Electronic supplementary information

Highly dispersed Cu(II), Co(II) and Ni(II) catalysts covalently immobilized on imine modified silica for cyclohexane oxidation with hydrogen peroxide

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EDS analysis of Silica gel

Net Counts

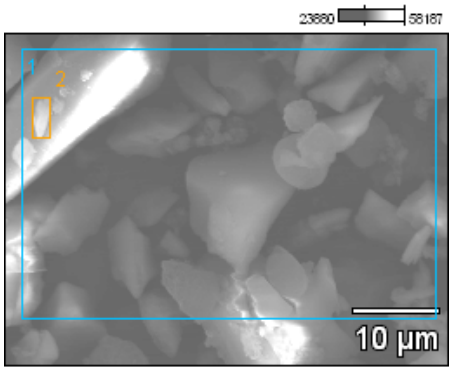
O	*Si*
19873	98836

Weight %

O	*Si*
41.90	58.10

Atom %

O	*Si*
55.87	44.13



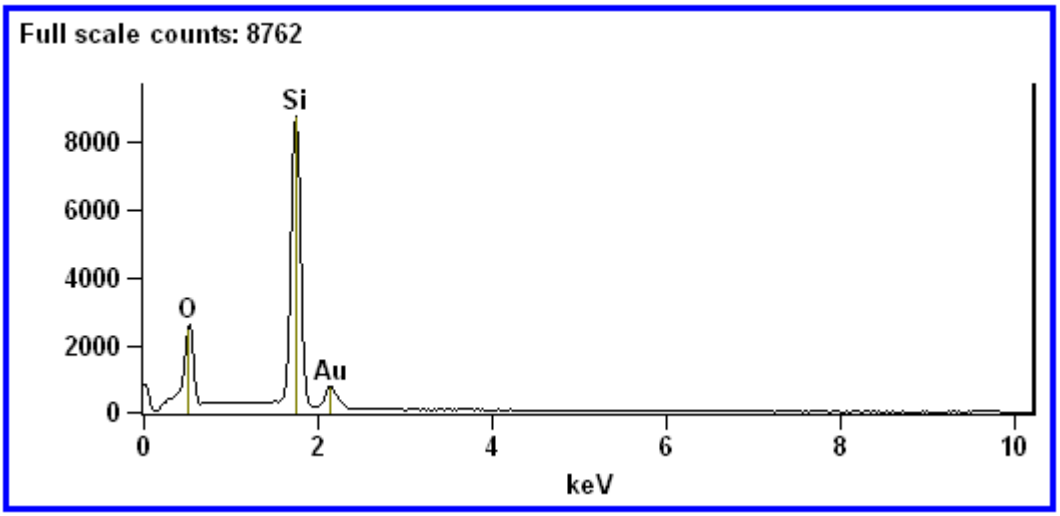


Fig. S1 EDS spectrum of silica gel

EDS analysis of amino modified silica gel

Net Counts

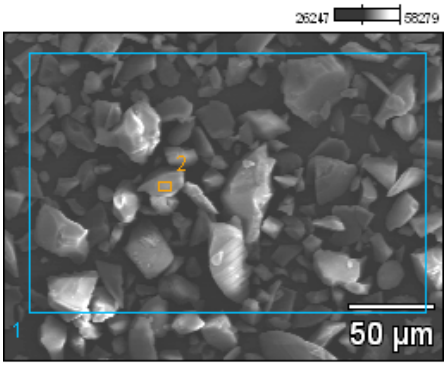
C	*N*	*O*	*Si*
3040	3005	19453	72307

Weight %

C	*N*	*O*	*Si*
11.10	12.06	42.04	34.81

Atom %

C	*N*	*O*	*Si*
16.35	15.23	46.49	21.93



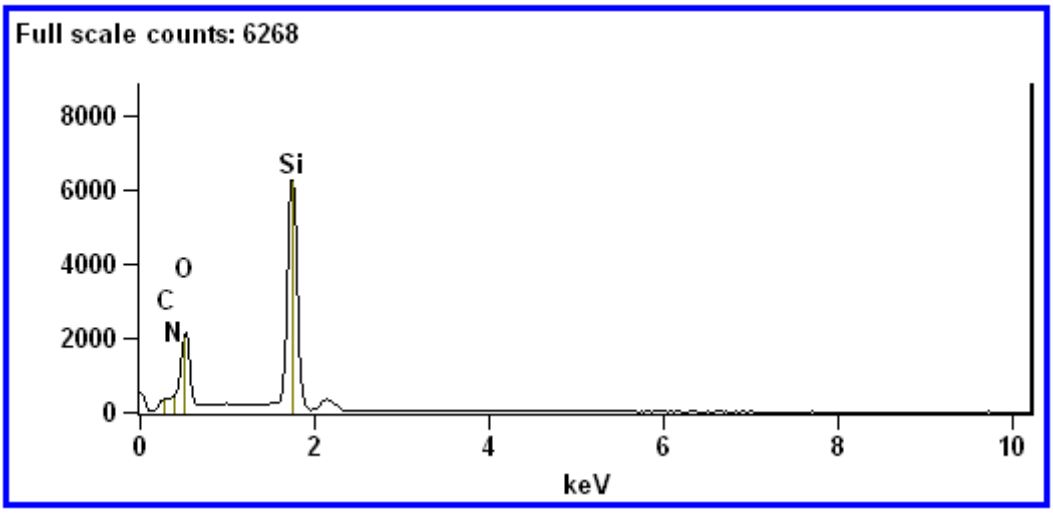


Fig. S2 EDS spectrum of amino modified silica gel, SiO_2-NH_2

EDS analysis of imine modified silica gel, L

Net Counts

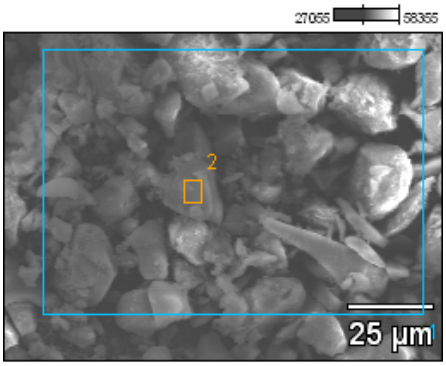
C	*N*	*O*	*Si*
3360	1770	13351	49000

Weight %

C	*N*	*O*	*Si*
15.92	10.74	40.93	32.41

Atom %

C	*N*	*O*	*Si*
22.83	13.21	44.07	19.88



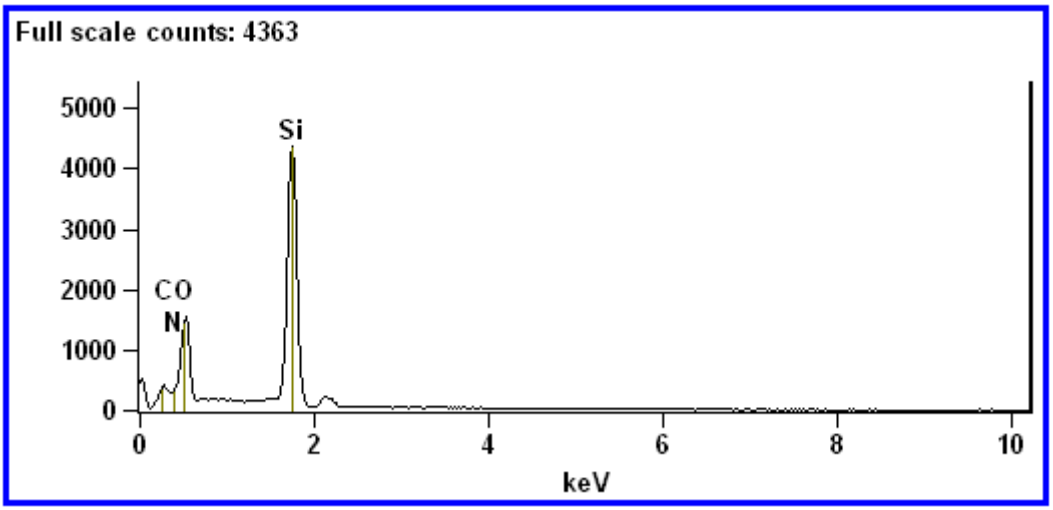


Fig. S3 EDS spectrum of imine modified silica gel, L

EDS analysis of Cu(II) catalyst (catalyst 1)

Net Counts

C	*N*	*O*	*Si*	*Cu*	*Cl*
3754	2082	14756	50505	292	271

Weight %

C	*N*	*O*	*Si*	*Cu*	*Cl*
15.60	11.11	39.51	29.63	2.21	1.94

Atom %

C	*N*	*O*	*Si*	*Cu*	*Cl*
22.60	13.81	43.75	18.68	0.60	0.55

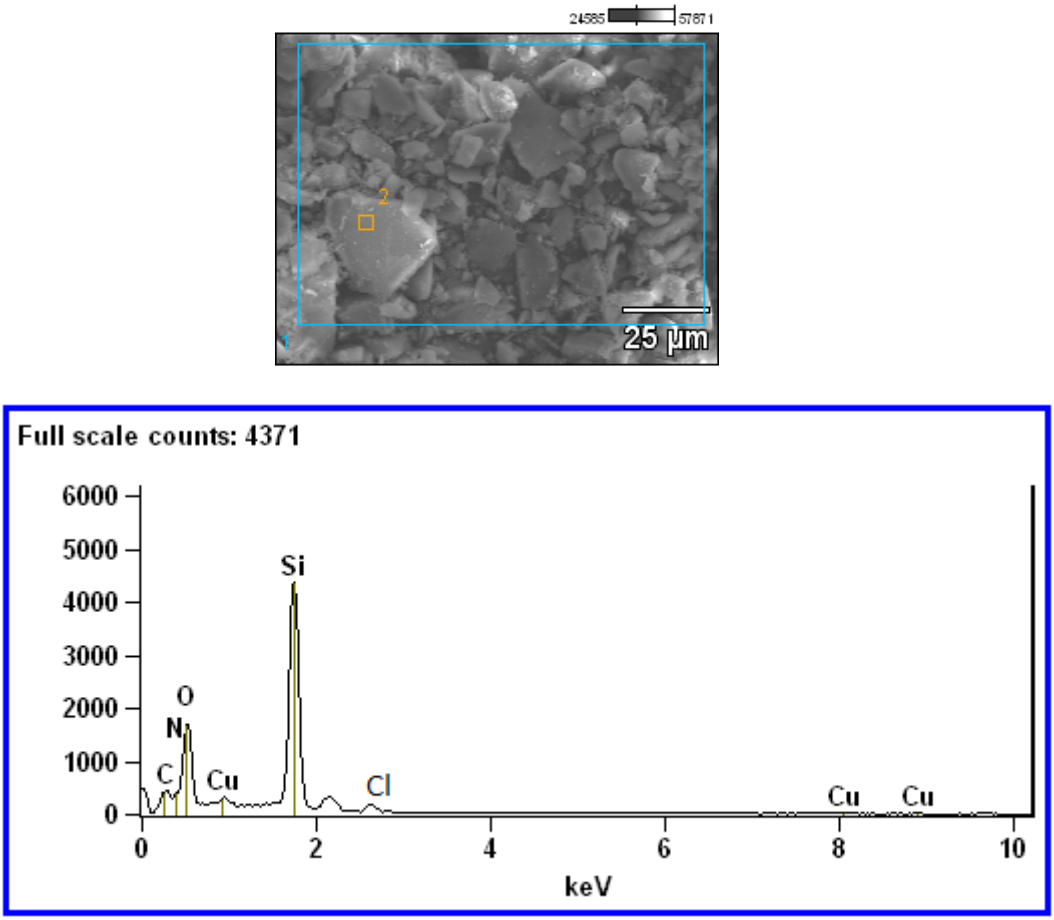


Fig. S4 EDS spectrum of Cu(II) catalyst (1)

EDS analysis of Co(II) catalyst (catalyst 2)

Net Counts

C	*N*	*O*	*Si*	*Co*	*Cl*
5818	3001	21999	69330	342	318

Weight %

C	*N*	*O*	*Si*	*Co*	*Cl*
16.30	11.19	41.80	28.68	1.06	0.97

Atom %

C	*N*	*O*	*Si*	*Co*	*Cl*
23.18	13.64	44.99	17.62	0.31	0.26

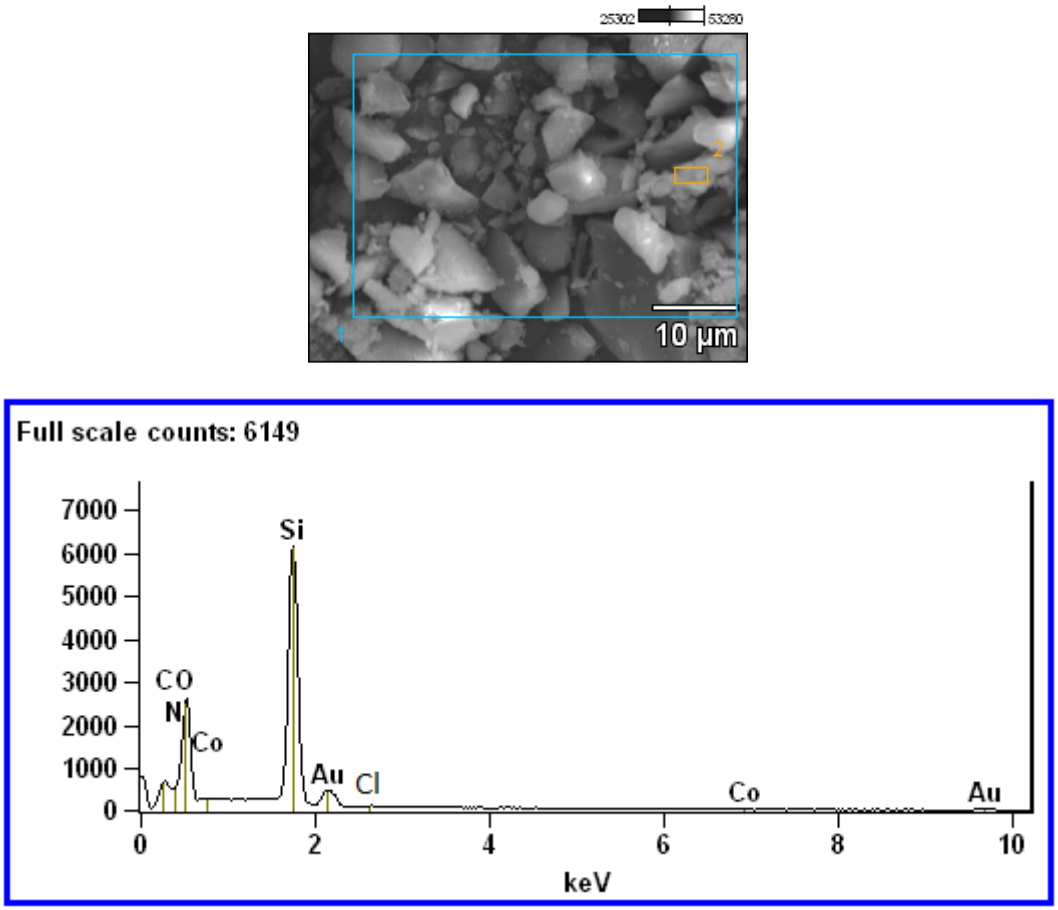


Fig. S5 EDS spectrum of Co(II) catalyst (2)

EDS analysis of Ni catalyst (catalyst 3)

Net Counts

C	*N*	*O*	*Si*	*Ni*	*Cl*
6629	*2813*	*21804*	*80450*	*230*	*208*

Weight %

C	*N*	*O*	*Si*	*Ni*	*Cl*
17.92	10.40	39.47	30.64	0.81	0.76

Atom %

C	*N*	*O*	*Si*	*Ni*	*Cl*
25.53	12.70	42.54	18.79	0.24	0.20

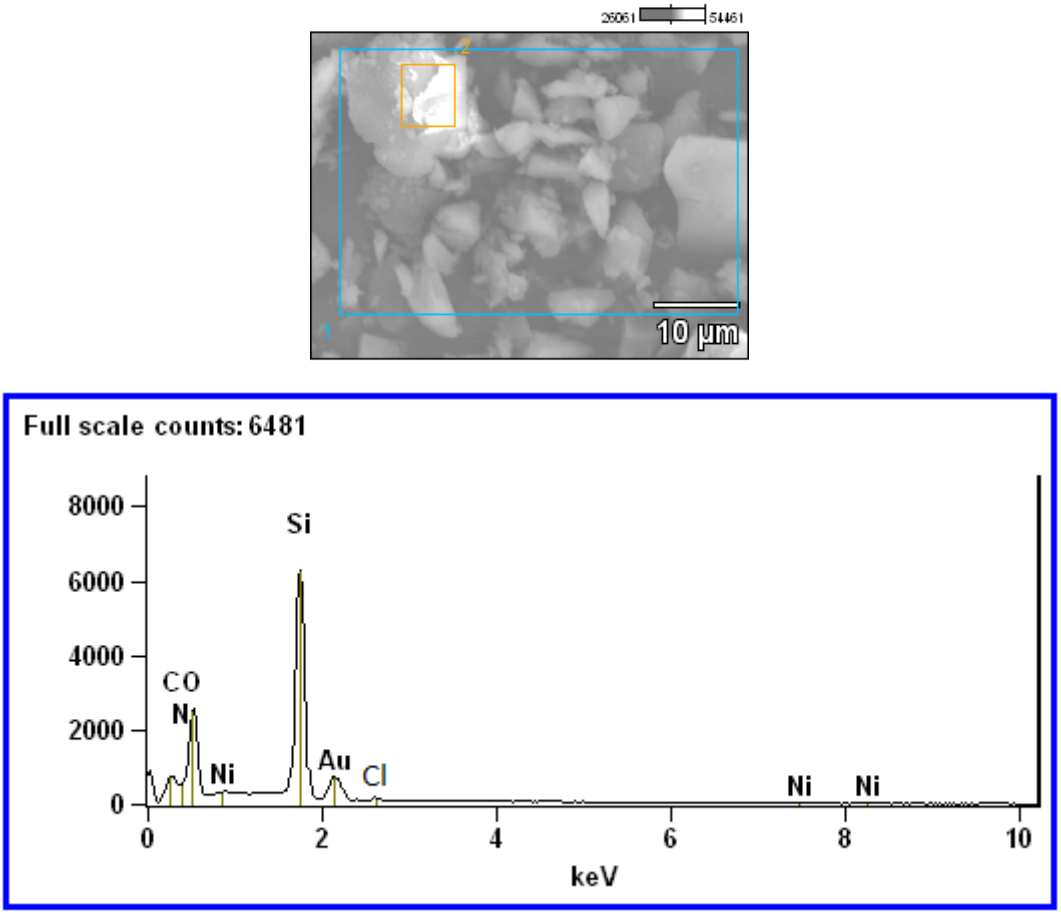


Fig. S6 EDS spectrum of Ni(II) catalyst (3)

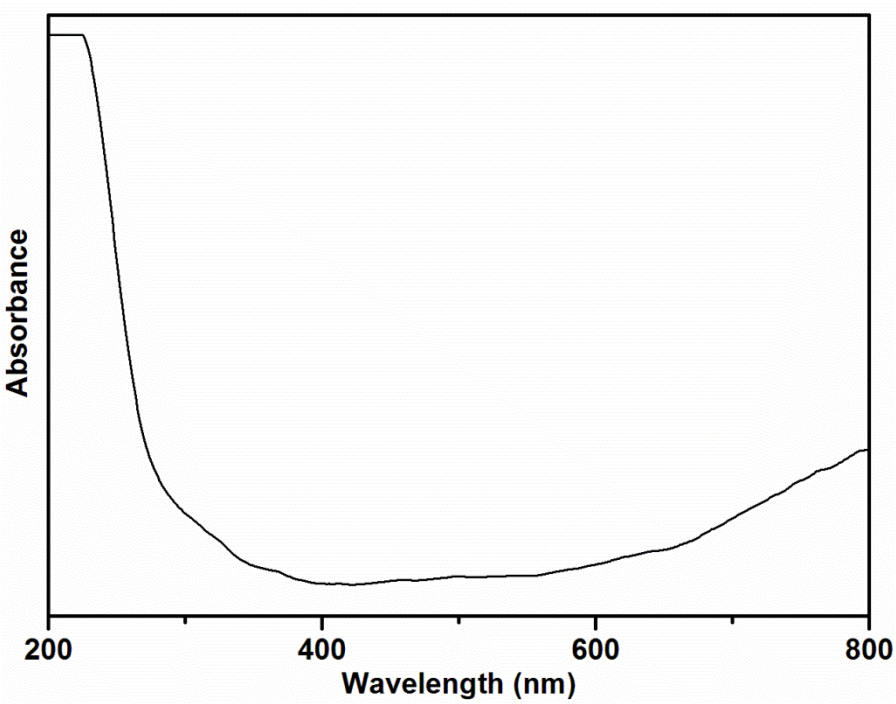


Fig. S7 UV-Vis. spectrum of silica gel

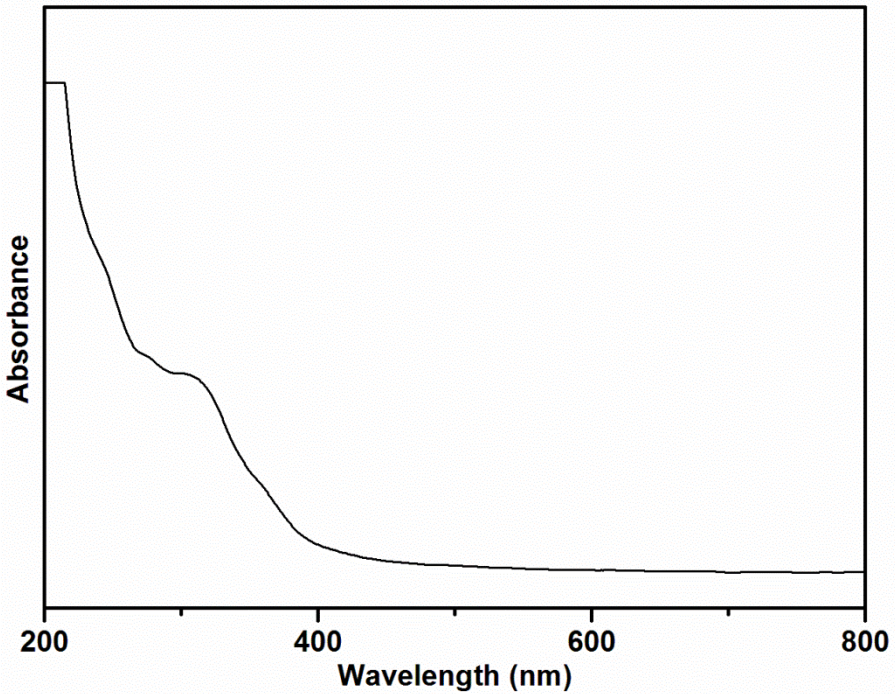


Fig. S8 UV-Vis. spectrum of amino modified silica gel, SiO_2-NH_2

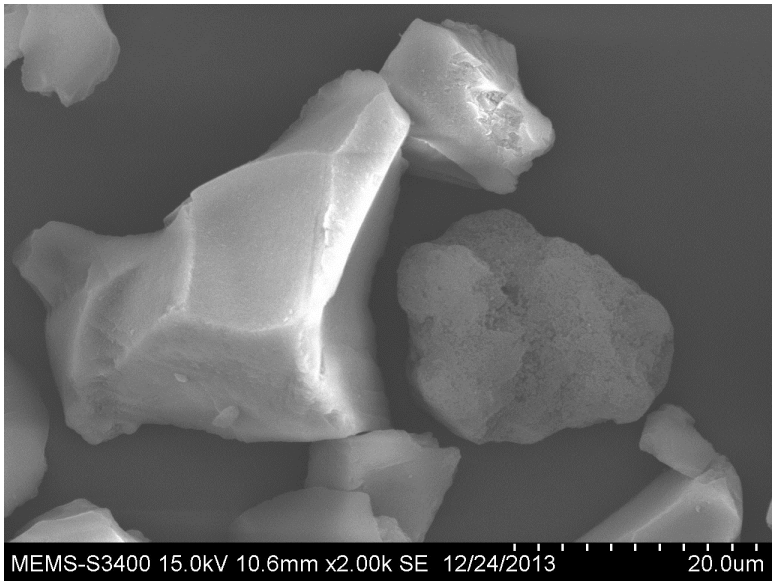


Fig. S9 SEM image of silica gel

Table S1 Thermal decomposition steps of silica gel, L and catalysts *viz* 1, 2 and 3

Compound	1st stage, °C (wt loss, %)	2nd stage, °C (wt loss, %)	3rd stage, °C (wt loss, %)	4th stage, °C (wt gain, %)
L	0-110 (~3)	110-370 (~4)	370-800 (~10)	-
Catalyst 1	0-110 (~2)	110-360 (~3)	360-570 (~3)	570-800 (~8)
Catalyst 2	0-110 (~3)	110-340 (~4)	340-570 (~7)	570-800 (~4)
Catalyst 3	0-110 (~2)	110-370 (~4)	370-610 (~5)	610-800 (~3)

1st stage: desorption of physically adsorbed water

2nd stage: decay of organic moiety

3rd stage: dehydroxylation of surface silanol groups

4th stage: oxidation reactions