Electronic Supplementary Material (ESI) for RSC Advances.

Supporting info.

Biochar production from cellulose under reductant atmosphere: Influence of the total pyrolysis time

J. L. Santos[*,a], M.A. Centeno[a] and J.A. Odriozola[a]

[a]Instituto de Ciencias de Materiales de Sevilla. Centro mixto CSIC-Universidad de Sevilla. Avda. Américo Vespucio 49, 41092 Seville, Spain

(*) corresponding author: josel.santos@icmse.csic.es

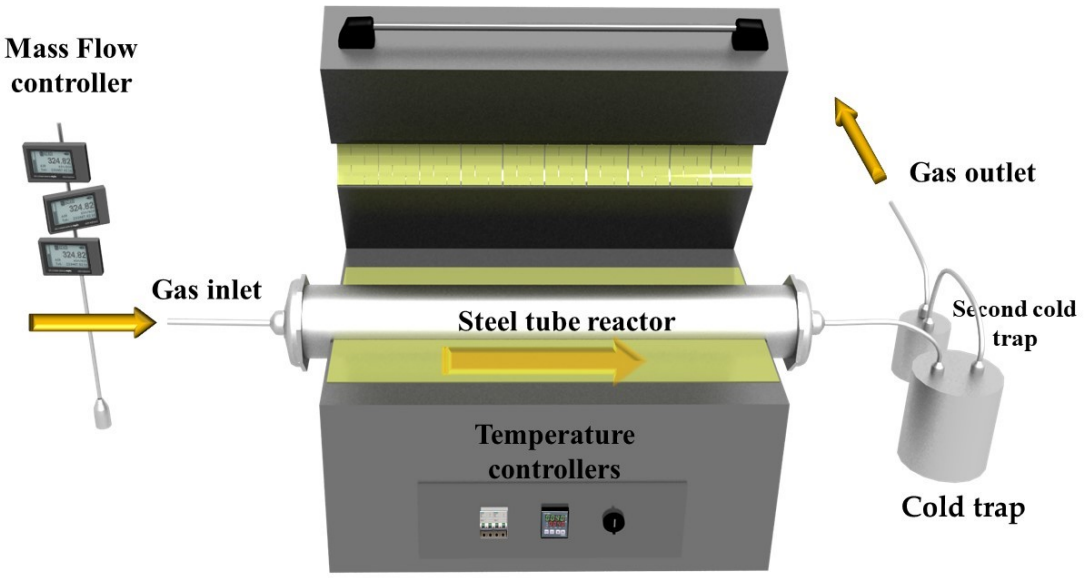


Figure S1. Reductant atmosphere pyrolysis set-up.

Table S1. Char yield and proximate analysis.

Sample	**Char yield (%)**	**Proximate analysis** (Dry basis, wt.%)			
		Moisture	Volatile matter	Carbon fixed[a]	Ash
C 1,10	16.3	4.2	3.5	92.3	<0.01
C 120,10	16	2.8	2.4	94.8	<0.01
C 240,10	14.5	1.8	1.1	97.1	<0.01
C 120,5	15	2	1.6	96.4	<0.01
C 120,20	16.2	3.2	2.7	94.1	<0.01

[a] *Calculated by difference*

Table S2. Elemental analysis and H/C, O/C and O/H ratios.

Sample	**Elemental composition** (wt.%)				**ratios** (wt.)		
	C	**H**	**N**	**O***	**H/C**	**O/C**	**O/H**
C 1,10	94.4	1.3	0.1	4.2	0.014	0.044	3.23
C 120,10	94.8	2.6	0.1	2.5	0.027	0.026	0.96
C 240,10	95.9	3.1	0.1	0.9	0.032	0.009	0.29
C 120,5	95.2	3.0	0.1	1.7	0.032	0.018	0.57
C 120,20	94.3	2.1	0.1	3.1	0.022	0.033	1.48

**estimated by difference*

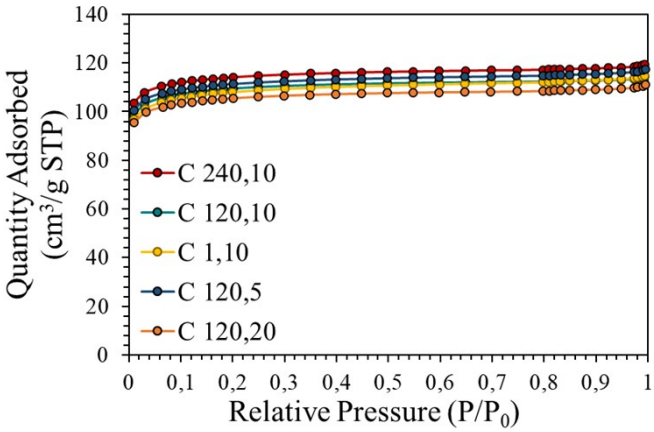


Figure S2. Nitrogen adsorption-desorption isotherms for the influence of the total pyrolysis time.

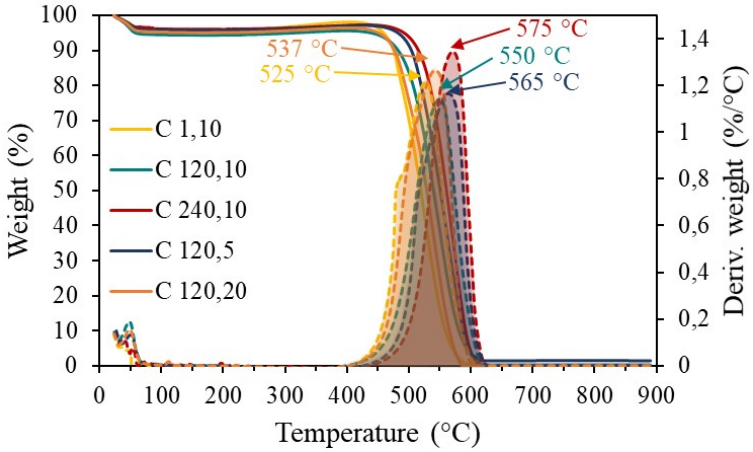


Figure S3. TGA/DT curves for the influence of total pyrolysis time.

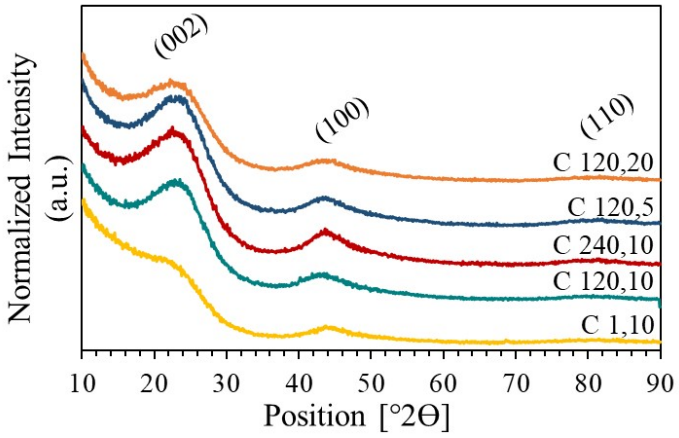


Figure S4. XRD diffractogram of resulted chars pyrolyzed to different conditions**.**

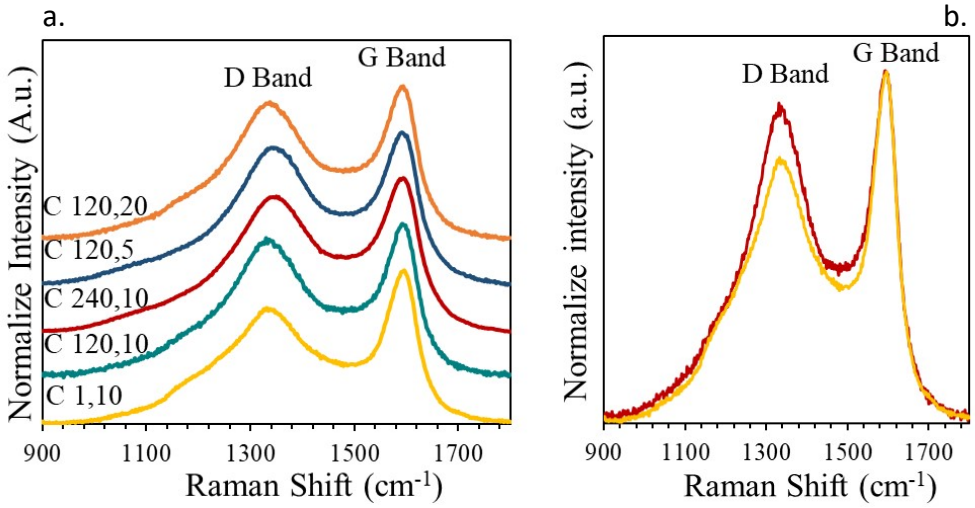


Figure S5a. Raman spectra for the influence of pyrolysis parameters and **b.** Raman spectra for the pyrolysis time impact.

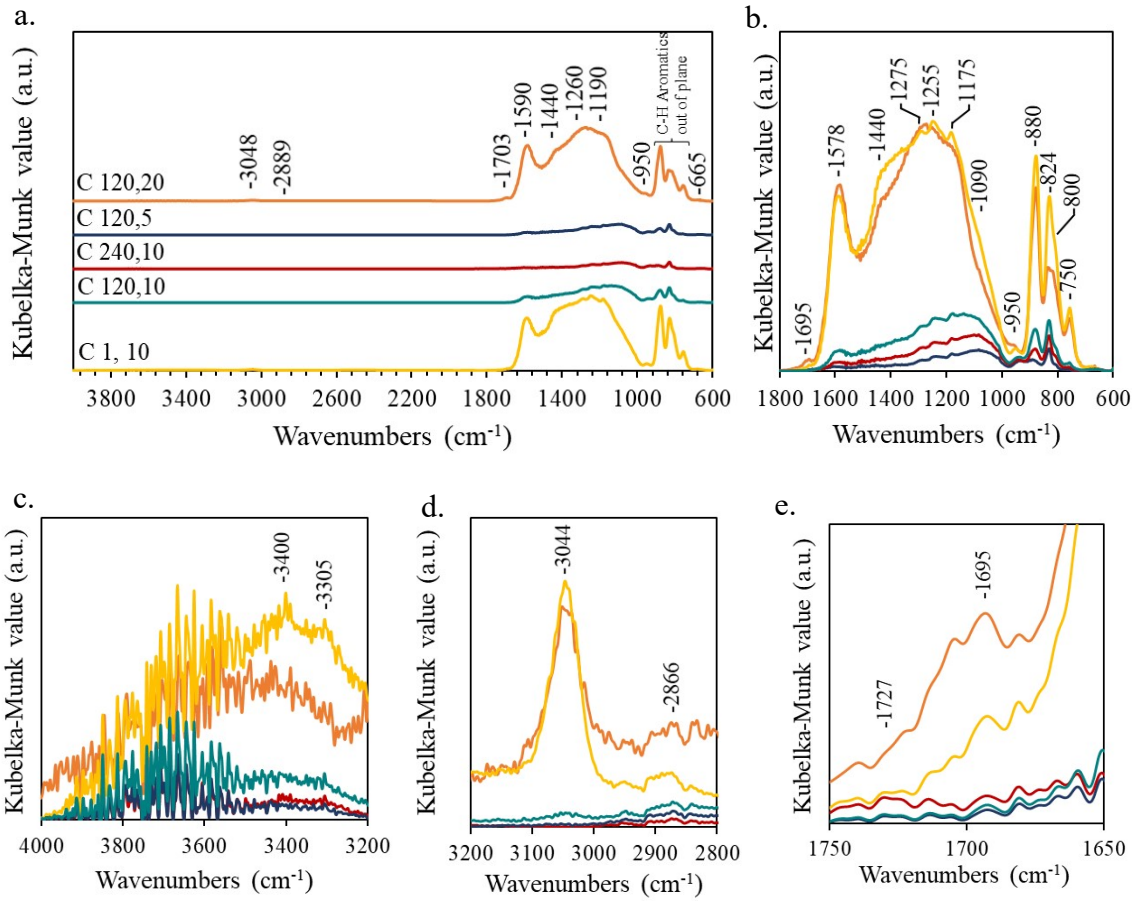


Figure S6. DRIFTS spectra for the influence of different pyrolysis parameters **a.** General spectra, **b.** Zone 1800-600 cm^{-1}, **c.** Zone 4000-3200 cm^{-1}, **d.** Zone 3200-2800 cm^{-1} and **e.** Zone 1750-1650 cm^{-1}.

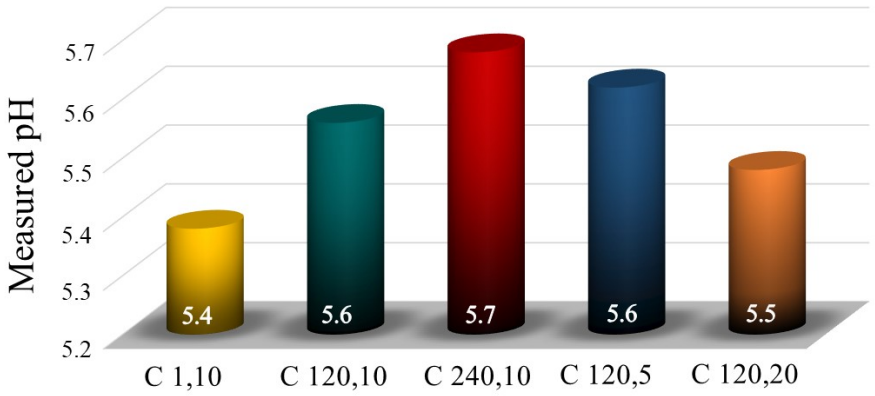


Figure S7. pH of slurry for resulted chars at different residence time and heating rate.

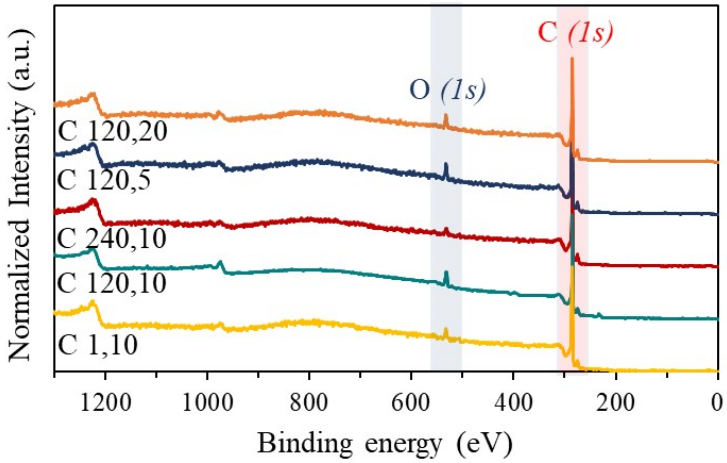
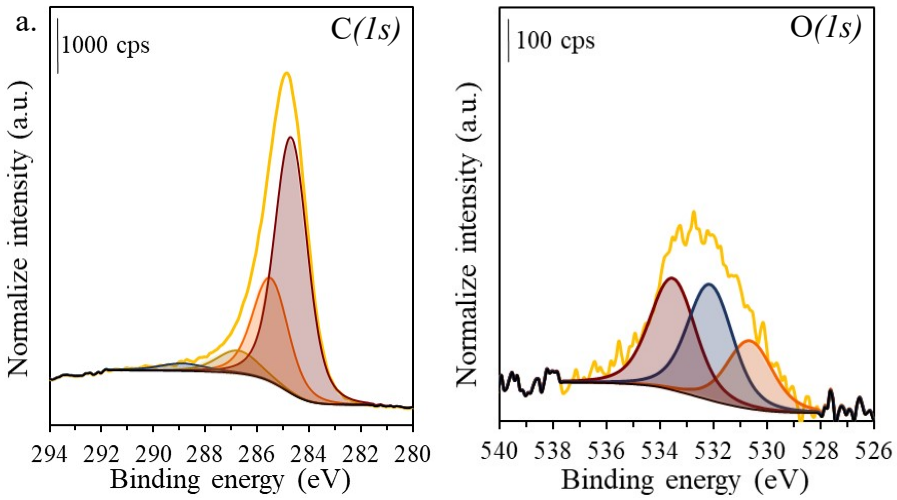
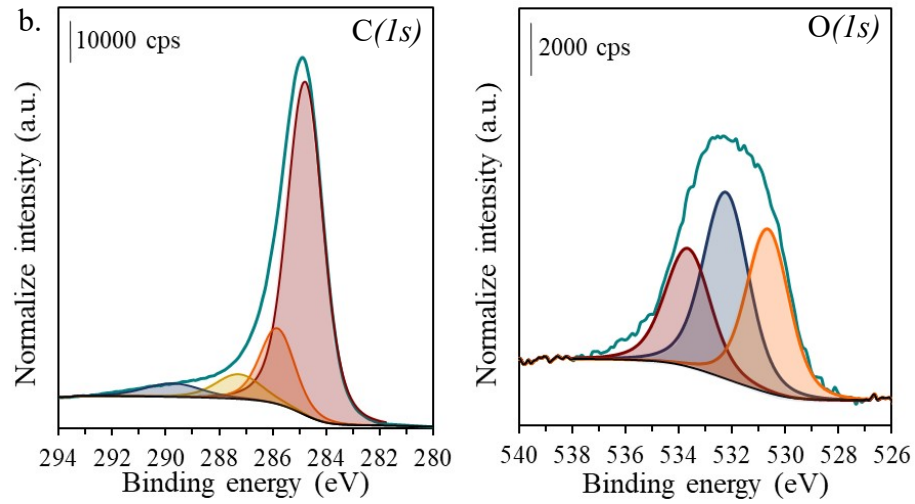
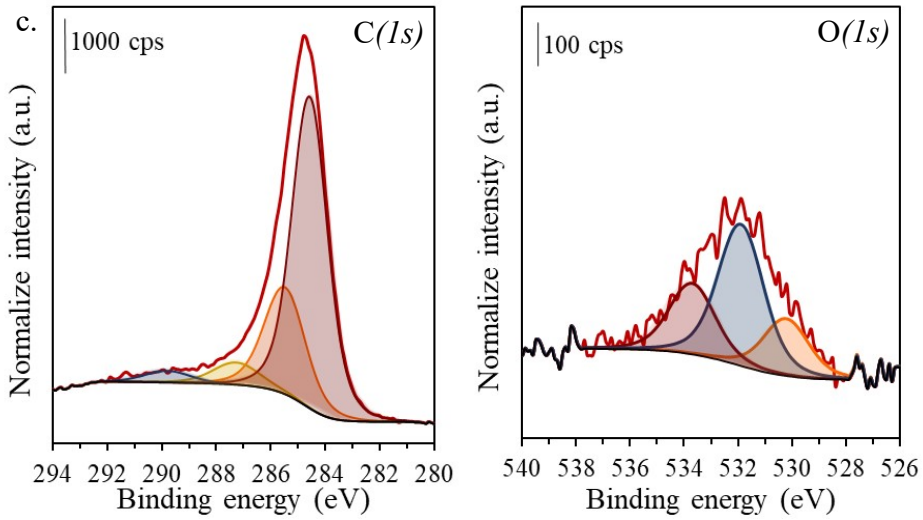
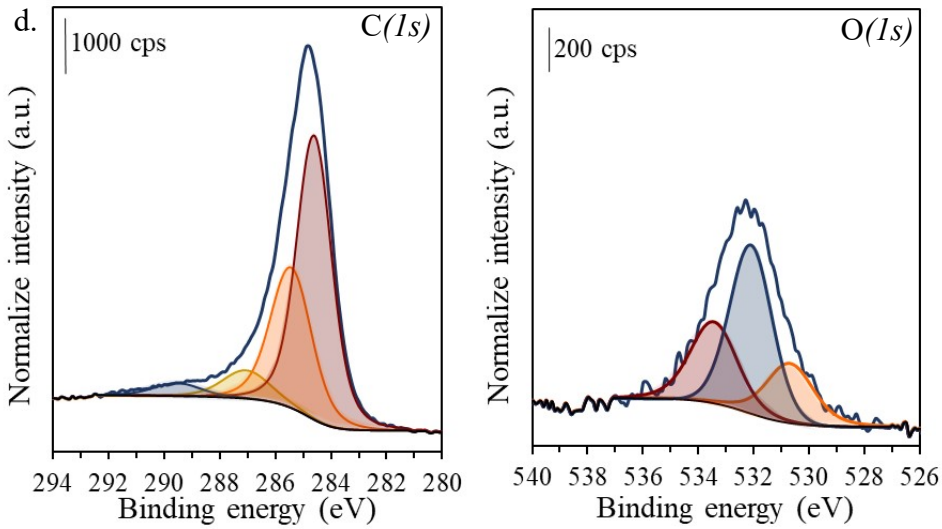


Figure S8. General XPS spectrum for chars obtained in function of total pyrolysis time.




b.
10000 cps
C(1s)
Normalize intensity (a.u.)
294 292 290 288 286 284 282 280
Binding energy (eV)
2000 cps
O(1s)
Normalize intensity (a.u.)
540 538 536 534 532 530 528 526
Binding energy (eV)


c.
1000 cps
C(1s)
Normalize intensity (a.u.)
294 292 290 288 286 284 282 280
Binding energy (eV)
100 cps
O(1s)
Normalize intensity (a.u.)
540 538 536 534 532 530 528 526
Binding energy (eV)


d.
1000 cps
C(1s)
Normalize intensity (a.u.)
294 292 290 288 286 284 282 280
Binding energy (eV)
200 cps
O(1s)
Normalize intensity (a.u.)
540 538 536 534 532 530 528 526
Binding energy (eV)

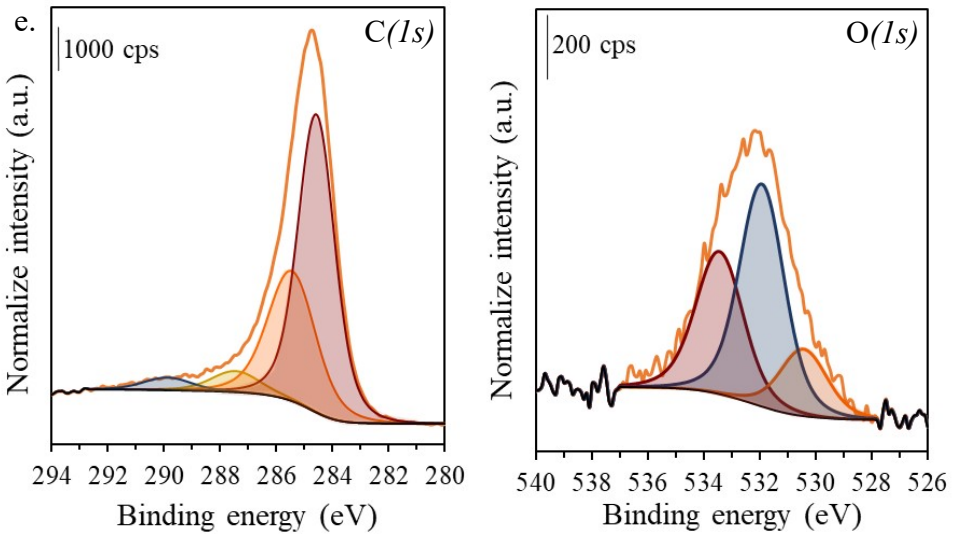


Figure S9. XPS spectra of the energy level C(*1s*) and O(*1s*) of **a.** C 1,10; **b.** C 120,10; **c.** C 240,10; **d.** C 120,5 and **e.** C 120,20.