Catalyst for Gasification of Biomass Derived Tars

Floria Rojas Chaves (frojasch@uwo.ca)
Supervisor: Hugo de Lasa (hdelasa@uwo.ca)
Co-supervisor: Cindy Torres Quirós (cindy.torres@ucr.ac.cr)

Western Engineering

Chemical and Biochemical Engineering

INTRODUCTION

- Tars formed during biomass gasification are a disadvantage, given they cause operational issues and lower quality syngas.
- A fluidizable catalyst for the conversion of tars from the biomass gasification process is needed.
- A possible candidate catalyst is: a) mesoporous **γ-Al_2O_3** as support b) **CeO_2** as a promoter to reduce acid sites, c) **Ni** as an active phase.
- Promoter and active phase loadings, as prepared with incipient wetness, are key issues.
- Physicochemical characterization (BET, TPR, XRD, NH_3-TPD) is very important.
- Catalyst evaluation in the CREC Riser Simulator, under different operational conditions, is needed to establish a kinetic model.

OBJECTIVES

- To develop a stable catalyst for secondary treatment of biomass tars.
- To prepare a set of catalysts suitable for tar conversion.
- To characterize the physical and chemical properties of the prepared catalysts using techniques such as NH_3-TPD, H_2-TPR, XRD, N_2 physisorption.
- To evaluate the performance under different operational conditions on the CREC Riser Simulator.
- To establish the kinetic modelling for the selected catalyst.

METHODOLOGY

Step # 1: Multi-step impregnation using incipient wetness technique.

CeO_2 as promoter and Ni as active phase. Calcination at 500 °C

Step # 2: Catalyst Characterization (BET, NH_3-TPD, XRD, CO_2-TPD, H_2-TPR)

(Pending)
Step # 3: Performance of the prepared catalyst

Different operational conditions, such as temperature and reaction time. Experiments in CREC Riser Simulator

RESULTS

N_2 Physisorption

Table 1. Textural properties of the samples with different CeO_2 loadings

	Surface Area (m²/g)	Pore Volume (cm³/g)	Average Pore Diameter (Å)
γ-Al_2O_3	199 ± 13	0.54 ± 0.04	109.5 ± 0.6
2%CeO_2/γ-Al_2O_3	201 ± 3	0.54 ± 0.01	106.7 ± 0.4
5%CeO_2/γ-Al_2O_3	183 ± 3	0.49 ± 0.01	106 ± 2
10%CeO_2/γ-Al_2O_3	183 ± 13	0.47 ± 0.03	103.7 ± 0.1

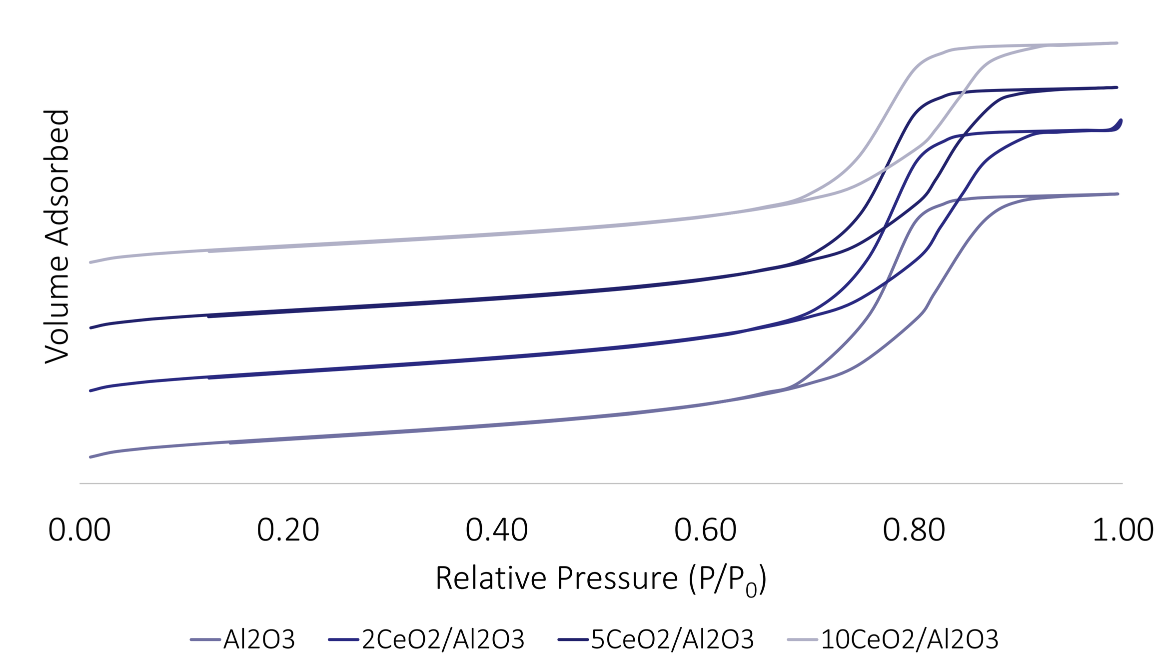

Figure 1. Adsorption-desorption isotherms for the different CeO_2 loadings

X-Ray Diffraction

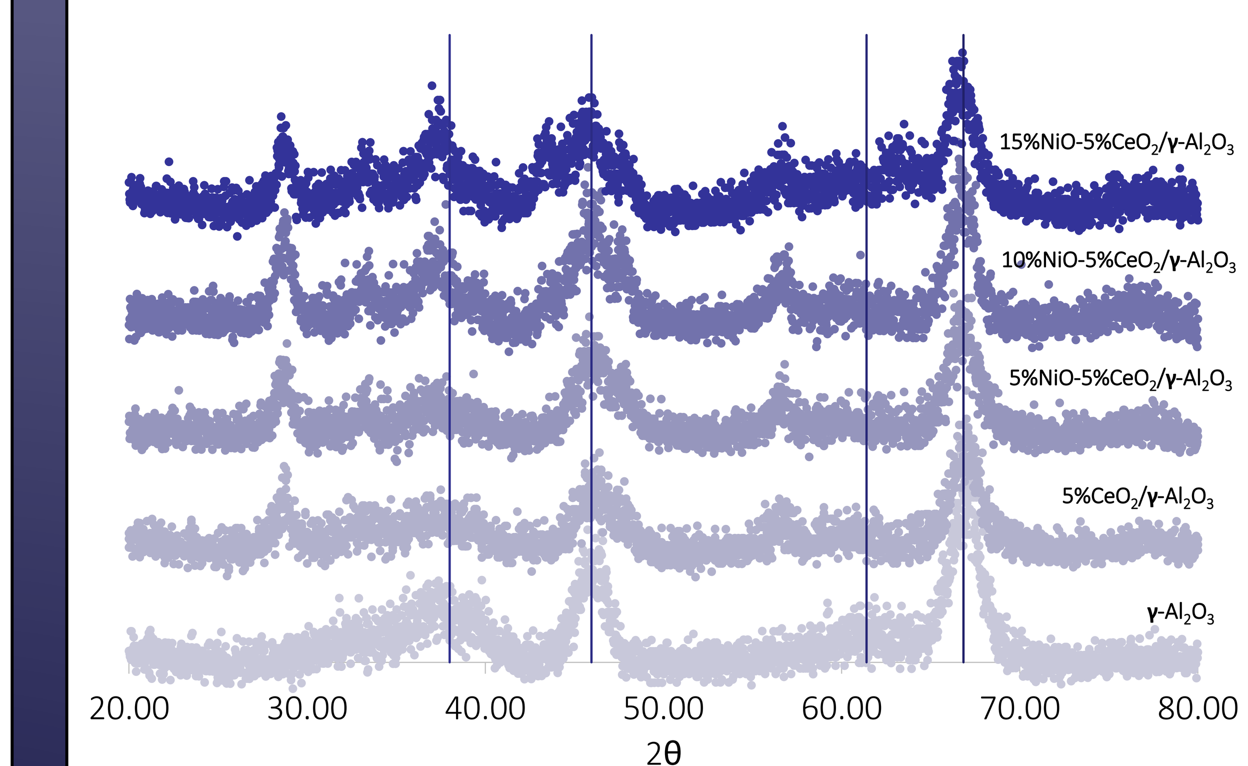

Figure 2. X-Ray Diffraction patterns for samples calcined at 500 °C.

Temperature Programmed Reduction

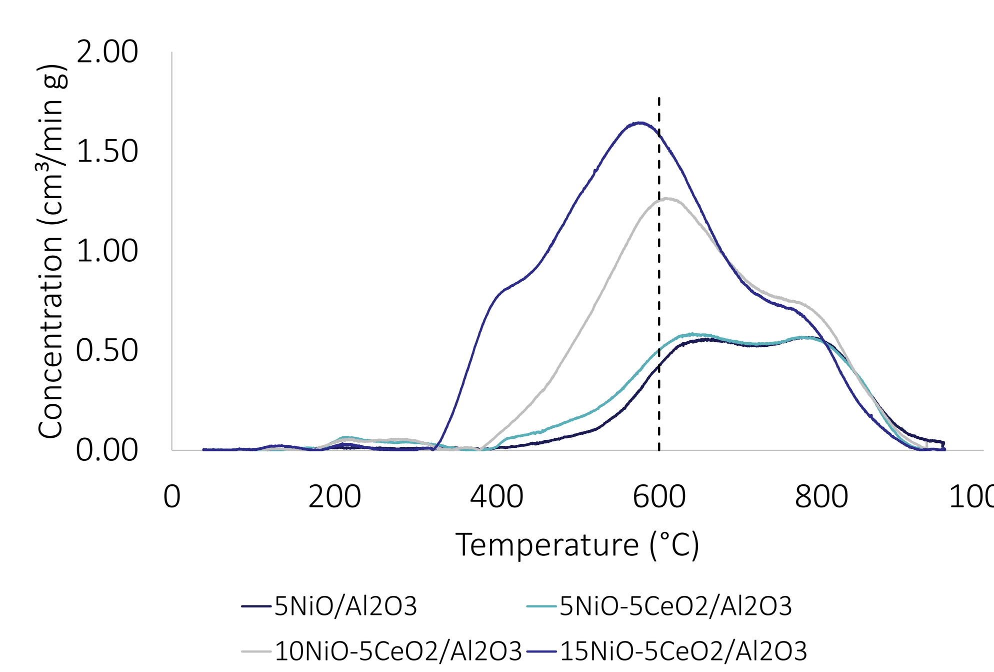

Figure 3. H_2-TPR of samples with different NiO loadings

NH_3-Temperature Programmed Desorption

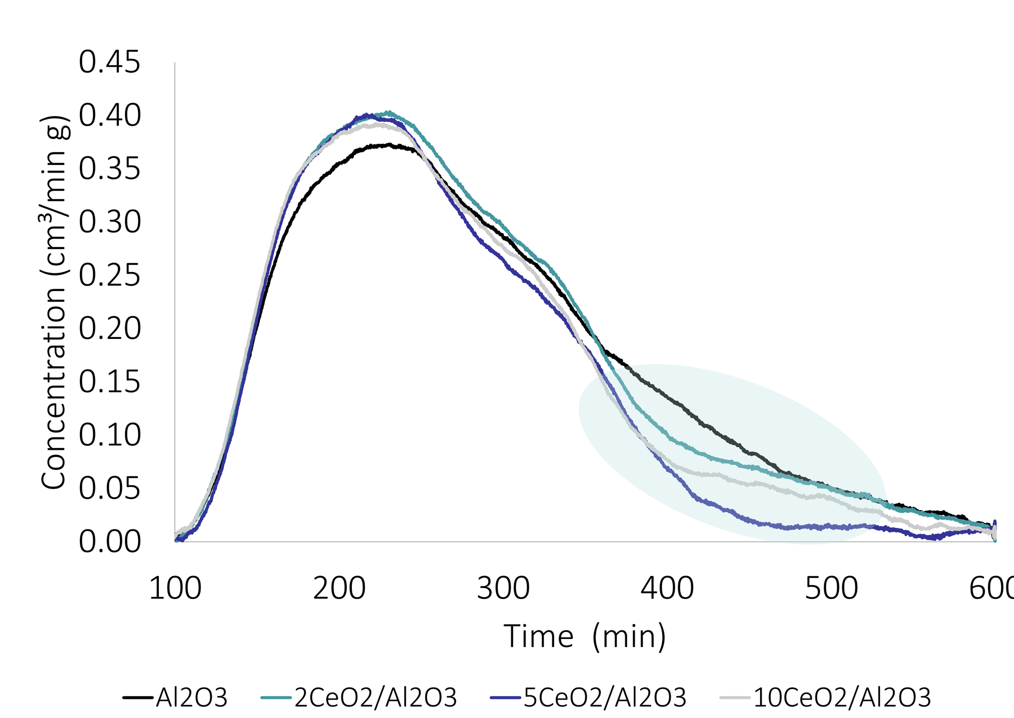

Figure 4. NH_3-TPD of samples with different CeO_2 loadings

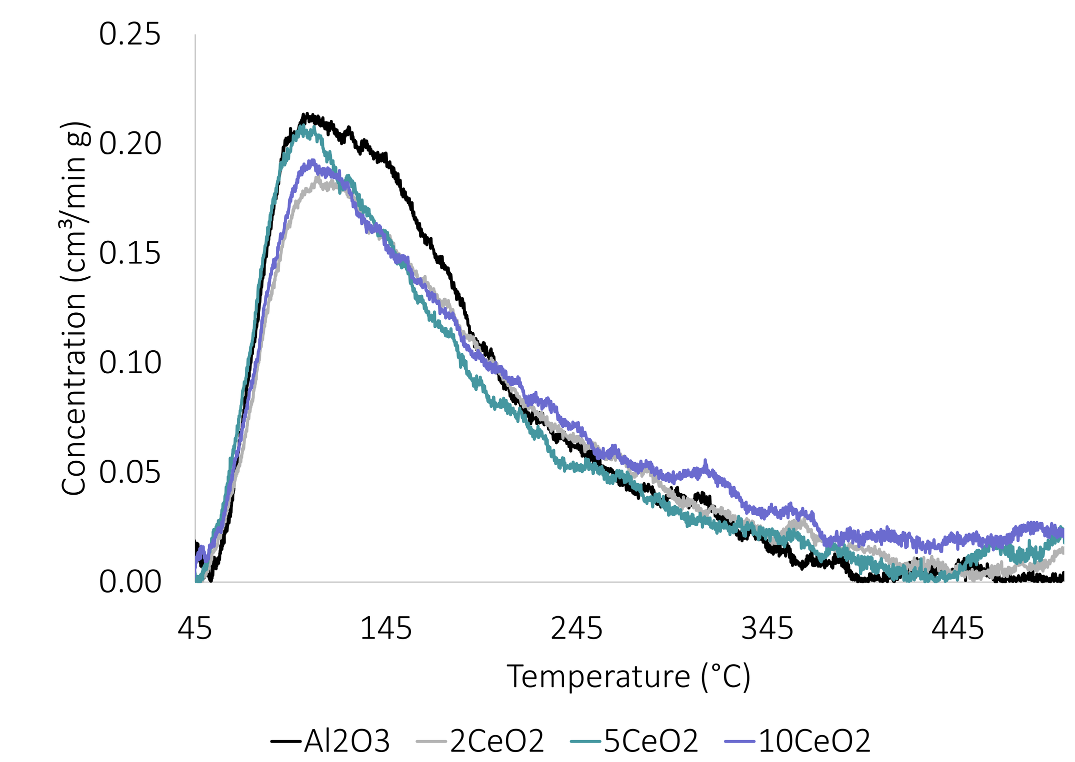

Figure 5. CO_2-TPD of samples with different CeO_2 loadings

CONCLUSIONS

- The addition of CeO_2 over γ-Al_2O_3 does not have a significant impact on the textural support properties.
- The isotherms found are of type IV, which are characteristic of mesoporous materials, with an hysteresis likely corresponding to cylindrical pores.
- As nickel loadings increases for a set CeO_2, the reduction temperature decreases.
- XRD patterns show a peak at 28° which is characteristic of the CeO_2. This peak remains without changes with Ni addition.
- CeO_2 addition slightly reduces the strong acid sites, specially with 5% CeO_2, while the basicity of the support remaining unchanged.

ACKNOWLEDGEMENTS OF SPONSORS

Organization of American States

NSERC CRSNG