SUPPORTING INFORMATION

The upgrading of bio-oil from the intermediate pyrolysis of waste biomass using steel slag as a catalyst

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THE NUMBER OF PAGES: 8

THE NUMBER OF FIGURES: 6

THE NUMBER OF TABLES: 2

INFORMATION
TCR (2 kg/h) unit at Fraunhofer UMSICHT, Germany (**Figure S1**), Process path flow diagram of the TCR plant (**Figure S2**), Feedstock characterization (**Table S1**), Steel slag metal composition (**Table S2**), GC-MS chromatograms of SB bio-oil and compounds detected at 400 and 500 ºC (pyrolysis and reforming temperatures) and different SS ratios in the reformer (**Figure S3**), GC-MS chromatograms of OH bio-oil and compounds detected at 400 and 500 ºC (pyrolysis and reforming temperatures) and different SS ratios in the reformer (**Figure S4**), GC-MS chromatograms of OH bio-oil and compounds detected at 400 and 500 ºC (pyrolysis and reforming temperatures) and different SS ratios in the OH feed (**Figure S5**), X-ray diffractions of SS, SB raw, SB char, OH raw and OH char (**Figure S6**).

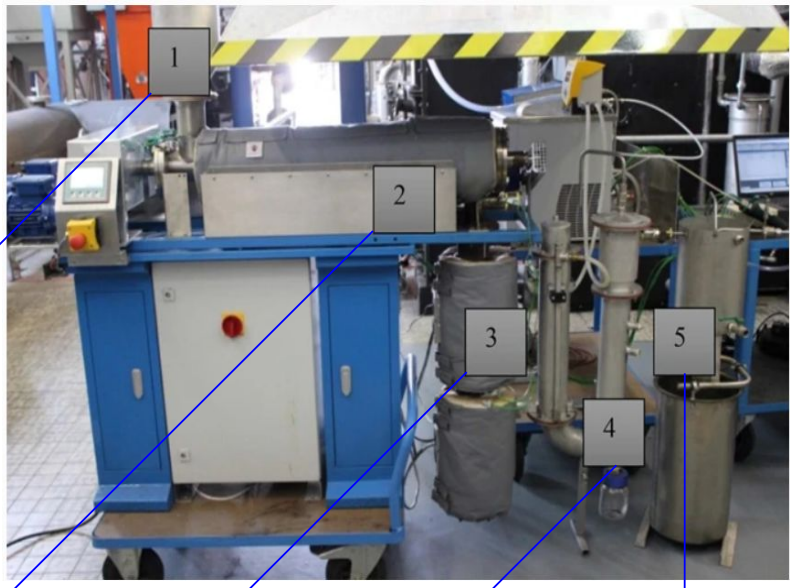

Figure S1. TCR (2 kg/h) unit at Fraunhofer UMSICHT, Germany. Reprinted with permission from ref. [50], Copyright © 2019, American Chemical Society.

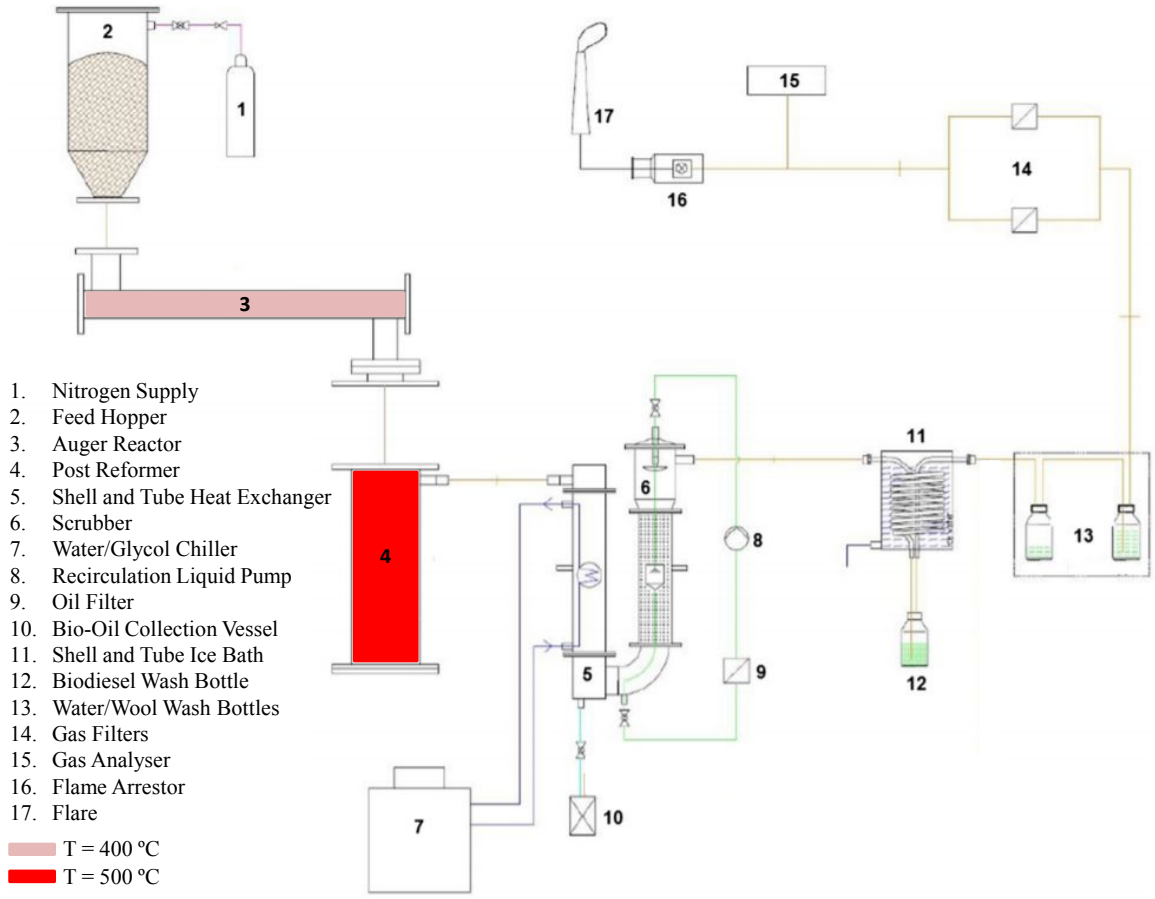

Figure S2. Process path flow diagram of the TCR plant. Reprinted with permission from ref. [51], Copyright © 2017, Elsevier.

Table S1. Feedstock characterization.

	SB	OH
Ultimate analysis (moisture-free basis)		
C (wt%)	43.7	40.6
H (wt%)	5.1	6.0
N (wt%)	0.1	1.1
S (wt%)	0.6	<0.1
O (wt%) (by difference)	46.5	49.9
Proximate analysis		
Moisture (wt%)	6.0	14.8
Ash (wt%)	4.0	2.4
Fixed carbon (wt%)	17.2	26.4
Volatiles (wt%)	72.8	56.4
HHV (MJ/kg)	16.4	16.0

Table S2. Steel slag metal composition.

Element	Metal Content	Element	Metal Content
Ca	30.6 (wt%)	Sr	169.5 (ppm)
Fe	24.1 (wt%)	Pb	147.5 (ppm)
Mg	4.9 (wt%)	Sn	30.5 (ppm)
Mn	1.9 (wt%)	Zr	22.0 (ppm)
Si	1.9 (wt%)	Sb	17.5 (ppm)
Al	1.3 (wt%)	Cu	14.0 (ppm)
P	0.59 (wt%)	Zn	14.0 (ppm)
Ti	0.59 (wt%)	Bi	11.5 (ppm)
V	0.50 (wt%)	Ce	5.5 (ppm)
Na	0.42 (wt%)	Lu	4.0 (ppm)
K	0.20 (wt%)	Mo	4.0 (ppm)
Cr	0.18 (wt%)	Li	3.0 (ppm)
B	219.0 (ppm)	Y	3.0 (ppm)
Ba	205.0 (ppm)	Ni	2.5 (ppm)
Ga	177.0 (ppm)	Er	2.0 (ppm)

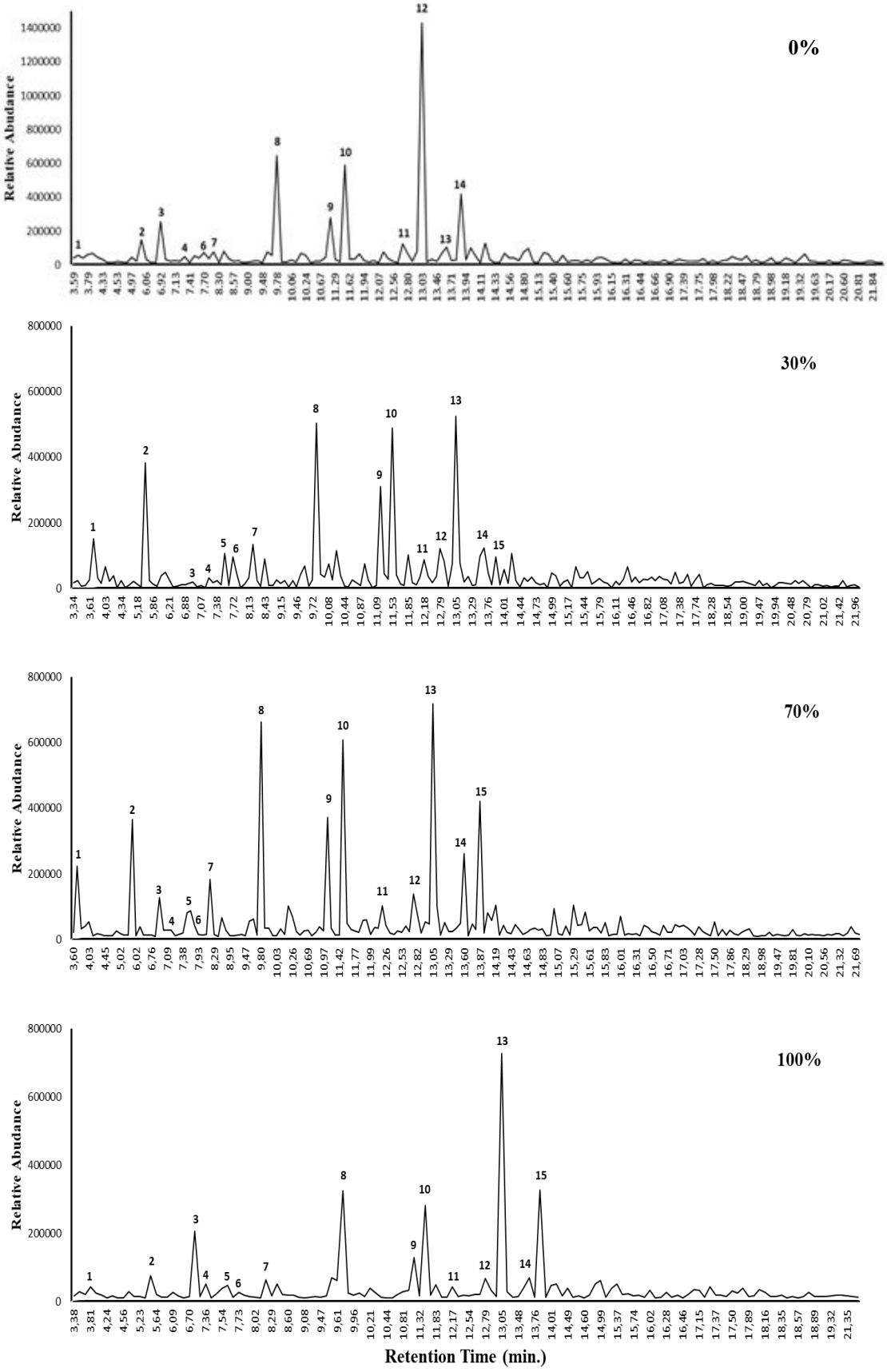

Figure S3. GC-MS chromatograms of SB bio-oil and compounds detected at 400 and 500 ºC (pyrolysis and reforming temperatures) and different SS ratios in the reformer.

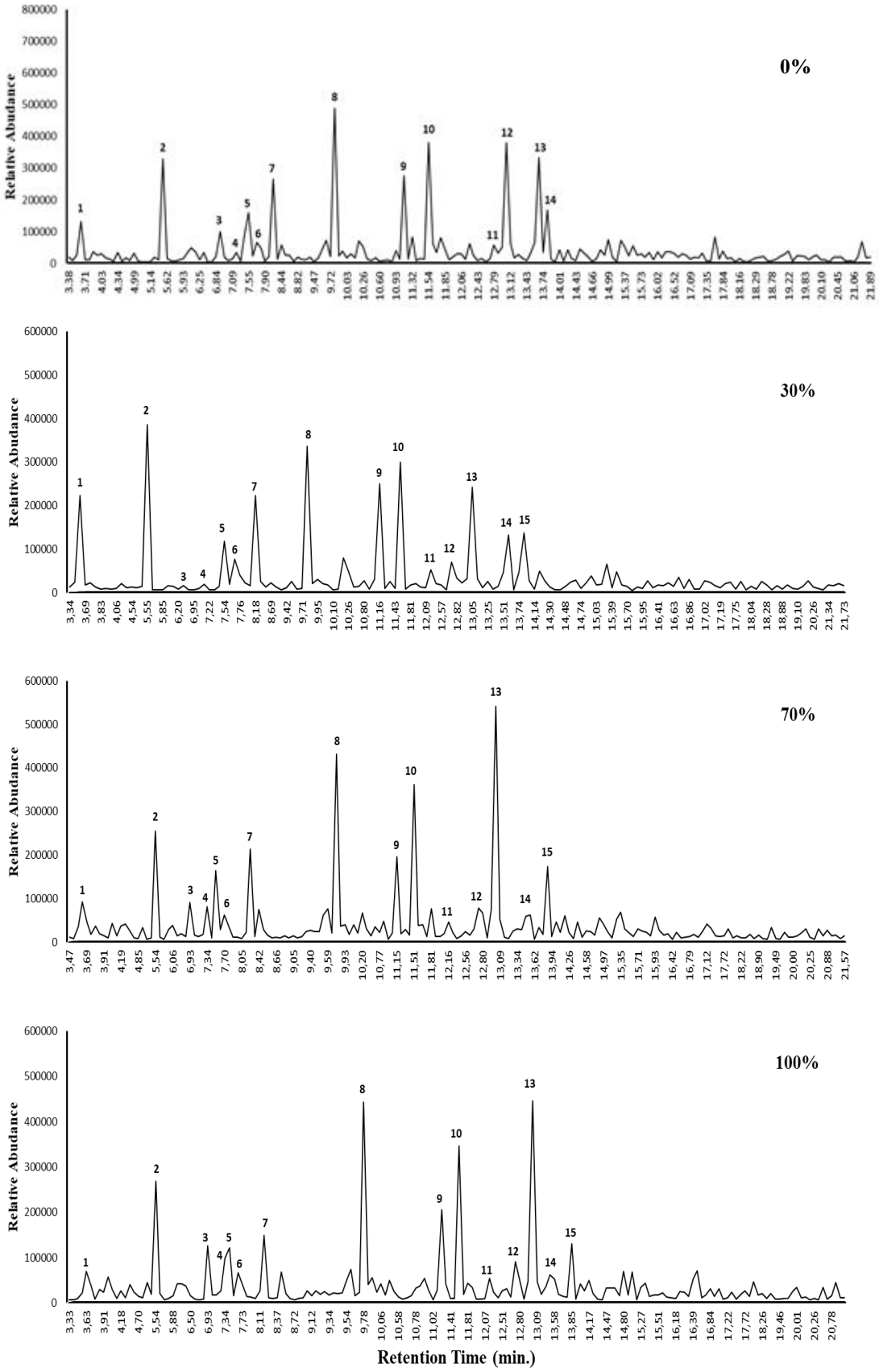

Figure S4. GC-MS chromatograms of OH bio-oil and compounds detected at 400 and 500 ºC (pyrolysis and reforming temperatures) and different SS ratios in the reformer.

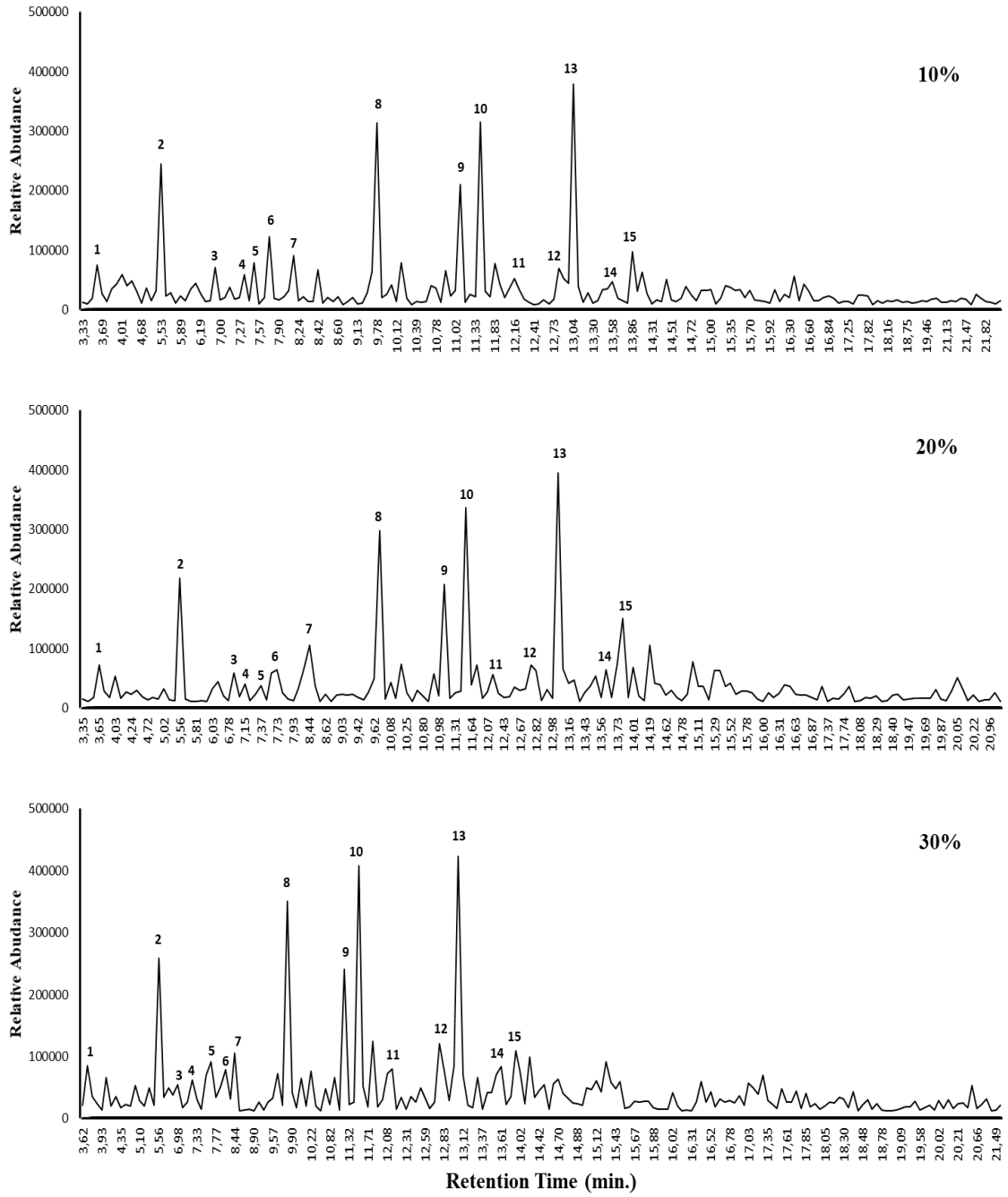

Figure S5. GC-MS chromatograms of OH bio-oil and compounds detected at 400 and 500 ºC (pyrolysis and reforming temperatures) and different SS ratios in the OH feed.

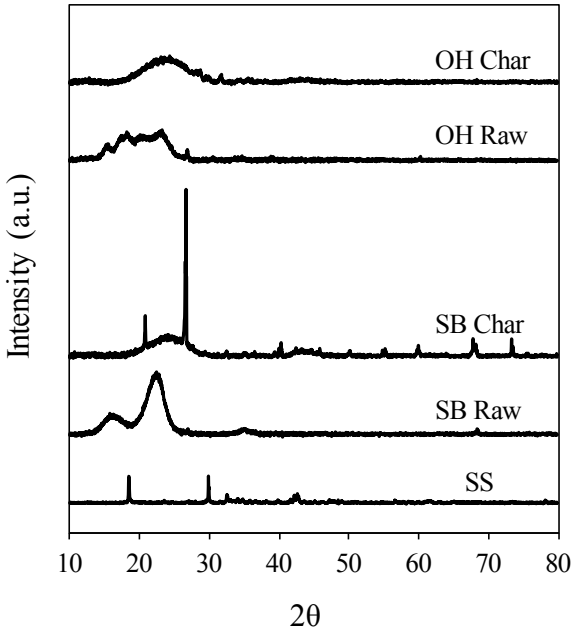

Figure S6. X-ray diffractions of SS, SB raw, SB char, OH raw and OH char.