***Supporting Information* for**

**Simultaneous removal of SO2 and NOx by potassium-modified carbide slag**

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**Characterization methods**

Using a Bruker D8 Advance X-ray diffractometer( XRD, Bruker D8 Advance A25X, Bruker, Germany ), the phase composition and crystal structure of the catalyst were characterized. A copper target with a preset voltage and current of 40 kV and 40 mA served as the X-ray source. Data is gathered in 0.01° steps over a 2θ range between 10° and 90°. Scanning electron microscopy (SEM, NOVA NANOSEM450, FEI, USA) was used to compare the microstructure and morphology of the CS before and after modification. Fourier transform infrared spectroscopy (FTIR, NICOLET-IS10, Nicoli Corporation, America) was used to differentiate between the functional groups present in the catalysts before and after modification. By using CO2-Temperature Programmed Desorption (CO2-TPD, Microtrac BELCat II, Japan), the modified-CS alkaline sites were identified. X-ray photoelectron spectroscopy (XPS, Escalab 250XI, Thermofisher, America) was used to determine the valence of the chemical elements present on the material's surface.

**Supplementary Figures**

**Fig. S1.Simultaneous desulfurization and denitrification of modified calcium carbide slag with different materials. Reaction conditions: gas flow rate of 200 mL·min-1; initial concentrations of SO2 at 1500 mg·m-3, NO at 700 mg·m-3, and O2 at 5%,.**



**Fig. S2. Full-scan XPS spectra of CS, CS-K2CO3, CS-KOH, CS-KHCO3.**



**Fig. S3. Full-scan XPS spectra of UCS-K2CO3, UCS-KOH, UCS-KHCO3.**



**Supplementary Tables**

**Table S1. XRF elemental analysis of CS, CS-KOH, CS-K2CO3, CS-KHCO3 (as oxides, wt %).**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | CaO | K2O | SiO2 | Al2O3 | Fe2O3 | SO3 |
| CS | 96.96 | 0.05 | 1.20 | 0.44 | 0.80 | 0.29 |
| CS-KOH | 87.03 | 10.34 | 1.48 | 0.38 | 0.49 | 0.15 |
| CS-K2CO3 | 74.38 | 22.92 | 1.32 | 0.32 | 0.43 | 0.22 |
| CS-KHCO3 | 84.80 | 12.20 | 2.11 | 0.00 | 0.66 | 0.05 |

**Table S2. Binding energies (BE) and relative contents (RC) of C 1s, O 1s, and K 2p of CS, CS-KOH, CS-K2CO3, and CS-KHCO3.**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Samples | CS | | CS-KOH | | CS-K2CO3 | | CS-KHCO3 | |
| BE (eV) | RC (%) | BE (eV) | RC (%) | BE (eV) | RC (%) | BE (eV) | RC (%) |
| C=O | 288.71 | 11.77 | 288.76 | 23.46 | 288.52 | 14.41 | 288.98 | 21.35 |
| C-C/C=C | 284.80 | 77.80 | 284.80 | 42.63 | 284.80 | 71.14 | 284.80 | 61.47 |
| -COO | 289.88 | 13.69 | 289.21 | 24.42 | 289.32 | 14.56 | 289.58 | 16.54 |
| C-O | 285.34 | 12.73 | 286.16 | 9.5 | - | - | - | - |
| Olat | 531.18 | 85.07 | 531.13 | 81.46 | 530.89 | 97.31 | 530.99 | 52.53 |
| Oads | 532.67 | 14.93 | 532.55 | 18.54 | 532.86 | 2.69 | 532.48 | 47.47 |
| K4+ | - | - | 292.78 | 23.05 | 293.24 | 13.80 | 293.16 | 26.77 |

**Table S3. Binding energies (BE) and relative contents (RC) of C 1s and O 1s of UCS-KOH, UCS-K2CO3, and UCS-KHCO3.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Samples | UCS-KOH | | UCS-K2CO3 | | UCS-KHCO3 | |
| BE (eV) | RC (%) | BE (eV) | RC (%) | BE (eV) | RC (%) |
| C=O | - | - | - | - | 288.96 | 10.26 |
| C-C/C=C | 284.80 | 45.51 | 284.80 | 33.23 | 284.80 | 35.62 |
| -COO | 290.11 | 8.9 | 290.14 | 11.63 | 289.89 | 20.23 |
| C-O | 286.26 | 45.51 | 286.10 | 55.13 | 285.50 | 33.89 |
| Olat | 531.08 | 100 | 531.19 | 100 | 531.04 | 61.66 |
| Oads | - | - | - | - | 532.47 | 38.34 |