



# Alkali Treatment and Plasma-Catalytic Testing of NiO/ZSM-5 Catalyst: Effect of NaOH Concentration



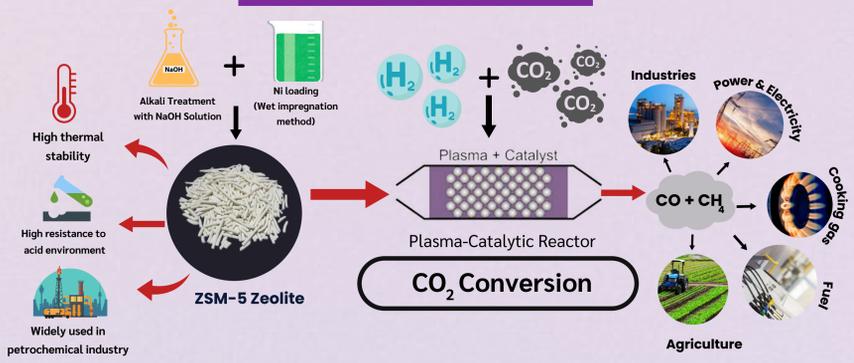
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## Abstract

This research is an investigation on alkali treatment and plasma-catalytic CO<sub>2</sub> conversion of NiO/ZSM-5 catalyst at different NaOH concentrations (0.05, 0.2 and 0.5 M). Commercial ZSM-5 zeolite in pellet form was alkali-treated at 75°C for 3 hour. NiO/ZSM-5 catalyst was prepared by wet impregnation method, with using 2M Ni(NO<sub>3</sub>)<sub>2</sub> aqueous solution. The prepared catalysts were characterized by Surface Area & Pore Analyzer using BET method, Scanning Electron Microscope–Energy Dispersive Spectrometer (SEM-EDS) and X-Ray diffractometer (XRD). It found that total surface area significantly decreased while average pore size obviously increased at higher NaOH concentrations. From surface morphology analysis by SEM, the rougher surface of ZSM-5 was observed at higher NaOH concentrations. For EDS analysis, Ni content of NiO/alkali-treated ZSM-5 at 0.05, 0.2 and 0.5 M NaOH was approximately 8, 14 and 30%wt., respectively. The activity of NiO/alkali-treated ZSM-5 catalyst was tested for CO<sub>2</sub> conversion under low-temperature plasma condition. The feed gas and product gas was analyzed by Gas Chromatograph (GC). The result showed that NiO/0.2M NaOH alkali-treated ZSM-5 catalyst exhibited the best plasma - catalytic performance, giving the highest CO<sub>2</sub> and H<sub>2</sub> conversions of 12.40% and 14.71%, respectively.

## Introduction

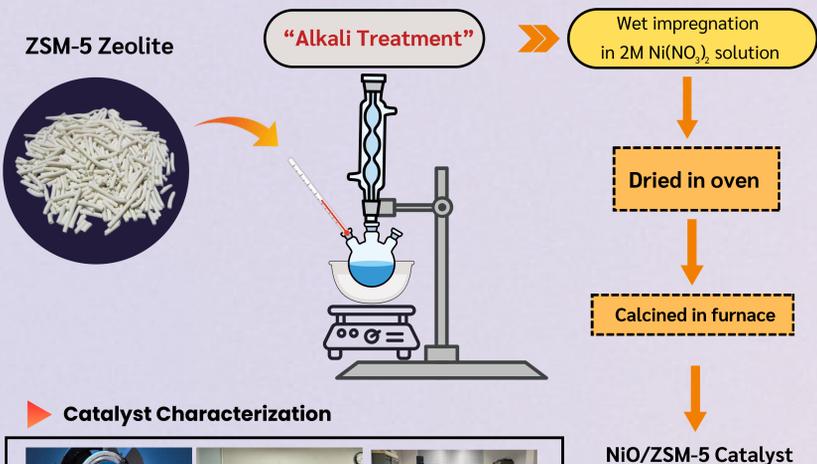


## Objectives

- To study the preparation of NiO/ZSM-5 catalyst by alkali treatment and wet impregnation method
- To study the effect of NaOH concentration for NiO/ZSM-5 catalyst on the plasma-catalytic activity of CO<sub>2</sub> conversion

## Experimental

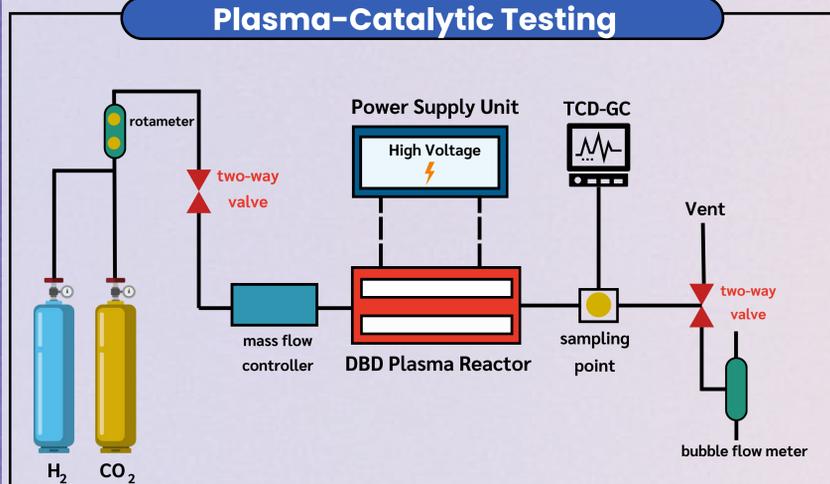
### Catalyst Preparation



### Catalyst Characterization



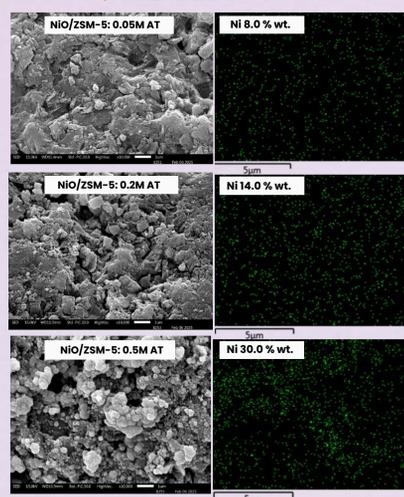
### Plasma-Catalytic Testing



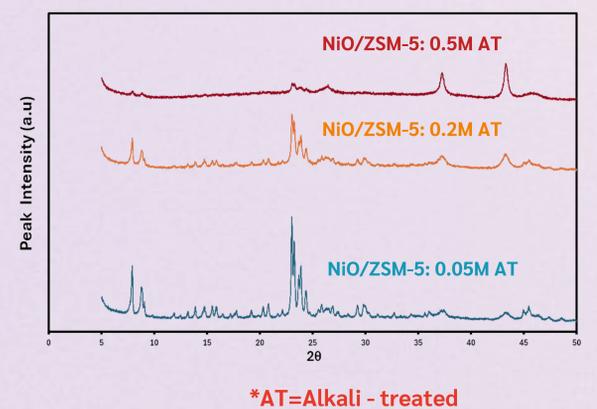
## Results and Discussion

### Catalyst Characterization

#### SEM-EDS



#### XRD Pattern

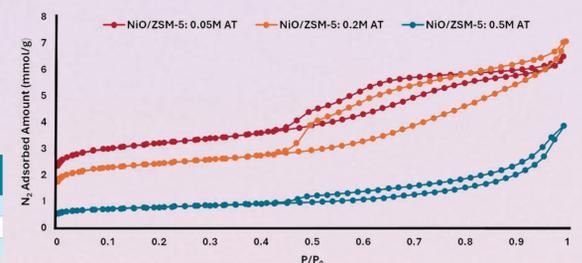


#### Surface Area, Pore Volume & Pore Size

Sample	Total Surface Area (m <sup>2</sup> /g)	Pore Volume (cm <sup>3</sup> /g)	Average Pore Size (Å)
NiO/ZSM-5: 0.05M AT	268.11	0.2262	33.76
NiO/ZSM-5: 0.2M AT	202.95	0.2460	48.49
NiO/ZSM-5: 0.5M AT	64.11	0.1343	83.78

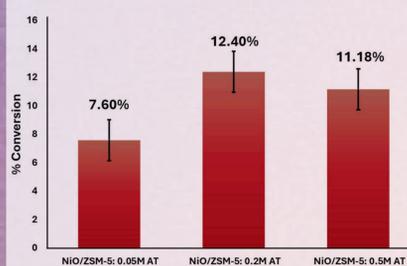
  

Sample	S <sub>mesopore</sub> (m <sup>2</sup> /g)	S <sub>micropore</sub> (m <sup>2</sup> /g)	V <sub>mesopore</sub> (cm <sup>3</sup> /g)	V <sub>micropore</sub> (cm <sup>3</sup> /g)
NiO/ZSM-5: 0.05M AT	102.98	165.13	0.0456	0.1844
NiO/ZSM-5: 0.2M AT	73.66	129.29	0.0330	0.2170
NiO/ZSM-5: 0.5M AT	15.71	48.40	0.0077	0.1223

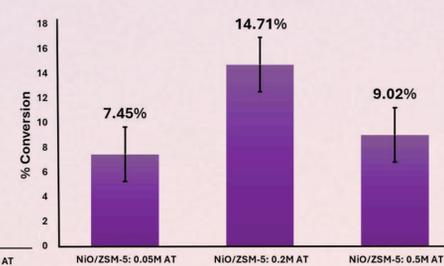


### Plasma-Catalytic Activity Testing

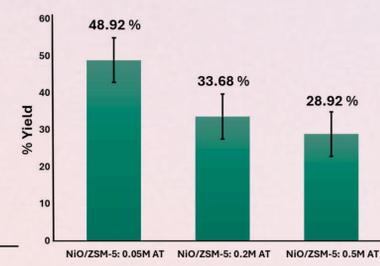
#### CO<sub>2</sub> Conversion



#### H<sub>2</sub> Conversion



#### CO Yield



## Conclusions

- In alkali-treatment, ZSM-5 zeolite support had lower surface area and larger pore size at higher NaOH concentrations, and 0.2M NaOH alkali-treated ZSM-5 had the highest mesopore volume.
- In wet impregnation, %Ni content loaded on ZSM-5 support significantly increased for NiO/ZSM-5 catalyst treated at higher NaOH concentrations.
- In plasma-catalytic CO<sub>2</sub> conversion testing, NiO/ZSM-5: 0.2M AT catalyst is the best condition, providing the CO<sub>2</sub> and H<sub>2</sub> conversions as well as CO yield of 12.40%, 14.71% and 33.68%, respectively.

## Acknowledgement

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