COLLEGE OF ENGINEERING
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Synthesis of ZIF-8 for the Oxidative Dehydrogenation of Ethane to Produce Ethylene

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Introduction

Ethylene(C_2H_4)is one of the most important substances in the materials industry, used as a monomer and a major feedstock for petrochemicals. The current commercial method for producing ethylene is by steam cracking of hydrocarbons, a process which demands high temperature, large amounts of energy, and frequent shutdowns due to coking.

An alternative method is the oxidative dehydrogenation, ODH, of ethane which, with efficient catalysts, has the potential for:

- Low operation temperature, and
- High energy efficiency.

$$C_2H_6 + O_2 \rightarrow C_2H_4 + H_2O \qquad \Delta H = -104.8 kJ/mol$$

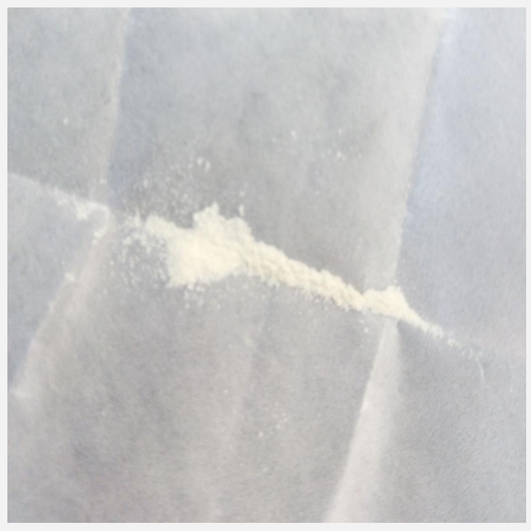
ZIF-8, a zinc-based metal organic framework, has permanent porosity and high surface area which make it a promising catalyst support for the ODH of ethane.

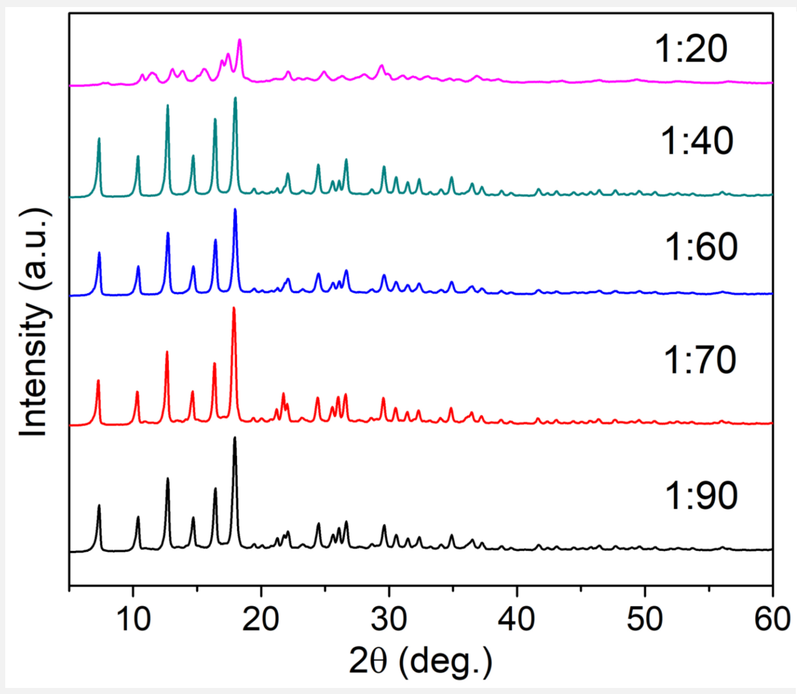
XRD Characterization

XRD is a process which is used to determine crystalline size and structure. XRD data was measured *(with the machine to the right)* from 5° to 60° at a rate of 1° per minute.

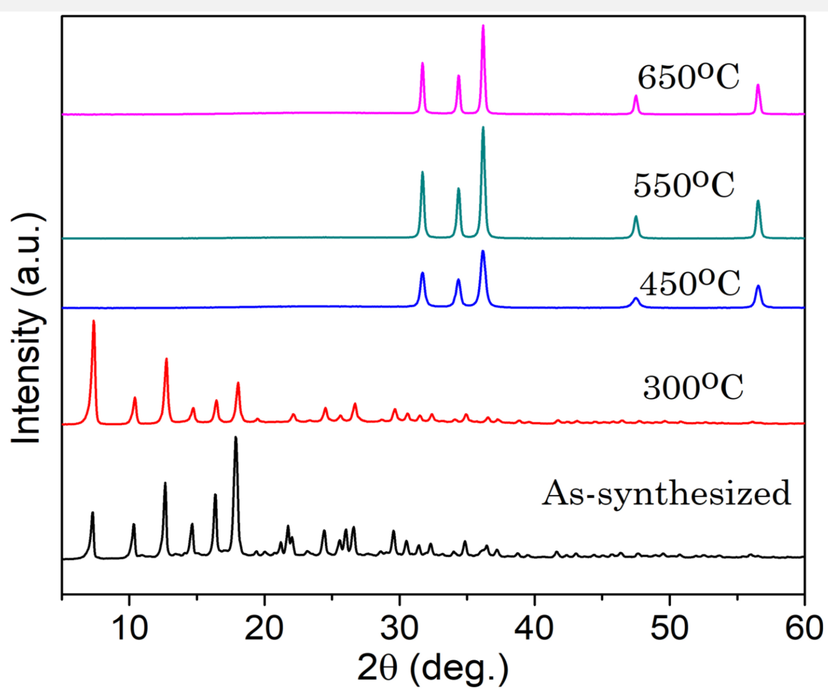
Catalyst Synthesis

ZIF-8 was synthesized by mixing aqueous solutions of zinc nitrate hexahydrate and 2-methlimidazole. The mixture was centrifuged for 40 to 70 minutes, then washed 4 times with water. The residue was dried overnight at 65°C. The amount of 2-methylimidazole was varied to give ratios of zinc to 2-methylimidazole 1:20, 1:40, 1:60, 1:70 and 1:90.

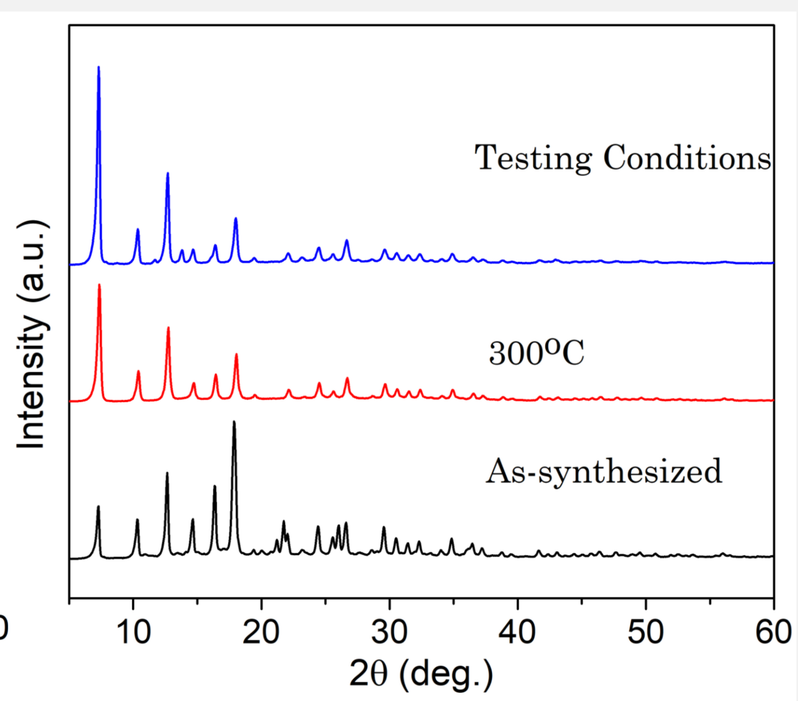




Samples of ratio 1:90 through 1:40 exhibited XRD pattern corresponding to ZIF-8 but the sample of ratio 1:20 appeared to lose its crystalline nature.



The synthesized ZIF-8 sample remained stable up to 300°C for 30 minutes but decomposed to give zinc oxide above 450°C



After 2 hour treatment to testing conditions, the crystal size of the sample decreased.

Testing Conditions

Catalytic performance of ZIF-8 in ODH of ethane was tested

- In a fixed bed reactor.
- At 250°C with a flow rate of 50mL/min
- With input: 6% ethane, 18% oxygen, 76% Helium.

Conclusions

- We successfully synthesized ZIF-8.
- The synthesized ZIF-8 exhibited thermal stability up to 300°C.

Future Work

- BET surface area characterization of ZIF-8.
- Testing ZIF-8 as a support for nickel and niobium in ODH of ethane.

References

1. **Yichang Pan et al. "Rapid Synthesis of Zeolitic Imidazolate Framework-8 (ZIF-8) Nanocrystals in an Aqueous System." Chemical Communications, 2011,47, 2071-2073, Doi: 10.1039/C0CC05002D.**

Acknowledgements

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