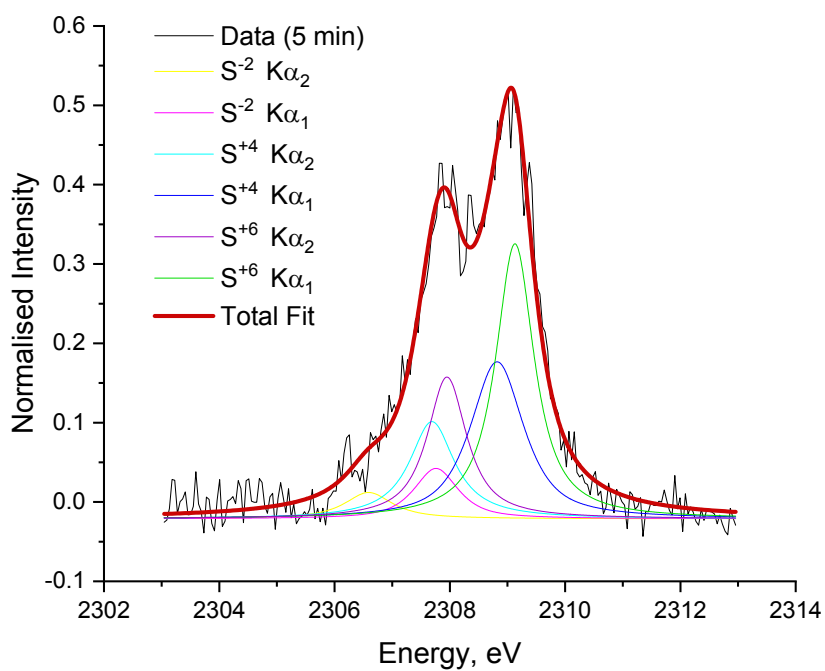
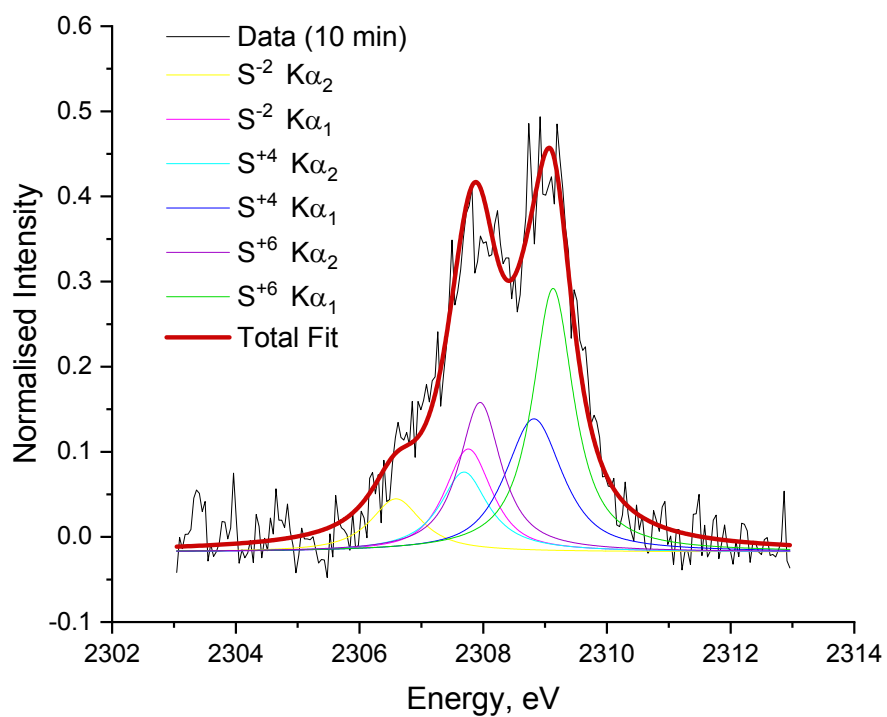


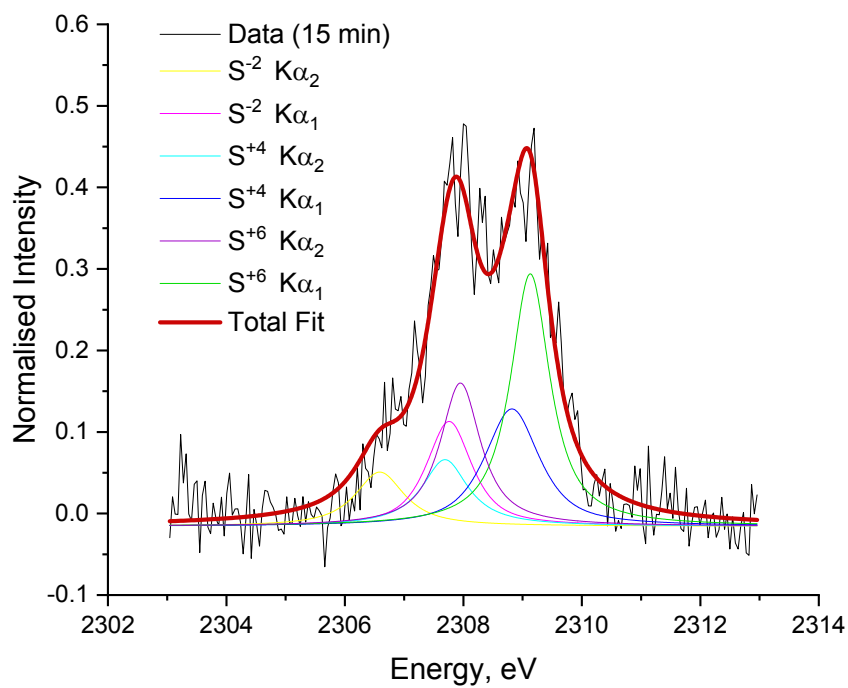
**Fig. S1:** DRIFTS spectra of poisoned Ru/SiO<sub>2</sub> exposed to oxidative regeneration at increasing oxygen concentration



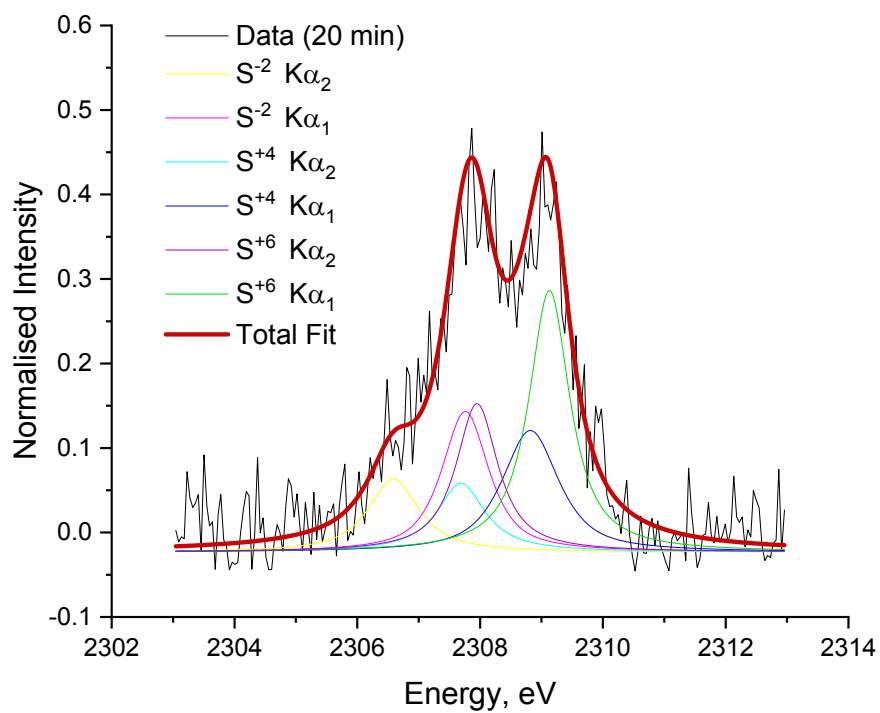
**Fig. S2:** 5 min into H<sub>2</sub>/CO treatment



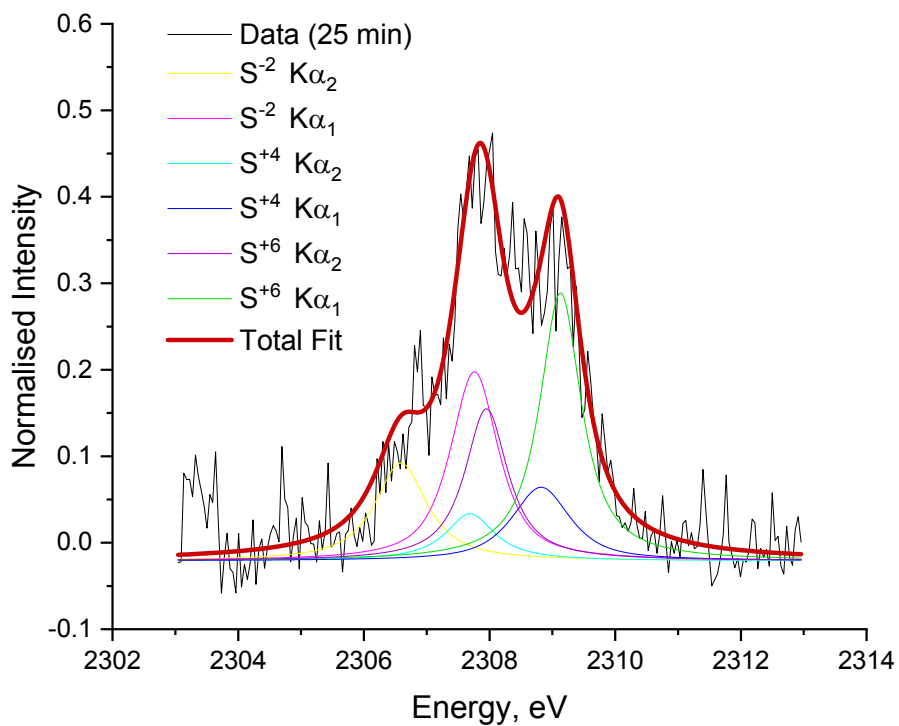
**Fig. S3:** 10 min into H<sub>2</sub>/CO treatment



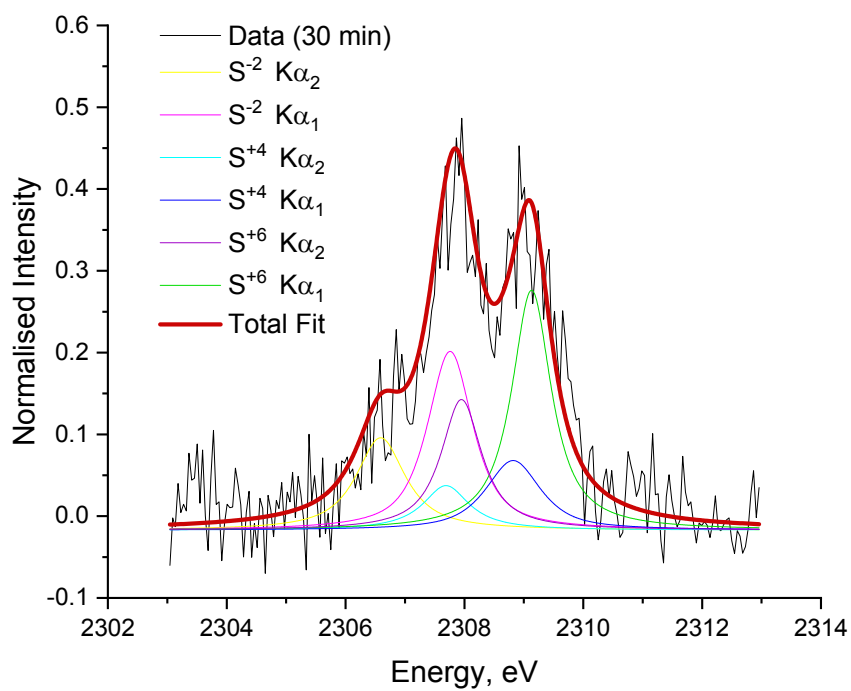
**Fig. S4:** 15 min into H<sub>2</sub>/CO treatment



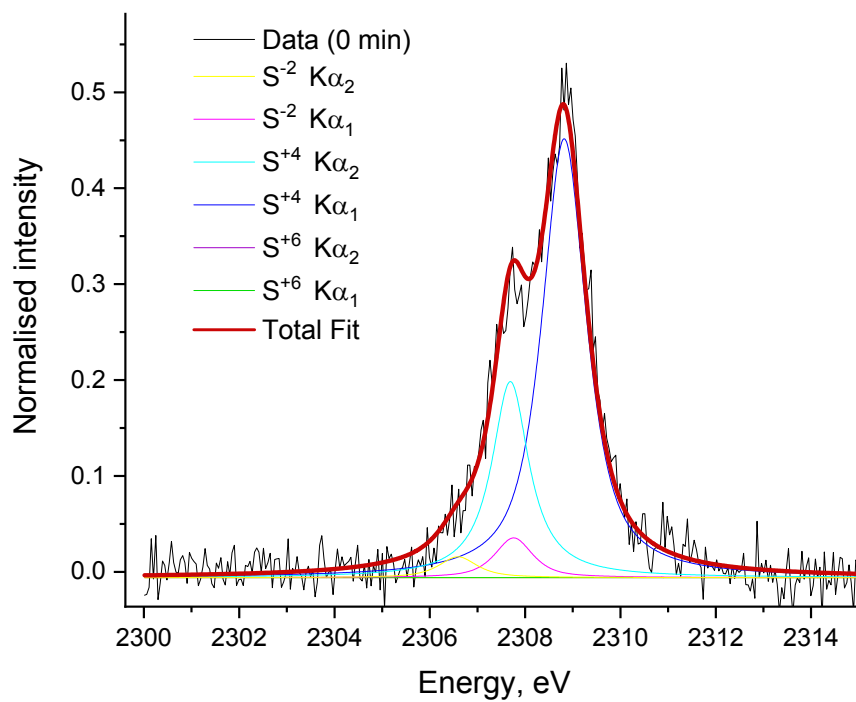
**Fig. S5:** 20 min into H<sub>2</sub>/CO treatment



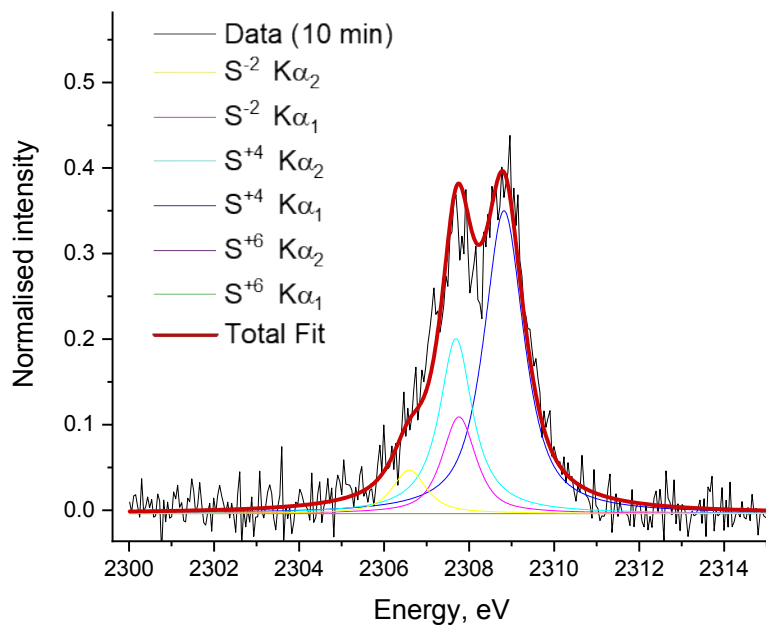
**Fig. S6:** 25 min into H<sub>2</sub>/CO treatment



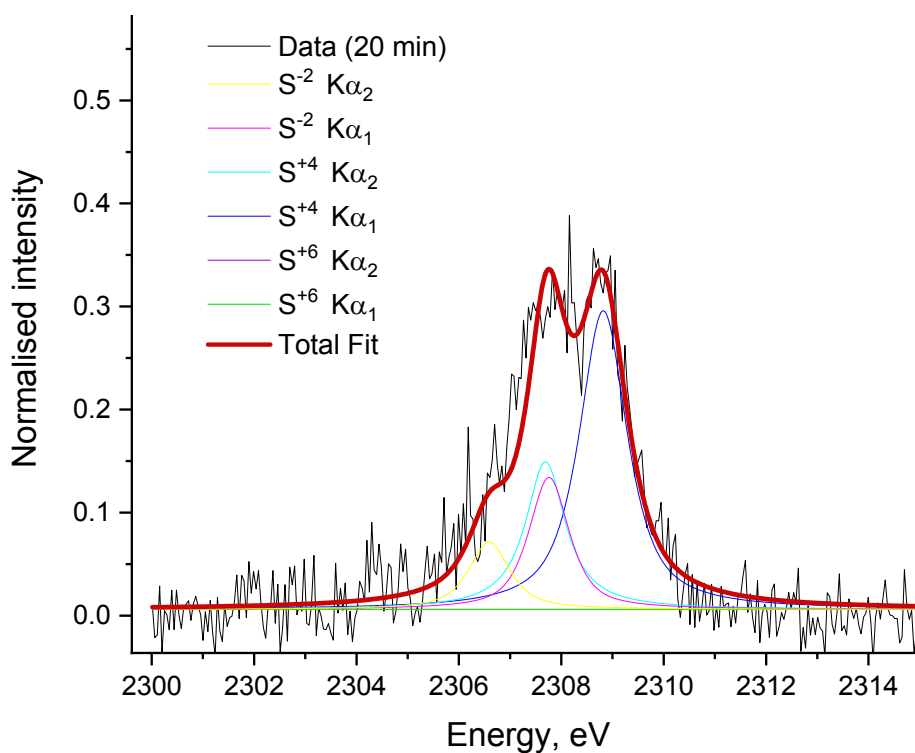
**Fig. S7:** 30 min into  $H_2/CO$  treatment



**Fig. S8:** 0 min into  $H_2/CO$  treatment



**Fig. S9:** 10 min into  $H_2/CO$  treatment



**Fig. S10:** 20 min into  $H_2/CO$  treatment

Reference	$K\alpha_1$			$K\alpha_2$			$K\alpha_1 / K\alpha_2$	$A_{\text{total}}$
	Center, eV	FWHM	$\mu$	Center, eV	FWHM	$\mu$		
$S^{-2}$	2307.76	0.91	0.83	2306.59	0.99	0.93	1.68	1.16
$S^{+4}$	2308.82	1.1	0.83	2307.69	0.94	0.99	1.82	1.07
$S^{+6}$	2309.13	0.8	0.95	2307.95	0.82	0.94	1.73	1.04

Table S1: Parameters used in fitting the in situ spectra

Time in H <sub>2</sub> /CO	% $S^{-2}$	% $S^{+4}$	% $S^{+6}$	Total area, a.u.	$S^{-2}$ area, a.u.	$S^{+4}$ area, a.u.	$S^{+6}$ area, a.u.
0 min	9	39	52	3076431	276878.8	1199808.09	1599744.12
5 min	10.5	39	50.5	2197392	230726.2	856982.88	1109682.96
10 min	20.5	31	48.5	1369559	280759.6	424563.29	664236.115
15 min	22	29	49	977774	215110.3	283554.46	479109.26
20 min	27	27	46	828384	223663.7	223663.68	381056.64
25 min	36	17	47	641755	231031.8	109098.35	301624.85
30 min	37	18	45	695306	257263.2	125155.08	312887.7

Table S2: The percentage and area of each component in the fit during H<sub>2</sub>/CO treatment after oxidative regeneration of Ru/Al<sub>2</sub>O<sub>3</sub>

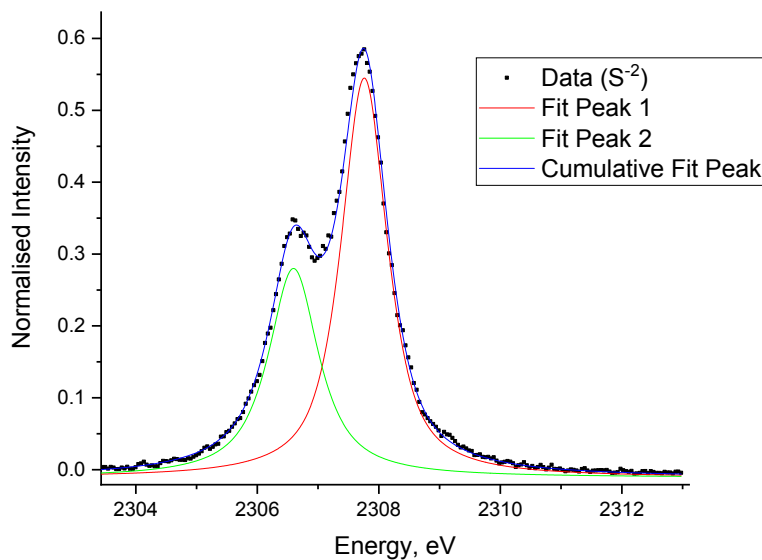
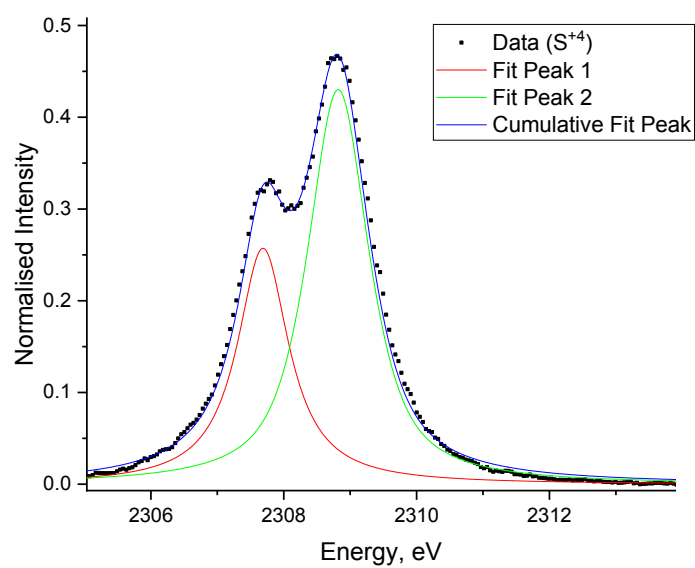
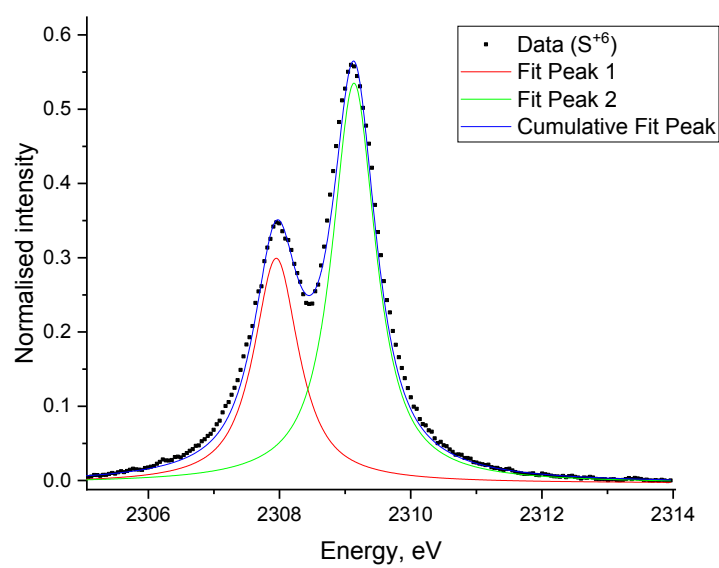


Fig. S11: Pseudo-Voigt fit of  $S^{-2}$  ( $Ag_2S$ ) reference



**Fig. S12:** Pseudo-Voigt fit of S<sup>+4</sup> (Na<sub>2</sub>SO<sub>3</sub>) reference



**Fig. S13:** Pseudo-Voigt fit of S<sup>+6</sup> (Na<sub>2</sub>SO<sub>4</sub>) reference