

Supplementary material

Co₃O₄/Al₂O₃

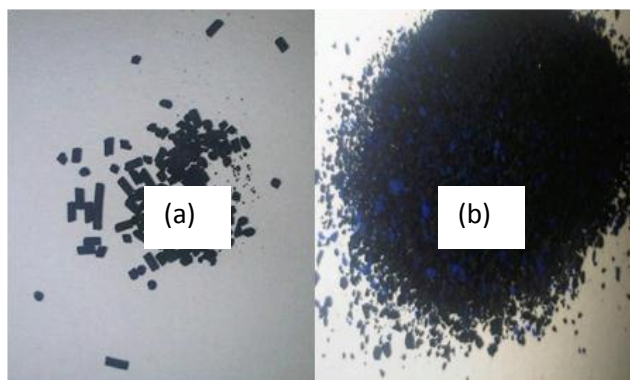


Figure S1: Fresh Co₃O₄/Al₂O₃ pellets, (b) Spent Co₃O₄/Al₂O₃ pellets (the bluish colour indicates the presence of cobalt aluminate in the spent catalyst)

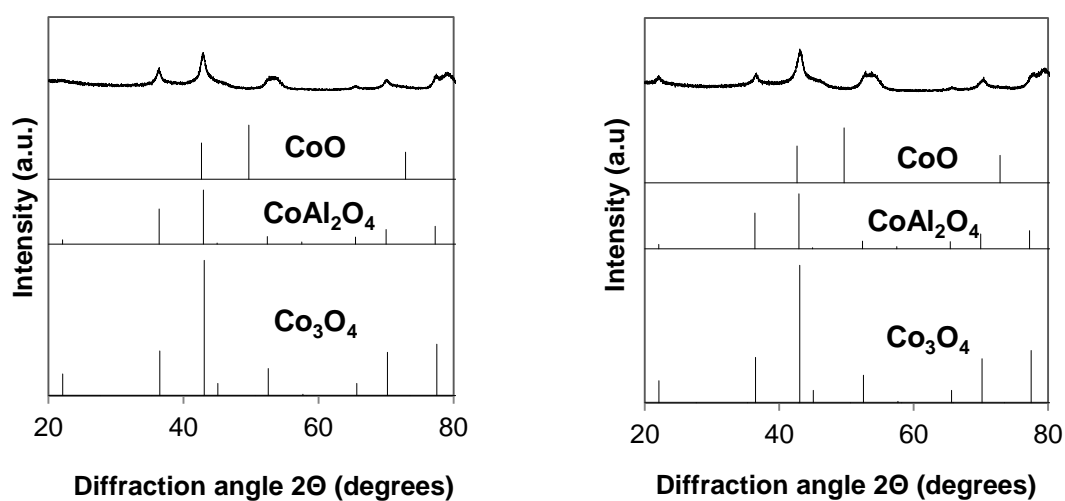


Figure S2: X-ray diffraction patterns of the fresh Co₃O₄/Al₂O₃ (left) and spent Co₃O₄/Al₂O₃ (right)

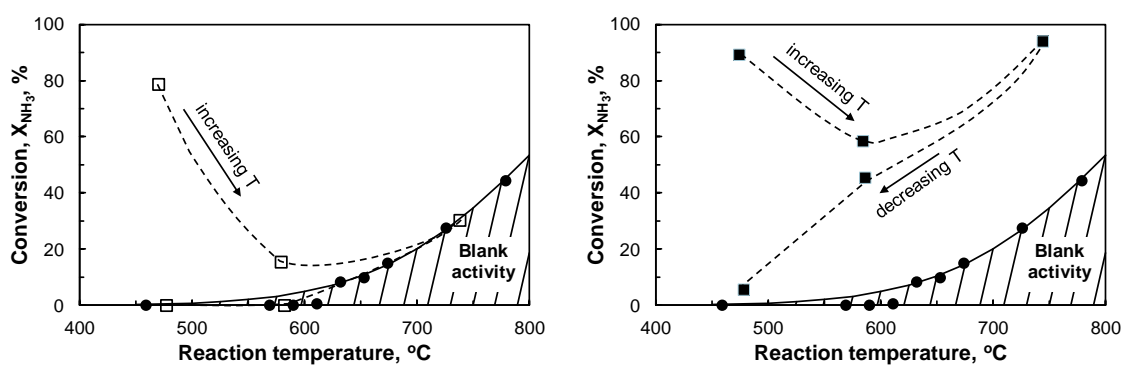


Figure S3: Ammonia conversion as a function of temperature for Co₃O₄/Al₂O₃

Left: Co₃O₄/Al₂O₃-powder (d_p = 125-210 μm); SV: 1.55 mmol NH₃/s/g)

Right: Co₃O₄/Al₂O₃-pellet (d_{pellet} = 1 mm; h_{pellet} = 4 mm); SV = 0.017 mmol NH₃/s/g

Co₃O₄/ZnAl₂O₄

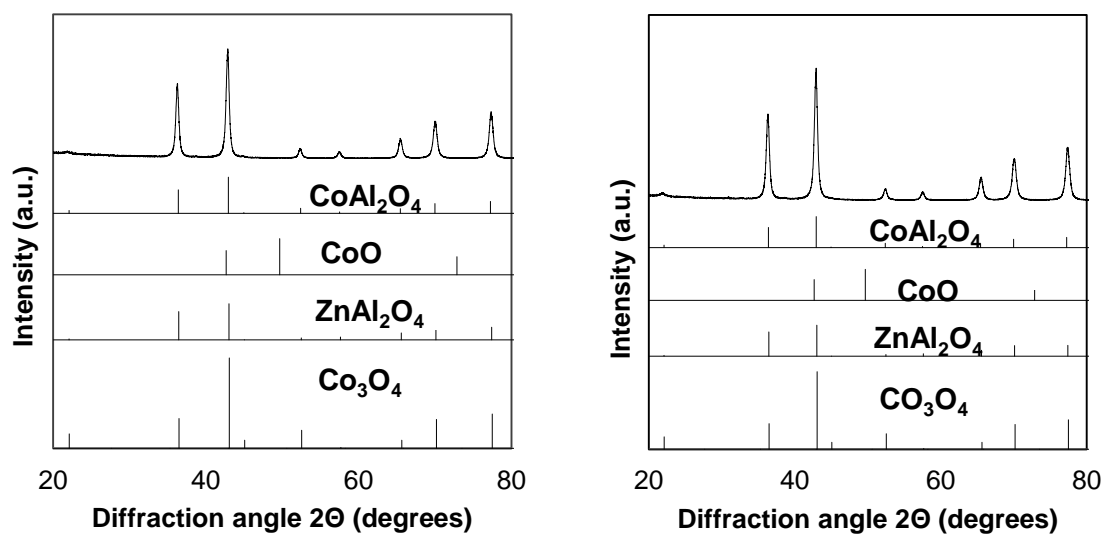


Figure S4: X-ray diffraction patterns of the fresh Co₃O₄/ZnAl₂O₄ (left) and spent Co₃O₄/ZnAl₂O₄ (right)

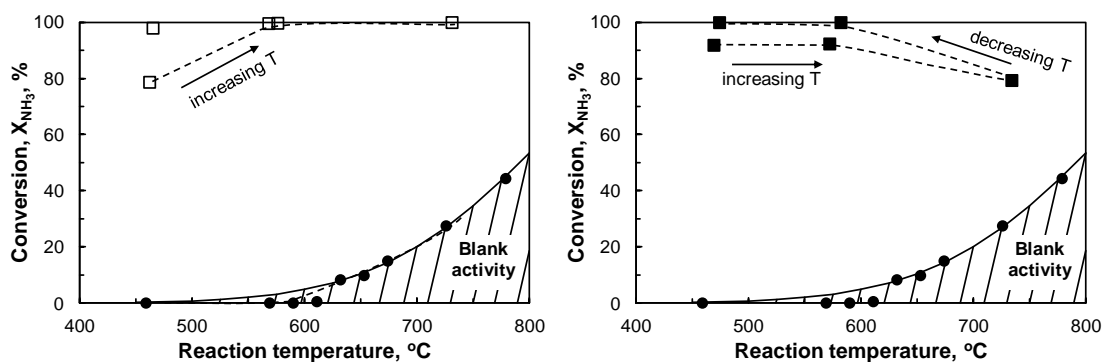


Figure S5: Ammonia conversion as a function of temperature for Co₃O₄/ZnAl₂O₄

Left: Co₃O₄/ZnAl₂O₄-powder ($d_p = 125\text{-}210 \mu\text{m}$); SV: 1.46 mmol NH₃/s/g)

Right: Co₃O₄/ZnAl₂O₄-pellet ($d_{\text{pellet}} = 3 \text{ mm}$; $h_{\text{pellet}} = 1 \text{ mm}$); SV = 0.017 mmol NH₃/s/g)

Co₃O₄/SiO₂

Table S1: Characterization of the fresh and spent^a Co₃O₄/SiO₂ catalysts used

		Co₃O₄/SiO₂		
Support		Silica		
	d _{pellet} , mm	2.5 x 4.5		
	S _{BET} , m ² /g	270		
	V _{pore} , cm ³ /g	0.92		
	d _{pore} , nm	12		
Catalyst	Co-loading, wt.-% ^b	10.1	17.0	23.1
	Co ₃ O ₄ -loading, wt.-% ^c	5.8	15.2	23.0
	S _{BET} , m ² /g	193	-	150
	d _{pore} , nm	16	-	17
	d _{Co₃O₄} , nm	24.8 ^f	22.0 ^f	25.5 ^f
				24.4 ± 4.5 ^e
Spent catalyst^a		II	I	I
	Co ₃ O ₄ -loading, wt.-% ^c	6.0	0	11.5
	CoO-loading, wt.-% ^c	0	3.8	0.2
	Co-support, wt.-% ^c	0	10.5	5.0
	S _{BET} , m ² /g	-	-	-
	d _{Co₃O₄} , nm	31 ^f	-	26 ^f
	d _{CoO} , nm	-	25.2 ^f	12.7 ^f
d _{Co₂SiO₄} , nm	-	89 ^f	111 ^f	

^a Spent catalyst after exposing a pellet of the catalyst to high temperature NH₃-oxidation conditions (I: catalyst pellet recovered after exposing the catalyst to ammonia oxidation conditions at 800°C; II: catalyst pellet recovered after exposing the catalyst to ammonia oxidation conditions at 740°C followed by exposure to ammonia oxidation conditions at 580°C and 450°C).

^b Co-loading as determined by elemental analysis (AAS-ICP)

^c Amount of a phase present according to Rietveld refinement of the catalyst

^e Distribution of sizes of Co₃O₄ crystallites as estimated using SEM or TEM (TEM average based on counting ca. 100 crystallites)

^f Average crystallite size of Co₃O₄ crystallites using XRD

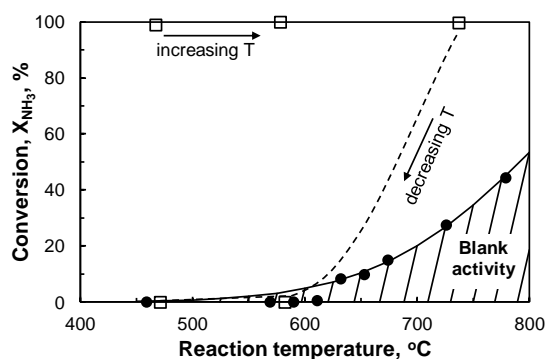


Figure S6: Ammonia conversion as a function of temperature for $\text{Co}_3\text{O}_4/\text{SiO}_2$ - powder ($d_p = 125\text{-}210 \mu\text{m}$; 10.1 wt.-% Co); SV: 1.50 mmol $\text{NH}_3/\text{s/g}$)

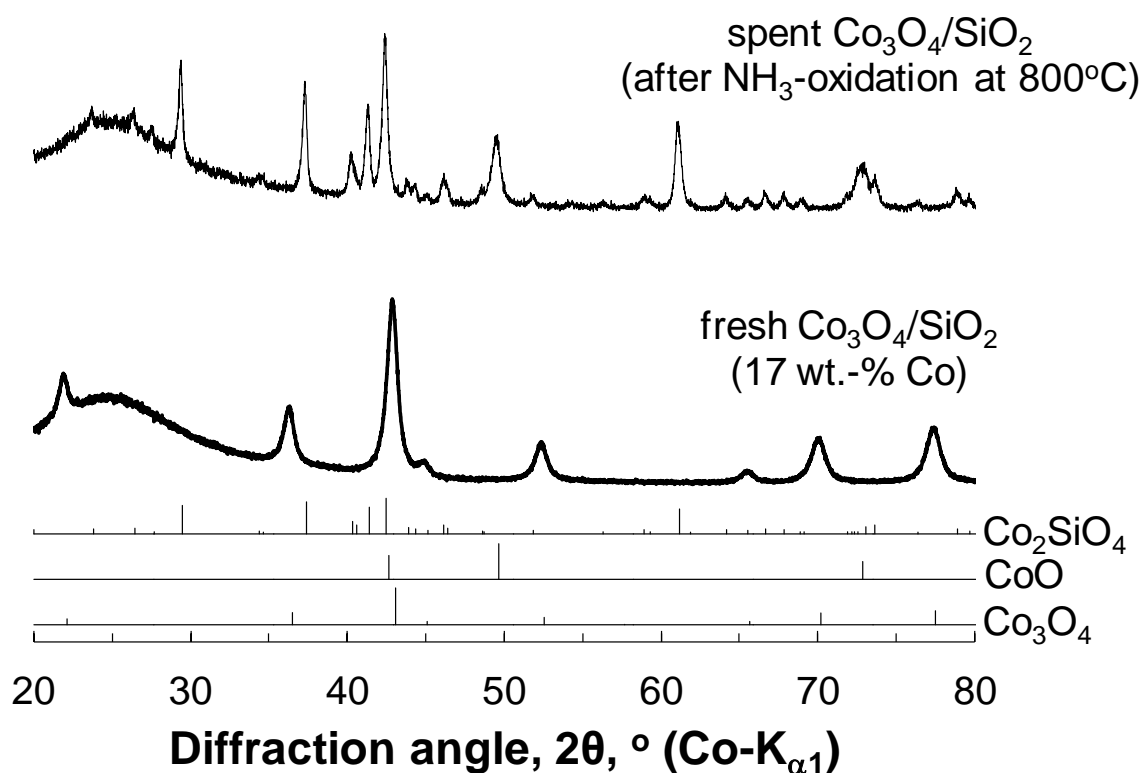


Figure S7: XRD-patterns of the fresh and spent $\text{Co}_3\text{O}_4/\text{SiO}_2$ pellet containing 17.0 wt.-% cobalt (spent catalyst had been exposed to ammonia oxidation conditions at 800°C and a space velocity: 0.05 mmol $\text{NH}_3/\text{s/g}$)