Supplementary Information (SI) for Chemical Society Reviews.

Supplementary Information

State-of-the-Art and Perspectives of Hydrogen Generation from Waste Plastics

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Table S1. Summary of hydrogen production from waste plastics upcycling by pyrolysis-reforming

Catalyst	Plastic	Conditions	H_2 yield ($mmol \cdot g_{plastic}^{-1}$)	Valued products	Ref.
Fe_2O_3/Al_2O_3	HDPE	HDPE 0.1 mg, catalyst 2 mg, pyrolysis 600 ºC, catalysis 800 ºC.	50.5	C_2-C_9 hydrocarbons	[1]
Ni/Al_2O_3, Fe/Al_2O_3	PP	(i) Pyrolysis: PP 1 g, 500 ºC; (ii) Reformer: Ni/Al_2O_3 1 g, 850 ºC; (iii) WGS: Fe/Al_2O_3 0.5 g, 650 ºC.	122.0	CO_2, CH_4	[2]
Ni/AC	PP	PP/catalyst ratio 1:0.75, H_2O, pyrolysis: 500 ºC; catalysis: 900 ºC.	134.9	Various forms of carbon	[3]
Ni/KIT-6	PE	Plastic 5 g, catalyst 0.25 g, N_2 60 mL/min, H_2O 0.1 mL/min, 1 atm, 700 ◦C, 0.5 h.	37.0	Heavy aromatics	[4]
Fe-Ni/Al_2O_3	PP	Plastic 1 g, catalyst 0.4 g, N_2 100 mL/min, pyrolysis: 500 ºC, catalysis: 600-800 ºC.	25.1	C_{2+} hydrocarbon, MWCNTs	[5]
Fe/Al_2O_3	HIPS	Plastic 1 g, catalyst 0.5 g, N_2 100 mL/min, pyrolysis: 500 ºC, catalysis: 800 ºC.	-	C_8-C_{16}, CNTs	[6]
Olivine, AC	HDPE	PE 8.3 g/min, 790-840 ºC, olivine 2200 g, AC 1500 g.	81.0	Toluene tar, active carbon	[7]
Ni/Al-SBA-15, Ni-Cu/CaO-SiO_2	PP, LDPE mixture	PP 3 g (LDPE 0.3 g), silica sand/catalyst 32:1, feedstock 19.8 g/min, first-stage 600 ºC, second-stage 800 ºC.	-	CNTs	[8]
Ni-Pt/Al-Ti	PET	Catalyst 0.2 g, SiC 0.3 g, H_2O 0.36 mL/min, N_2 30 mL/min, feedstock/water ratio 1:9, 700 ºC.	-	Aromatic hydrocarbons	[9]

MgO, AC	LDPE	LDPE 2 g, catalyst/LDPE 2:1, N_2 70 mL/min, 500 °C.	-	Alkanes, aromatics	[10]
Ni-Fe/γ-Al_2O_3	Waste plastic	Plastic 1 g, catalyst 0.2 g, N_2 110 mL/min, 800 °C.	31.8	CNTs	[11]
Ni/Al_2O_3	PS	PS 1 g, catalyst 0.5 g, N_2, H_2O 6 g h^{-1}, 800 °C.	62.3	CO	[12]
Ni/ZSM5-30	HDPE	HDPE 1 g, catalyst 0.5 g, N_2, H_2O 6 g h^{-1}, 850 °C.	66.1	CO	[13]
NiO/$NiAl_2O_4$-CaO	WP	Catalyst and sorbent mixture of 50-60 g, N_2 carrier gas of 5.0 ×10^{-3} m^3/min, 818 °C.	-	Hydrocarbons	[14]
NiO/$CaAl_2O_3$	HDPE	16.7 g_{cat} min g^{-1}_{HDPE}, steam/plastic 5:1, 700 °C.	190.5	Hydrocarbons	[15]
Ni-Mn-Al	HDPE	HDPE 1 g, catalyst 0.5 g, N_2 80 mL/min, H_2O 2.85 g h^{-1}, 800 °C.	94.4	Hydrocarbons	[16]
SS 316	PP	PP 1 g, catalyst 15 g, N_2 50 mL/min, pyrolysis at 500 °C, catalysis at 800 °C.	51.3	MWCNTs	[17]
Ni-TiO_2-Al_2O_3	LDPE	Catalyst 4 g, LDPE 2 g, solar simulator irradiation, N_2, 700 °C.	54.0	CNTs	[18]
Ni/MCM-41	HDPE	HDPE 1 g, catalyst 1 g, steam WHSV 2 g h^{-1} g_{cat}^{-1}, N_2, DBD plasma power 80W, 250 °C.	18.0	CO, CO_2, CH_4, C_2-C_4 hydrocarbons	[19]
ZSM-5	PP	PP 2 g, catalyst 4 g, Ar 100 mL/min, plasma power 120W, 400 °C.	4.2	BTX (benzene, toluene, xylene)	[20]
/	LDPE	LDPE 10 g, gliding arc reactor, 300 W of output power, processing gas N_2, ~750 K.	0.4	Carbon compounds	[21]

MCM-41	HDPE	HDPE 1 g, catalyst 1 g, steam 2 g h^{-1}, 250 ^oC.	11.0	C_1-C_4 hydrocarbons	[22]
/	Sawdust, HDPE	Feedstock 300 g, plasma 22 kW, steam/carbon flow ratio 1:1, 600 ^oC.	78.6	CO, CO_2, CH_4	[23]
$FeAlO_x$@C	PE	PE 0.4 g, catalyst 0.8 g, microwave power 900 W, carbon fiber cloth (CFC) as the microwave igniter.	67.3	CNTs, alkane gases	[24]
Fe-Co-Al	LDPE	LDPE 1 g, catalyst 0.5 g, microwave power 700 W, catalyst bed 800 ^oC.	61.4	CNTs, alkane gases	[25]
/	Mixed plastics	Swirl steam 3 kg/h, plasma power 7.5 kW, ambient pressure, 1500 ^oC.	75.0	CO, CO_2, CH_4	[26]
$Fe/FeAl_2O_4$	HDPE	HDPE 3 g, catalyst 3 g, microwave power 300 W, catalyst surface temperature 300 ^oC.	47.0	CNTs	[27]
Ti_3AlC_2	LDPE	LDPE 300 mg, catalyst 120 mg, microwave power 1000 W, 500-1000 ^oC.	51.3	Carbon nanofibers	[28]
$FeAlO_x$	HDPE	LDPE 0.3 g, catalyst 0.3 g, microwave 1000 W, 300 ^oC.	55.6	MWCNTs	[29]
/	PE	0.08 g conductive additive Carbon Black, 0.42 g PE, resistance 5-10 Ohm, 100-130 V.	47.0	Graphene, small hydrocarbons	[30]

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Table S2. Summary of hydrogen production from waste plastics upcycling by gasification

Feedstock	Reactor	Gasifying agent	Conditions	H_2 yield ($mmol\cdot g_{plastic}^{-1}$)	Ref.
Pine, PE	Fluidized bed	Steam	40% (w/w) of PE, 885 ^oC, steam/waste mixture ratio 0.4-0.9	87.5	[1]
Mixed plastics	Fixed bed	Steam	Plastics 0.5 g, catalyst 0.5 g, 800 ^oC.	150.3	[2]
PP, pine, coal	Fluidized bed	Air	Feedstock 1-4 kg/h, ER 0.36, dolomite catalyst, 850 ^oC.	33.5	[3]
PE	Fluidized bed	Steam	AC 1500 g, feed rate 8.3 g/min, 790-840 ^oC, 60 min.	74.4	[4]
PP	Fluidized bed	Air	Feeding 1.8-3.9 kg/h, air 6-12 Nm^3/h, ER 0.45, 915 ^oC.	10.0	[5]
PE	Fluidized bed	Air/steam	Feedstock 26.1 kg/h, air rate 90.1 kg/h, ER 0.24, 813 ^oC.	71.9	[6]
PE	Fixed bed	Steam	Feedstock 0.3 kg/h, steam 0.4 kg/h, steam/PE ratio 1.33, NiO/γ-Al_2O_3 catalyst, 900 ^oC.	33.7	[7]
PP	Fluidized bed	Air	Feedstock 1 kg/h, ER 0.25, 910 ^oC.	32.7	[8]
PE, PP, wood, coal	Fluidized bed	Air	35% O_2, gas velocity 0.4 m/s, ER 0.25, 600 ^oC.	73.4	[9]
PE	Fixed bed	Steam	Ni-Al_2O_3 0.5 g, steam 1.9 g/h, 600/800 ^oC.	44.7	[10]

PS/PE	Fixed bed	-	Catalyst 0.5 g, feed rate 0.1 g/min, 550/750 °C.	36.2	[11]
PE	Conical spouted bed	Steam	HDPE 1.5 g/min, steam 1.86 L min^{-1}, steam/plastic ratio 1, olivine/γ-Al_2O_3, 900 °C.	91.3	[12]
PE, PP	Fluidized bed	Air	Feedstock 13-20 g/min, air 50 L/min, ER 0.25-0.35, 750 °C.	62.5	[13]
Mixed plastics	Dual fluidized bed	Air/steam	Feedstock 7.9 kg/h, steam 14.2 kg/h, primary air 4.2 Nm^3/h, secondary air 49.2 Nm^3/h, 855 °C (gasification), 907 °C (combustion).	43.1	[14]
Waste plastics	Plasma reactor	Ar/H_2O plasma	Feedstock 11.4 kg/h, H_2O 11 kg/h, 1200-1400 °C	-	[15]
PE, PVC, RS	Fixed bed	Steam	Feedstock 1 g, N_2 200 mL/min, 900 °C.	23.9	[16]
PE	Fluidized bed	Air	Dolomite additive, feed rate 1 kg/h, ER 0.32-0.36, 850 °C.	24.4	[17]
ABS	Plasma reactor	CO_2	Feedstock 4 g/min, CO_2 0.5 L/min, 1312 °C.	-	[18]

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Table S3. Summary of hydrogen production from waste plastics photoreforming

Catalyst	Plastic	Conditions	H_2 yield ($mmol \cdot g_{plastic}^{-1}$)	Valued products	Ref.
$ZnIn_2S_4$	PET	Catalyst 7.5 mg, PET (1 M KOH), N_2, simulated sun light (AM 1.5G, 150 mW cm^{-2}), 25 ^oC, 12 h.	0.05	Pyruvate	[1]
d-$NiPS_3$/CdS	PLA	Catalyst 1 mg, 10 mg mL^{-1} pretreated PLA, 300 W Xe lamp (λ > 400 nm), Ar, 9 h.	3.6	Acetates, pyruvate	[2]
$Ni_2P/ZnIn_2S_4$	PLA	Catalyst 5 mg, PLA (5 M KOH), Ar, LED irradiation (λ > 420 nm, 4 × 25 W).	4.0	Pyruvic acid	[3]
Ag_2O/Fe-MOF	PET	Catalyst 0.1 g, PET (1 M NaOH), 300 W Xe lamp (AM 1.5G, 100 mW cm^{-2}), 25 ^oC, 2.5 h.	1.0	Acetic acid	[4]
MoS_2/CdS	PLA	Catalyst 0.1 g, PLA (10 M KOH), 300 W Xe lamp (AM 1.5G), 5 ^oC, 25 h.	10.3	Lactate	[5]
CdS/CdO_x QDs	PLA	Catalyst 1 nmol, PLA (10 M NaOH), simulated solar light (AM 1.5G, 100 mW cm^{-2}), 25 ^oC, 4 h.	0.53 ± 0.12	Formate, acetate, pyruvate	[6]
NiCoP/rGO/ CN	PLA	Catalyst 10 mg, PLA (1 M KOH), 300 W Xe lamp (λ > 420 nm), 10 ^oC, 5 h.	0.03	Formate, acetate	[7]
CN_x|Ni_2P	PLA	Catalyst 1.6 mg mL^{-1}, PLA (1 M KOH), simulated solar light (AM 1.5G, 100 mW cm^{-2}), 25 ^oC, 20 h.	0.06	Formate	[8]
CdO_x/CdS/SiC	PE	Catalyst 50 mg, Pt 0.5 wt%, PE (10 M NaOH), 300 W Xe lamp, 70 ^oC, 3 h.	0.04	CO_2	[9]

O-$CuIn_5S_8$	PET	Catalyst 100 mg, PET (1.5 M KOH), 300 W Xe lamp, vacuum, 5 ^oC, 5 h.	0.36	Formate, acetate, glycolate	[10]
Pt/TiO_2	PET	Catalyst 0.5 g, PET 0.5 g (3 M KOH), UV mercury vapor lamp (60 mW/cm^2), 25 ^oC, 20 h.	2.0	CO_2	[11]
Pt/TiO_2	PE	Catalyst 30 mg, plasma treated PE 30 mg, simulated solar light (AM 1.5G, 100 mW cm^{-2}), 24 h.	2.4	CO_2	[12]
Pt/g-C_3N_4	PET	Catalyst 0.1 g, PET (5 M NaOH), simulated solar light (AM 1.5G, 100 mW cm^{-2}), 25 ^oC, 6 h.	4.4	Formate	[13]
Ni_2P-Co_2P/ZrO_2/C	PET	Catalyst 0.2 g, PET (10 M KOH), 500 W mercury lamp, 24 h.	0.2	Glycolate, formate, acetate	[14]
Pt/TiO_2	PET	Catalyst 0.5 g, PET 0.5 g (5% EtOH, 3 M KOH), UV mercury vapor lamp (160 W), 25 ^oC, 20 h.	0.03	TPA, Na_2TP	[15]
RP@Co_xP_y/$Cd_{0.5}Zn_{0.5}S$	PLA	Catalyst 25 mg, PLA (10 M NaOH), 300 W Xe lamp (λ > 420 nm), 5 h.	12.6	Pyruvate	[16]
CdS/NiS	PLA	Catalyst 5 mg, PLA (10 M NaOH), 300 W Xe lamp (λ > 420 nm), 25 ^oC, 4 h.	0.1	Pyruvate, formate	[17]
Co-Ga_2O_3	PE	Catalyst 0.05g, PE 0.1g, 300 W Xe lamp (AM 1.5G), 24 h.	0.8	CO	[18]
MXene/$Zn_xCd_{1-x}S$	PET	Catalyst 0.1 mg, 300 W Xe lamp (λ > 420 nm), 4 h.	-	Glycolate, acetate, ethanol	[19]
MoS_2/$Cd_{0.5}Zn_{0.5}S$	PET	Catalyst 10 mg, PET (10 M NaOH), 300 W Xe lamp (AM 1.5G), 5 h.	0.5	Formate, acetate	[20]

HEON	PET	Catalyst 50 mg, 50 mg PET (10 M NaOH, 3 mL), 250 μL $H_2PtCl_6 \cdot 6H_2O$, 300 W Xe lamp, 4 h.	1.6	EG, formic acid	[21]
Pt/g-C_3N_4	PET	Catalyst 50 mg, 10 mg PET (0.1 M NaOH, 10 mL), simulated solar Xe lamp (λ > 420 nm), 60 °C, 4 h.	40.0	Formic acid	[22]

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