# Temperature-Programmed Desorption as a Tool for Kinetic Analysis of $NH_3$ Decomposition on $Ru/Al_2O_3$ and $Ru/CeO_2$

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**Background and motivation.** Green $NH_3$ emerged as a promising H2 carrier for energy transition[1]. Among catalysts used for ammonia decomposition, Ru shows the higher activity[2]. In this work, $Ru/CeO_2$ and $Ru/Al_2O_3$ catalysts were synthesized via traditional wet impregnation and tested with steady state and transient response methods. The study focused on assessing how the choice of support material influences the catalytic behaviour and reaction kinetics in $NH_3$ decomposition.

**Materials and methods.** $Ru/Al_2O_3$ and $Ru/CeO_2$ catalysts were prepared by incipient wetness impregnation using $Ru(NO)(NO_3)_3$ precursor, characterized by XRD, Raman, DRIFTS, CO chemisorption, and pre-treated with 1% H2 flow in He from 50°C to 450°C before testing. $NH_3$ cracking was performed in micro-fixed bed unit, with diluted $NH_3$ in He. $H_2$ and $N_2$ cofeeding tests were performed. All tests were conducted at 20,000 Nl/h/kgcat. The modelling analysis was based on 1D pseudo-homogeneous reactor model. Dynamic N2/H2/NH3 adsorption/desorption experiments are now being performed to measure surface coverage evolution with temperature and support the kinetic investigation.

**Results and discussion.** Characterization results show high dispersion of Ru for both catalysts. As shown in Figure 1, $Ru/CeO_2$ catalysts outperformed $Ru/Al_2O_3$. The kinetic study suggests that $NH_3$ cracking over $Ru/Al_2O_3$ is limited by $NH_3$ activation and H* surface poisoning across the entire temperature range. By contrast, experiments involving $Ru/CeO_2$ catalysts are best explained by assuming that N* desorption is rate-limiting at low temperatures, while $NH_3$ activation and H* poisoning control the rate at higher temperatures. Preliminary results from dynamic experiments show that N* species prevail below 300 °C, while the surface becomes H*-rich at higher temperatures.

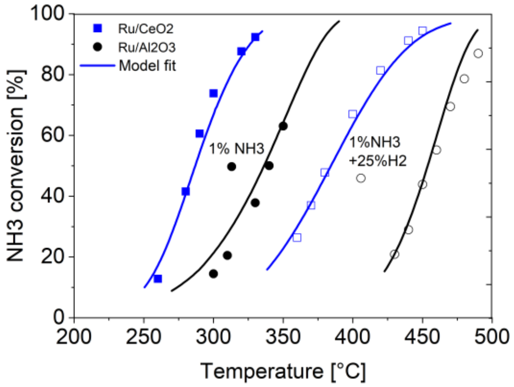

**Figure 1.** Catalytic activity and kinetic model comparison for $Ru/CeO_2$ and $Ru/Al_2O_3$

**Keywords:** ammonia cracking, ceria catalysts, temperature-programmed-desorption

## References

[1] Triviño, M.L.T. et al., *Chem. Eng. J.* **2023**, *476*, 146715.
[2] Yamazaki, K. et al., *Appl. Catal. B* **2023**, *325*, 122352.