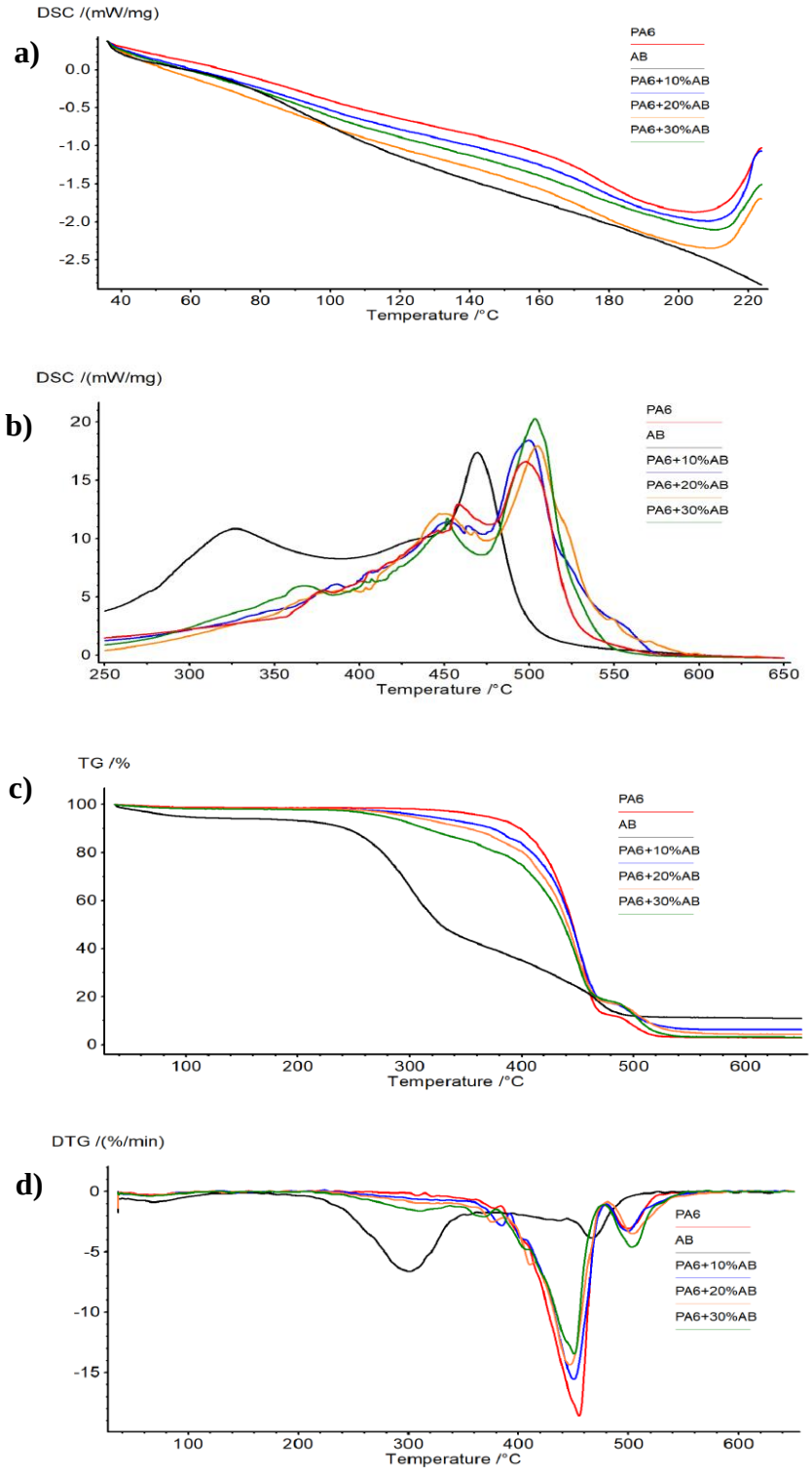

Figure S3. Thermal analysis of PA6 waste, biomass (AB), biomass + PA6 (10%/90%), biomass + PA6 (20%/80%), biomass + PA6 (30%/70%):
a) DSC (endothermic peak); b) DSC (exothermic peaks); c) TG; d) DTG

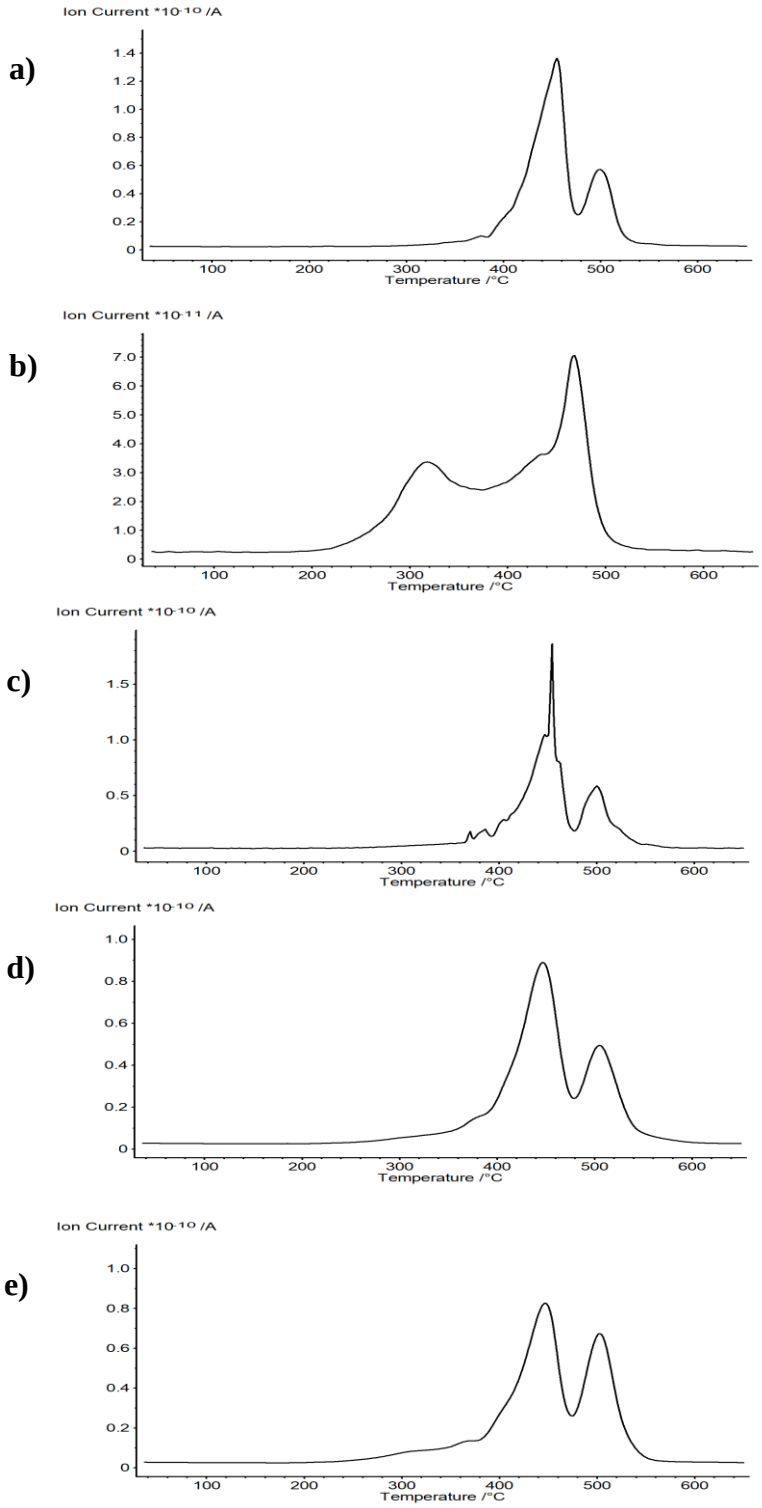

Figure S4. Thermograms MS (m/z=44) of biomass waste + PA6 waste mixture:

a) PA6 waste; b) biomass waste; c) biomass waste + PA6 waste (10%/90%); d) biomass waste + PA6 waste (20%/80%); e) biomass waste + PA6 waste (20%/80%); biomass waste + PA6 waste (30%/70%)

Table S4.

Values of TG/DTG/DSC/MS for different mixtures of fuels

Material	DSC (the characteristic peaks)	TG	DTG (the characteristic peaks)	MS (m/z=44) (the characteristic peaks; total ion current I)
biomass (AB)	Exothermic peaks $T_{DSC\ peak}$ = 322 °C DSC_{peak} = 10.67 mW/mg $T_{DSC\ max.\ peak}$ = 469 °C $DSC_{max\ peak}$ = 16.45 mW/mg ΔDSC (Exothermic effect) = 12045 J/g onset = 335 °C end = 496 °C	T = 200 °C TG = 93% T = 400 °C TG = 35% T = 600 °C TG = 11% TG = 95% T= 95 °C TG = 50% T= 329 °C	$DTG_{max.\ peak}$ = 6.58 %/min. DTG_{peak} = 3.85 %/min.	$I_{peak} = 0.03 \cdot 10^{-9}$A $I_{max.\ peak} = 0.07 \cdot 10^{-9}$A $\Delta I = 41.23 \cdot 10^{-9}$A·s onset = 168 °C end = 533 °C
AB + PA6 (10%/90%)	Endothermic peaks $T_{DSC\ peak}$ = 205 °C DSC_{peak} = – 2.27 mW/mg Exothermic peaks $T_{DSC\ peak}$ = 450 °C DSC = 11.73 mW/mg $T_{DSC\ max.\ peak}$ = 499 °C DSC_{max} = 18.06 mW/mg ΔDSC (Endothermic effect) = 436.6 J/g onset = 179 °C end = 222 °C ΔDSC (Exothermic effect) = 10930 J/g onset = 458 °C end = 526 °C	T = 200 °C TG = 98% T = 400 °C TG = 83% T = 600 °C TG = 6% TG = 95% T= 315 °C TG = 50% T= 445 °C	$DTG_{max.\ peak}$ =15.55%/min. DTG_{peak} = 3.28 %/min.	$I_{max.\ peak} = 0.19 \cdot 10^{-9}$A $I_{peak} = 0.06 \cdot 10^{-9}$A $\Delta I = 44.04 \cdot 10^{-9}$A·s onset = 288 °C end = 567 °C
AB + PA6 (20%/80%)	Endothermic peaks $T_{DSC\ peak}$ = 205 °C DSC_{peak} =2.62 mW/mg Exothermic peaks $T_{DSC\ peak}$ = 385 °C DSC_{peak} = 7.30 mW/mg $T_{DSC\ peak}$ = 448 °C DSC_{peak} = 13.95 mW/mg $T_{DSC\ max.\ peak}$ = 505 °C $DSC_{max\ peak}$ = 18.04 mW/mg ΔDSC (Endothermic effect) = 338.7 J/g onset = 211 °C	T = 200 °C TG = 98% T = 400 °C TG = 80% T = 600 °C TG = 4% TG = 95% T= 299 °C TG = 50% T= 441 °C	DTG_{peak} = 2.50 %/min. $DTG_{max.\ peak}$ =14.34%/min. DTG_{peak} = 3.46 %/min.	$I_{max.\ peak} = 0.09 \cdot 10^{-9}$A $I_{peak} = 0.05 \cdot 10^{-9}$A $\Delta I = 41.81 \cdot 10^{-9}$ A·s onset = 225 °C end = 596 °C

	end = 222 °C ΔDSC (Exothermic effect) = 11086 J/g onset = 414 °C end = 535 °C			
AB + PA6 (30%/70%)	Endothermic peaks $T_{DSC\ peak}$ = 205 °C DSC_{peak} = – 2.36 mW/mg Exothermic peaks $T_{DSC\ peak}$ = 366 °C DSC_{peak} = 6.86 mW/mg $T_{DSC\ peak}$ = 451 °C DSC_{peak} = 12.49 mW/mg $T_{DSC\ max.\ peak}$ = 527 °C $DSC_{max\ peak}$ = 20.16mW/mg ΔDSC (Endothermic effect) = 287.5.7 J/g onset = 146 °C end = 222 °C ΔDSC (Exothermic effect) = 11827 J/g onset = 448 °C end = 527 °C	T = 200 °C TG = 97% T = 400 °C TG = 74% T = 600 °C TG = 3% TG = 95% T= 275 °C TG = 50% T= 437 °C	DTG_{peak} =2.03 %/min. $DTG_{max.\ peak}$ =13.45%/min. DTG_{peak} =4.58 %/min.	$I_{max.\ peak} = 0.08 \cdot 10^{-9}$A $I_{peak} = 0.07 \cdot 10^{-9}$A $\Delta I = 41.54 \cdot 10^{-9}$ A·s onset = 214 °C end = 575 °C

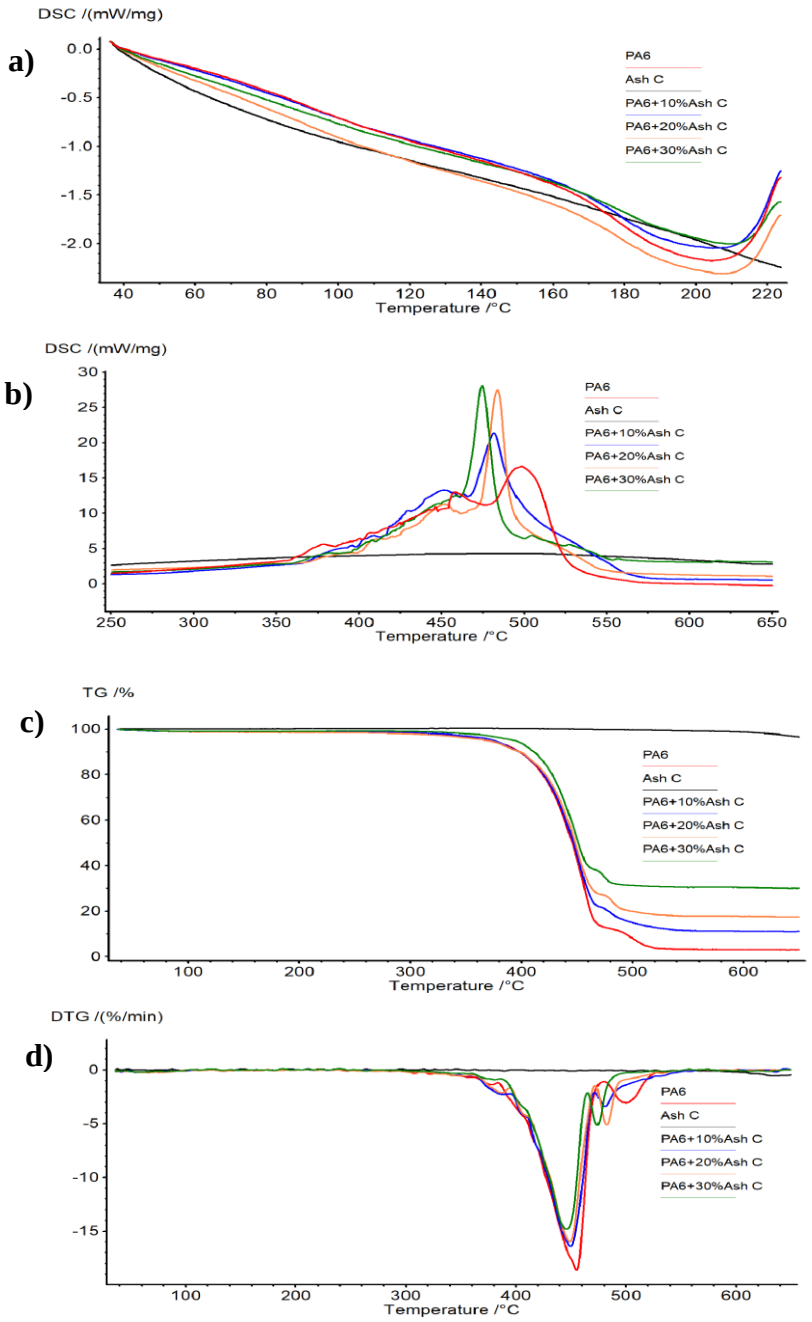

Figure S5. Thermal analysis of PA6 waste, fly ash C, fly ash C + PA6 waste (10%/90%), fly ash C + PA6 waste (20%/80%), fly ash C + PA6 waste (30%/70%): a) DSC (Endothermic peak); b) DSC (Exothermic peaks); c) TG; d) DTG

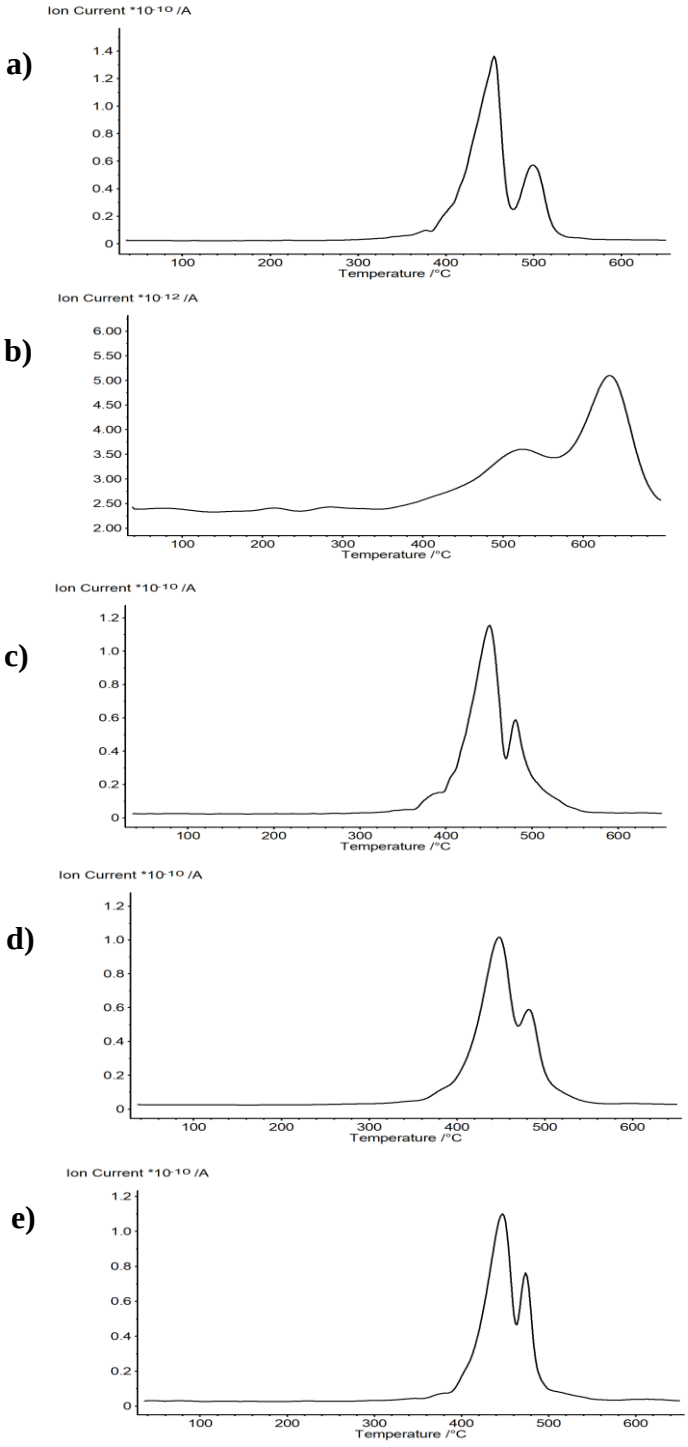

Figure S6. Thermograms MS (m/z=44) of coal fly ash + PA6 waste mixture:
a) PA6 waste; b) coal fly ash; c) coal fly ash + PA6 waste (10%/90%); d) coal fly ash + PA6 waste (20%/80%); e) coal fly ash + PA6 waste (20%/80%); coal fly ash + PA6 waste (30%/70%)

Table S5.

Values of TG/DTG/DSC/MS for different mixtures of fuels

Material	DSC (the characteristic peaks)	TG	DTG (the characteristic peaks)	MS (m/z=44) (the characteristic peaks; total ion current I)
fly ash C	Exothermic peaks $T_{DSC\ max.\ peak}$ = 500 °C $DSC_{max\ peak}$ = 3.86 mW/mg $T_{DSC\ peak}$ = 655 °C DSC_{peak} = 2.80 mW/mg	T = 200 °C TG = 100% T = 400 °C TG = 100% T = 600 °C TG = 98%	$DTG_{max.\ peak}$ =0.58 %/min.	$I_{peak} = 0.004 \cdot 10^{-9}$A $I_{max.peak} = 0.005 \cdot 10^{-9}$A $\Delta I = 1.82 \cdot 10^{-9}$A·s onset = 258 °C end = 696 °C
fly ash C + PA6 (10%/90%)	Endothermic peaks $T_{DSC\ peak}$ = 205 °C DSC_{peak} = – 2.05 mW/mg Exothermic peaks $T_{DSC\ peak}$ = 454 °C DSC_{peak} = 13.21 mW/mg $T_{DSC\ max.\ peak}$ = 483 °C $DSC_{max\ peak}$ = 20.37 mW/mg ΔDSC (Endothermic effect) = – 239.1 J/g onset = 164 °C end = 223 °C ΔDSC (Exothermic effect) = 9703 J/g onset = 452 °C end = 495 °C	T = 200 °C TG = 98% T = 400 °C TG = 88% T = 600 °C TG = 11% TG = 95% T= 370 °C TG = 50% T= 446 °C	$DTG_{max.\ peak}$ =16.41%/min. DTG_{peak} = 3.40 %/min.	$I_{max.\ peak} = 0.12 \cdot 10^{-9}$A $I_{peak} = 0.06 \cdot 10^{-9}$A $\Delta I = 39.42 \cdot 10^{-9}$A·s onset = 316 °C end = 572 °C
fly ash C + PA6 (20%/80%)	Endothermic peaks $T_{DSC\ peak}$ = 205 °C DSC_{peak} = 2.33 mW/mg Exothermic peaks $T_{DSC\ peak}$ = 450 °C DSC_{peak} = 11.15 mW/mg $T_{DSC\ max.\ peak}$ = 482 °C $DSC_{max\ peak}$ = 25.91 mW/mg ΔDSC (Endothermic effect) = 211.4 J/g onset = 165 °C end = 223 °C ΔDSC (Exothermic effect) = 7320 J/g onset = 471 °C end = 493 °C	T = 200 °C TG = 98% T = 400 °C TG = 89% T = 600 °C TG = 17% TG = 95% T= 370 °C TG = 50% T= 448 °C	$DTG_{max.\ peak}$ =15.99%/min. DTG_{peak} =5.03 %/min.	$I_{max.\ peak} = 0.10 \cdot 10^{-9}$A $I_{peak} = 0.06 \cdot 10^{-9}$A $\Delta I = 37.50 \cdot 10^{-9}$A·s onset = 312 °C end = 576 °C

fly ash C + PA6 (30%/70%)	Endothermic peaks $T_{DSC\ peak}$ = 205 °C DSC_{peak} = – 2.04 mW/mg Exothermic peaks $T_{DSC\ peak}$ = 462 °C DSC_{peak} = 12.48 mW/mg $T_{DSC\ max.\ peak}$ = 474 °C $DSC_{max\ peak}$ = 25.24 mW/mg ∆DSC (Endothermic effect) = 175.2 J/g onset = 164 °C end = 222 °C ∆DSC (Exothermic effect) = 6255 J/g onset = 463 °C end = 485 °C	T = 200 °C TG = 99% T = 400 °C TG = 93% T = 600 °C TG = 30% TG = 95% T= 390 °C TG = 50% T= 451 °C	$DTG_{max.\ peak}$ =14.79%/min. DTG_{peak} =5.13 %/min.	$I_{max.\ peak} = 0.11 \cdot 10^{-9}$A $I_{peak} = 0.08 \cdot 10^{-9}$A $\Delta I = 33.28 \cdot 10^{-9}$A·s onset = 333 °C end = 577 °C

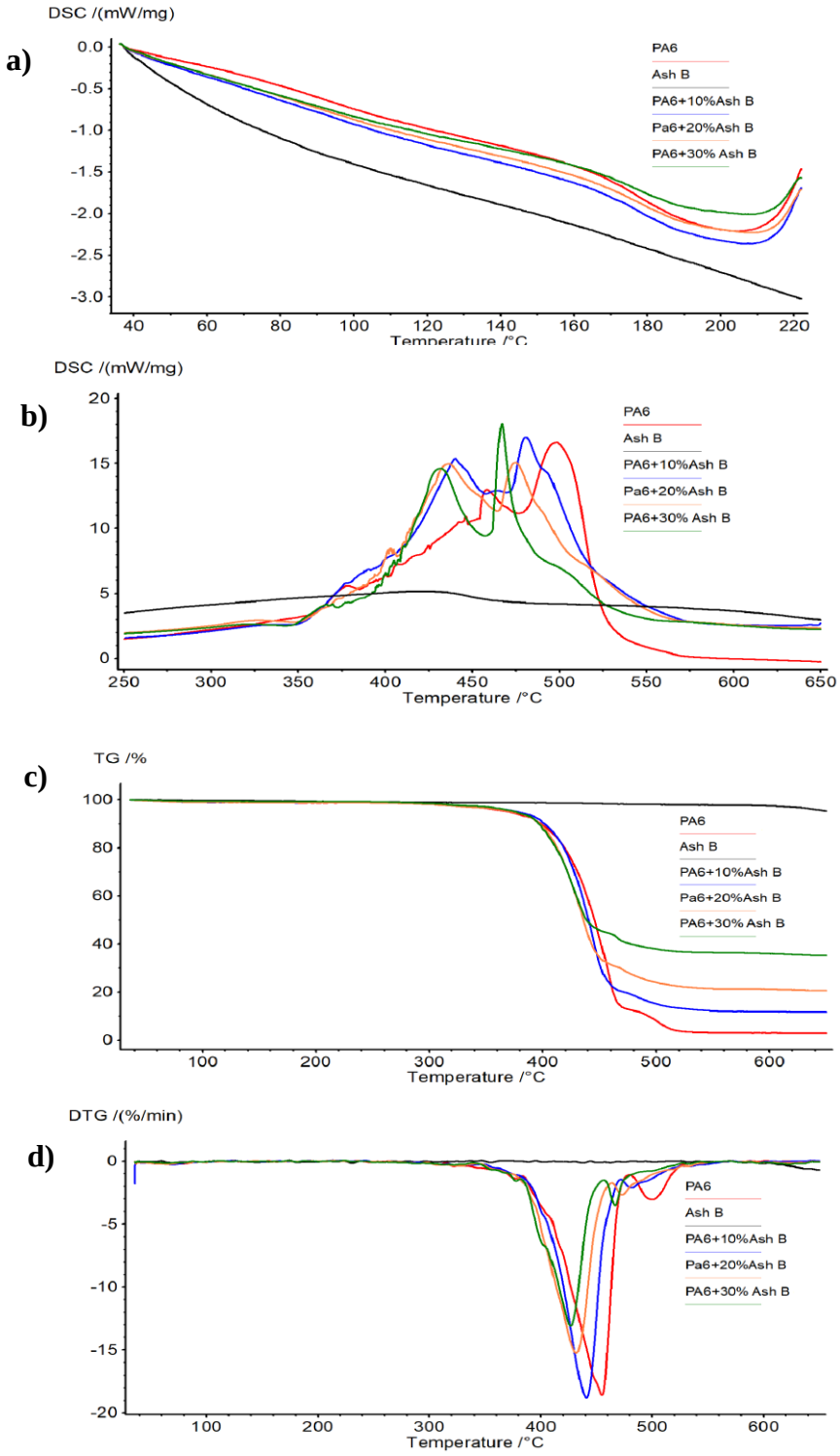

Figure S7. Thermal analysis of PA6 waste, fly ash B, fly ash B + PA6 waste (10%/90%), fly ash B + PA6 waste (20%/80%), fly ash B + PA6 waste (30%/70%):
a) DSC (Endothermic peak); b) DSC (Exothermic peaks); c) TG; d) DTG

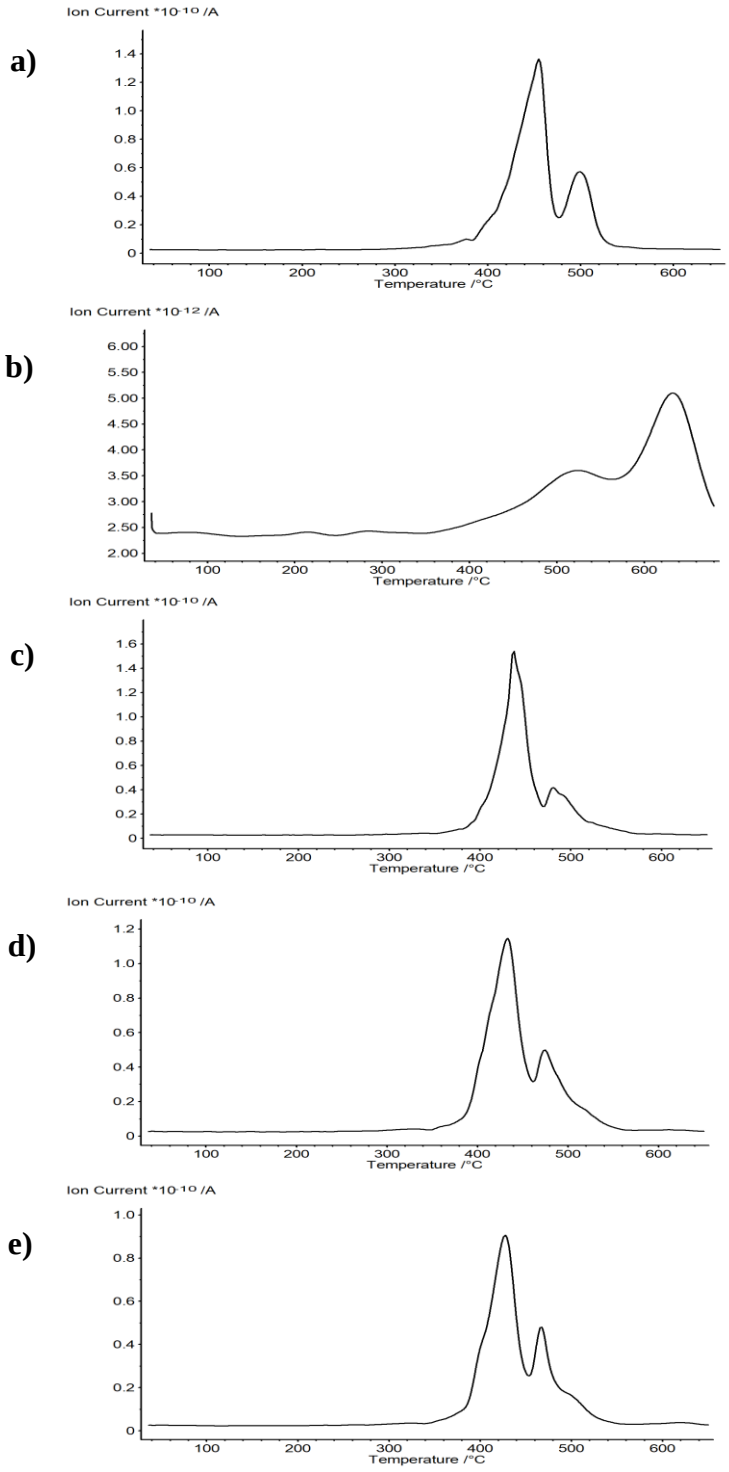

Figure S8. Thermograms MS (m/z=44) of biomass fly ash + PA6 waste mixture: a) PA6 waste; b) biomass fly ash; c) biomass fly ash + PA6 waste (10%/90%); d) biomass fly ash + PA6 waste (20%/80%); e) biomass fly ash + PA6 waste (20%/80%); biomass fly ash + PA6 waste (30%/70%)

Table S6.

Values of TG/DTG/DSC/MS for different mixtures of fuels

Material	DSC (the characteristic peaks)	TG	DTG (the characteristic peaks)	MS (m/z=44) (the characteristic peaks; total ion current I)
fly ash B	Exothermic peaks $T_{DSC\ max.\ peak}$ = 420 °C $DSC_{max\ peak}$ = 5.01 mW/mg $T_{DSC\ peak}$ = 675 °C DSC_{peak} = 3.14 mW/mg	T = 200 °C TG = 99% T = 400 °C TG = 98% T = 600 °C TG = 97%	$DTG_{max.\ peak}$ =0.71 %/min.	$I_{peak} = 0.004 \cdot 10^{-9}$A $I_{max.\ peak} = 0.005 \cdot 10^{-9}$A $\Delta I = 2.17 \cdot 10^{-9}$A·s onset = 328 °C end = 783 °C
fly ash B + PA6 (10%/90%)	Endothermic peaks $T_{DSC\ peak}$ = 205 °C DSC_{peak} = – 2.34 mW/mg Exothermic peaks $T_{DSC\ peak}$ = 440 °C DSC_{peak} = 15.39 mW/mg $T_{DSC\ max.\ peak}$ = 480 °C $DSC_{max\ peak}$ = 14.38mW/mg ΔDSC (Endothermic effect) = 320 J/g onset = 168 °C end = 223 °C ΔDSC (Exothermic effect) = 8354 J/g onset = 476 °C end = 514 °C	T = 200 °C TG = 98% T = 400 °C TG = 90% T = 600 °C TG = 11% TG = 95% T= 375 °C TG = 50% T= 439 °C	$DTG_{max.\ peak}$ =18.81%/min. DTG_{peak} =2.12 %/min.	$I_{max.\ peak} = 0.15 \cdot 10^{-9}$A $I_{peak} = 0.04 \cdot 10^{-9}$A $\Delta I = 41.17 \cdot 10^{-9}$A·s onset = 326 °C end = 584 °C
fly ash B + PA6 (20%/80%)	Endothermic peaks $T_{DSC\ peak}$ = 205 °C DSC_{peak} = – 2.21 mW/mg Exothermic peaks $T_{DSC\ peak}$ = 436 °C DSC_{peak} = 14.95 mW/mg $T_{DSC\ max.\ peak}$ = 474 °C $DSC_{max\ peak}$ = 12.43mW/mg ΔDSC (Endothermic effect) = 197.7 J/g onset = 161 °C end = 222 °C ΔDSC	T = 200 °C TG = 98% T = 400 °C TG = 88% T = 600 °C TG = 21% TG = 95% T= 367 °C TG = 50% T= 436 °C	$DTG_{max.\ peak}$ =15.23%/min. DTG_{peak} = 2.67 %/min.	$I_{max.\ peak} = 0.11 \cdot 10^{-9}$A $I_{peak} = 0.05 \cdot 10^{-9}$A $\Delta I = 39.63 \cdot 10^{-9}$A·s onset = 304 °C end = 572 °C

	(Exothermic effect) = 7582 J/g onset = 406 °C end = 507 °C			