Supplementary Information

Extending catalyst lifetime by doping of Ce in Ni loaded on acid-washed lignite char for biomass catalytic gasification

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Instruments of characterization

X-ray diffraction (XRD) tests were conducted using a Bruker D8 ADVANCE X-ray diffraction with Cu Kα radiation at 40 kV and 30 mA. The scanning of X-ray ranged from 20° to 80° (2θ). Jade 5.0 software was used to determine NCS of Ni.

FEI QuantaTM 250 scanning electron microscope (SEM) equipped with Bruker Quantax 400 energy dispersive spectrometer (EDS) was employed to show images of the catalysts. The particle samples were mounted on a sticky pad of a SEM stem and metal was sprayed to increase the electrical conductivity of samples.

FEI Tecnai G2 F20 transmission electron microscope (TEM) equipped with Bruker Quantax 400 energy dispersive spectrometer (EDS) was employed to show morphology of the Ni/AWSL, Ni/Al_2O_3 and Ce-dropped catalysts.

N_2 adsorption-desorption experiments were carried out at 77 K using a V-Sorb4800 instrument for the determination of SSA (multipoint BET method), total pore volume (at $p/p_0 = 0.99$), total pore volume (t-plot method) and average pore diameter. Prior to the measurement, the catalyst sample was outgassed at 300 ^oC under vacuum for 8 h.

Section 3.2.2

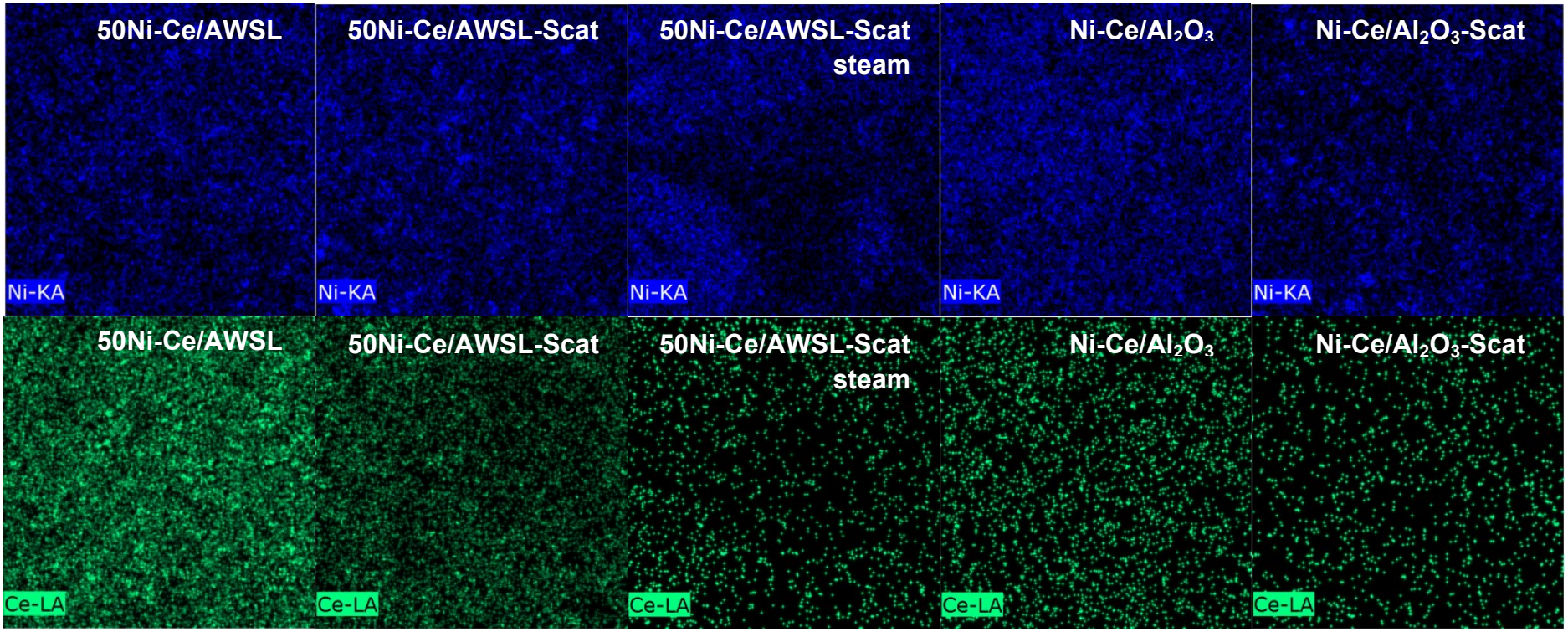

Fig. S1 EDS of spectra for different catalysts.

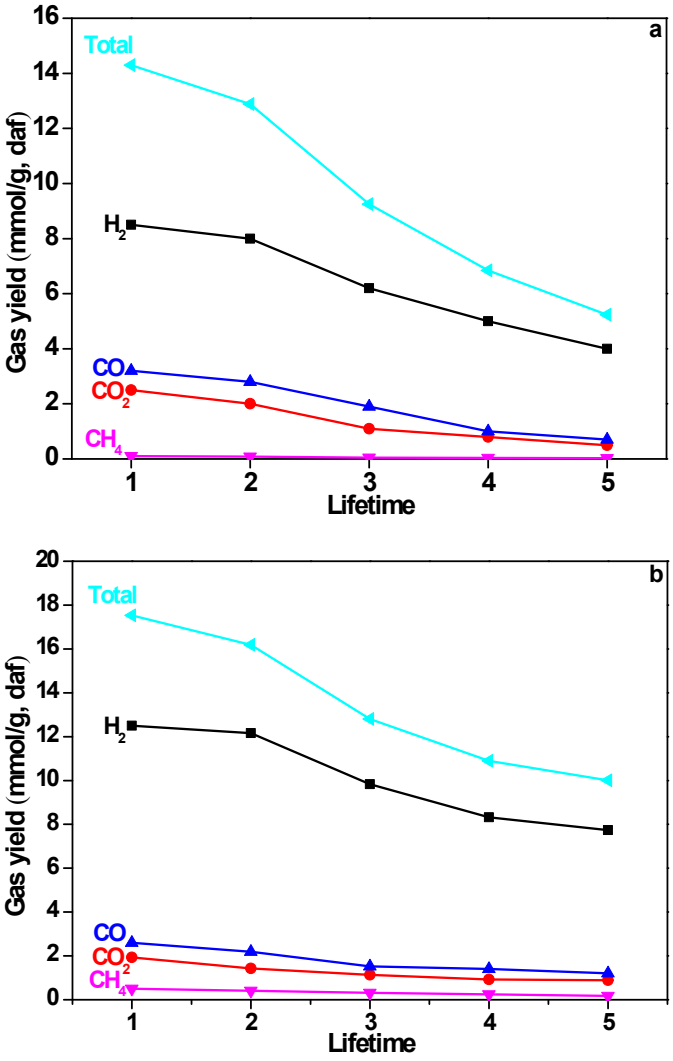

Fig. S2 Gas yield over AWSL char under inert (a) and steam atmospheres (b).

Section 3.2.3

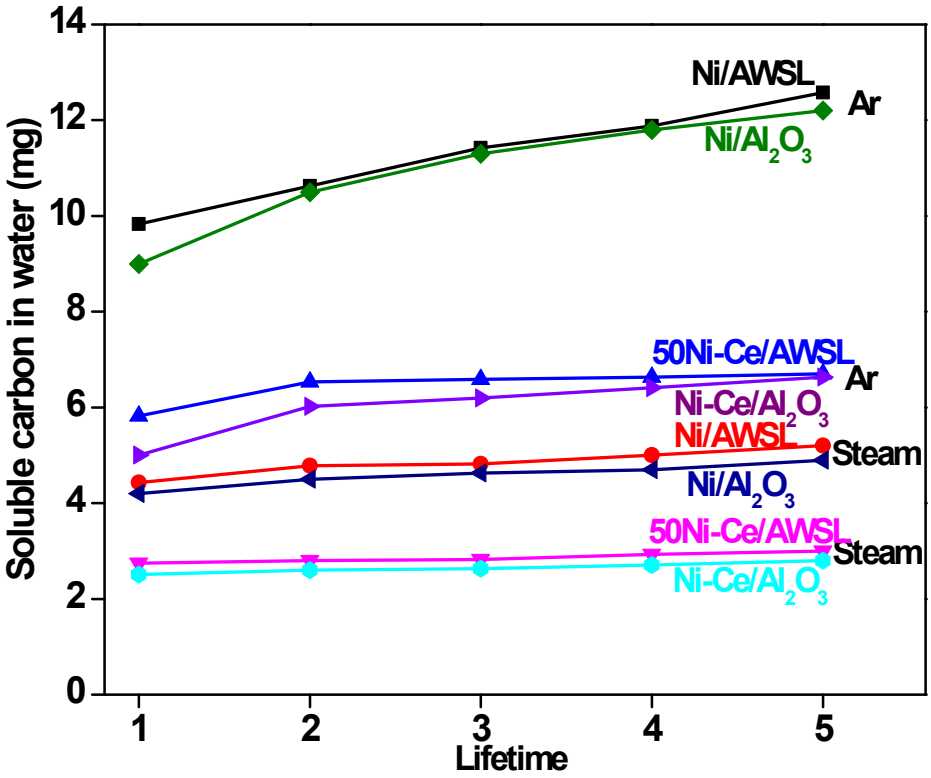

Fig. S3 The yield of C_{WSO} over different catalysts under Ar and steam atmosphere.

Table S1. Proximate and ultimate analyses of the samples.

Sample	Proximate analysis (wt.%) [a]				Ultimate analysis (wt.%, daf)				$S_{t,d}$
	M_{ar}	A_d	VM_d	FC_d [b]	C	H	N	O [b]	
Corncob	8.9	0.9	80.9	18.2	44.3	6.4	0.7	48.5	0.1
SL	16.2	11.3	47.1	41.6	64.6	4.8	1.0	28.5	1.1
AWSL	16.1	9.2	56.4	34.4	67.0	5.2	1.0	25.7	1.0

[a] A: ash; M: moisture; VM: volatile matter; FC: fixed carbon; ar: as received basis; d: dried basis; daf: dried and ash-free basis; $S_{t,d}$: total sulfur in dried basis.

[b] by difference.