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L-III | Catalytic Oxygen Removal from Synthetic Coke Oven Gas

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INTRODUCTION

The relatively high hydrogen content makes COG a valuable source of hydrogen. For hydrogen recovery from COG and its application in the conversion of CO_2 to valuable products, COG conditioning is essential. Platinum-based catalysts have mainly been studied for oxygen removal in hydrogen excess. This study focuses on the capability of the transition metal sulfide catalyst. For the removal of oxygen from coke oven gas, the activity of the commercial catalyst CoMo/γ-Al_2O_3 was compared to the Pt/γ-Al_2O_3 reference catalyst.

CATALYST — ACTIVITY

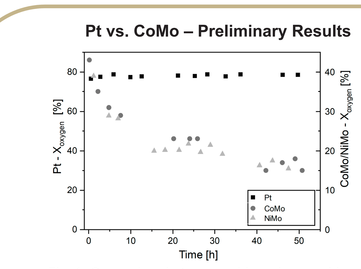


Fig. 1: Comparison between noble and non-noble metal based catalysts

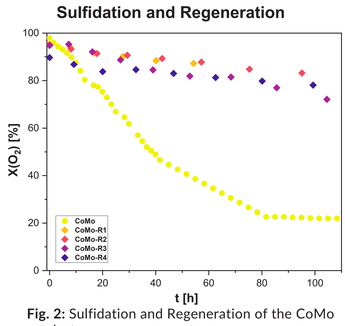


Fig. 2: Sulfidation and Regeneration of the CoMo catalyst

CHARACTERIZATION

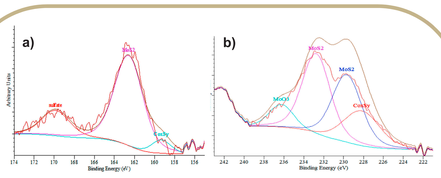


Fig. 3: XPS spectra of the sulfided CoMo-catalyst a) S2p b) Mo3d

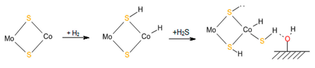


Fig. 4: Heterolytic dissociation of H_2 followed by H_2S and the two types of S-H groups[1]

$O_2 + 2\ H_2 \rightarrow 2\ H_2O$ vs. $O_2 + H_2S + M_xS_y \rightarrow M_xSO_y + H_2O$

M = Mo, Co, Ni

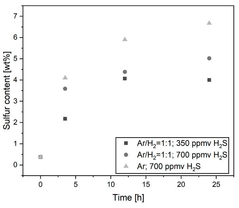


Fig. 5: Sulfur content related to the sulfidation atmosphere

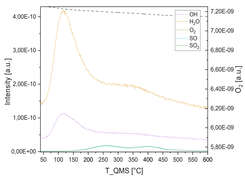


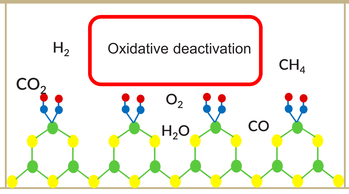
Fig. 6: TG-MS analysis of the sulfided/regenerated CoMo-catalyst

STRUCTURE – ACTIVITY RELATIONSHIP

SUMMARY

- Pt/γ-Al_2O_3 featured the highest activity in the presence of 150 ppmv H_2S.
- The activity of the CoMo/ γ-Al_2O_3 depends on the sulfidation condition and thus sulfidic active sites.
- The sulfidation atmosphere influences the sulfidation degree. A sulfidation atmosphere without H_2 is favored.

MAJOR CHALLENGE



OUR APPROACH

- Application of the characterization methods, e.g. Raman, XPS to identify the stable active phase
- Development of the sulfidation process
- In-situ regeneration in the presence of H_2S

REFERENCES
[1] T.Wiesmann, S.Suh, S.Kaluza, H.Lohmann, B.Zeidler-Fandrich, *Chem. Ing. Tech.* **2020**, *92*, 1533-1541
[2] G.M. Bremmer et al. *Appl. Catal. B: Environmental* **2019**, *243* 145-150
[3] G. Avgouropoulos, T. Ioannides, C. Papadopoulou, J. Batista, S. Hocevar, H.K. Matralis, *Catalysis Today* **2002**, *75 (1-4)*, 157 – 167

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