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SYNTHESIS AND PHYSICOCHEMICAL PROPERTIES OF ZINC METAL-ORGANIC FRAMEWORK-5 SUITABLE FOR METHANE CAPTURE

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INTRODUCTION & AIM

- Methane (CH_4), the second most significant greenhouse gas after carbon dioxide, is released into the atmosphere by a range of sources at varying amounts (the global average mean atmospheric methane abundance peaked in 2022 at 1,911.88 parts per million).[1]
- Landfill gas (LFG) is a natural by-product from the landfills decomposition of organic material. LFG is composed roughly of 50% methane (the primary compound of natural gas), 50% of carbon dioxide and a small amount of non-methane organic compounds.[2]

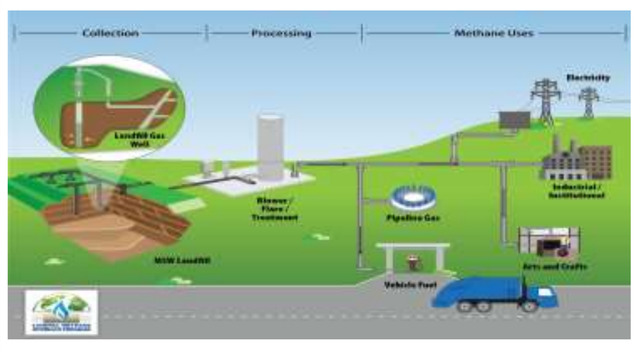

Figure 1: Potential uses of LFG including industrial uses, arts and crafts and vehicle fuel (IPCC, 2024).

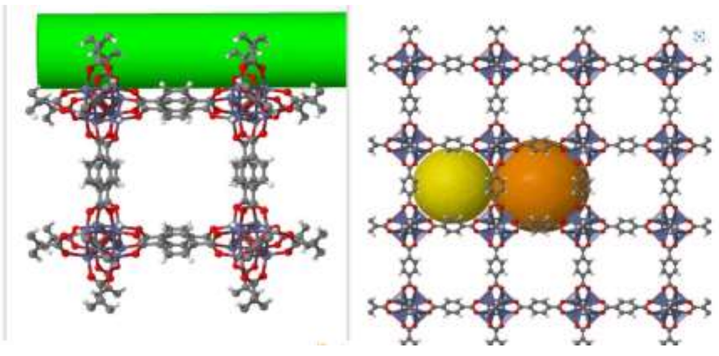

Figure 2: Zinc-oxygen tetrahedral pore size, cavity fill, and channel (Greeves, 2023).

- Zinc-based metal-organic frameworks (MOFs) are thought to be the best for adsorption because of their wide accessible pore volume, variable pore size, and high specific surface area. Zn-MOF-5 is recognized as one of the most extensively investigated MOF materials.[3]

AIMS AND OBJECTIVES

Main objective: To synthesize Zn-MOF-5 crystals through the solvothermal process, which have a high capability of adsorbing CH_4 at room temperature.

Sub-objectives:

- To synthesize Zn-MOF-5 at 85, 88, 90° C for 24, 36 and 48 hours.
- To characterize Zn-MOF-5 and to evaluate Zn-MOF-5 physicochemical

METHOD

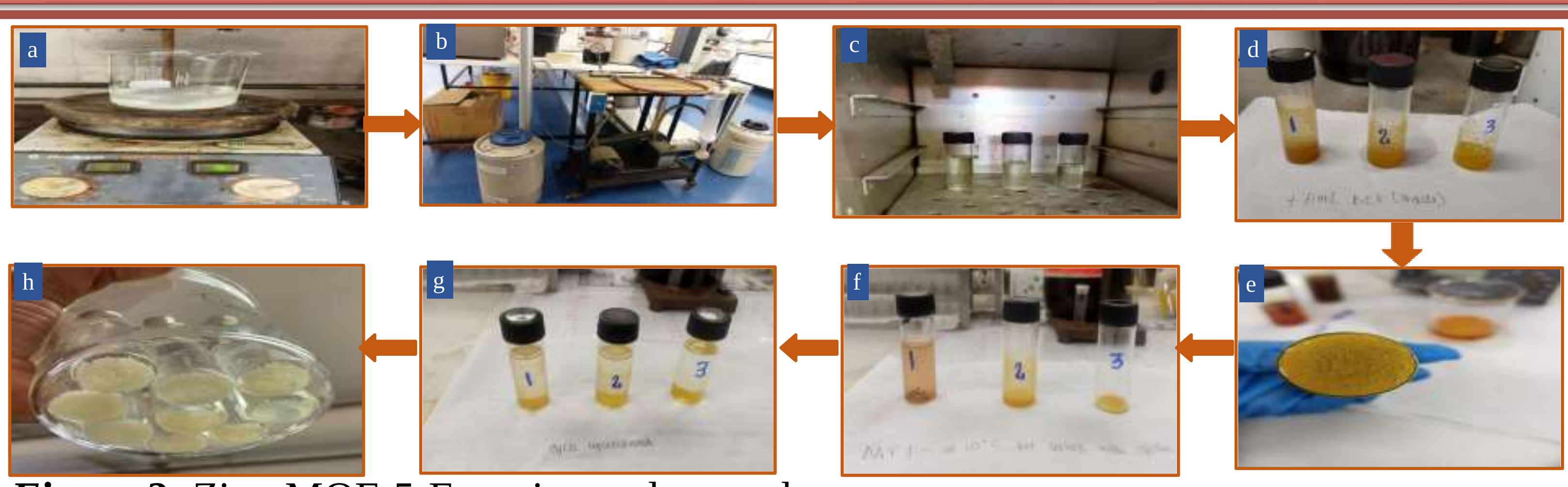

Figure 3: Zinc-MOF-5 Experimental procedure

a. Zinc nitrate hexahydrate [$Zn(NO_3)_2.6H_2O$], terephthalic acid and Diethylformamide (DEF) were mixed in a beaker, agitated until all particles dissolved.
b. The solution was transfered into a schlenk flask to degas the solvent using a freeze pump thaw.
c. The solution was transfered into vials and put in the oven for the specified reaction time and temperature.
d. Samples were removed from the oven, washed with unreacted $Zn(NO_3)_2.6H_2O$.
e. Golden brown crystals formed on the walls of the vials.
f. Chloroform ($CHCl_3$) was added to purify the Zn crystals
g. Chloroform replenishement for 3 days.
h. Zn-MOF-5 transparent crystals formed

RESULTS & DISCUSSION

The PerkinElmer UATR Two FTIR spectra and Bruker D8 Advanced XRD patterns of the synthesized Zn-MOF-5 at various temperatures and reaction times are shown in Figure 4 and Figure 5, respectively.

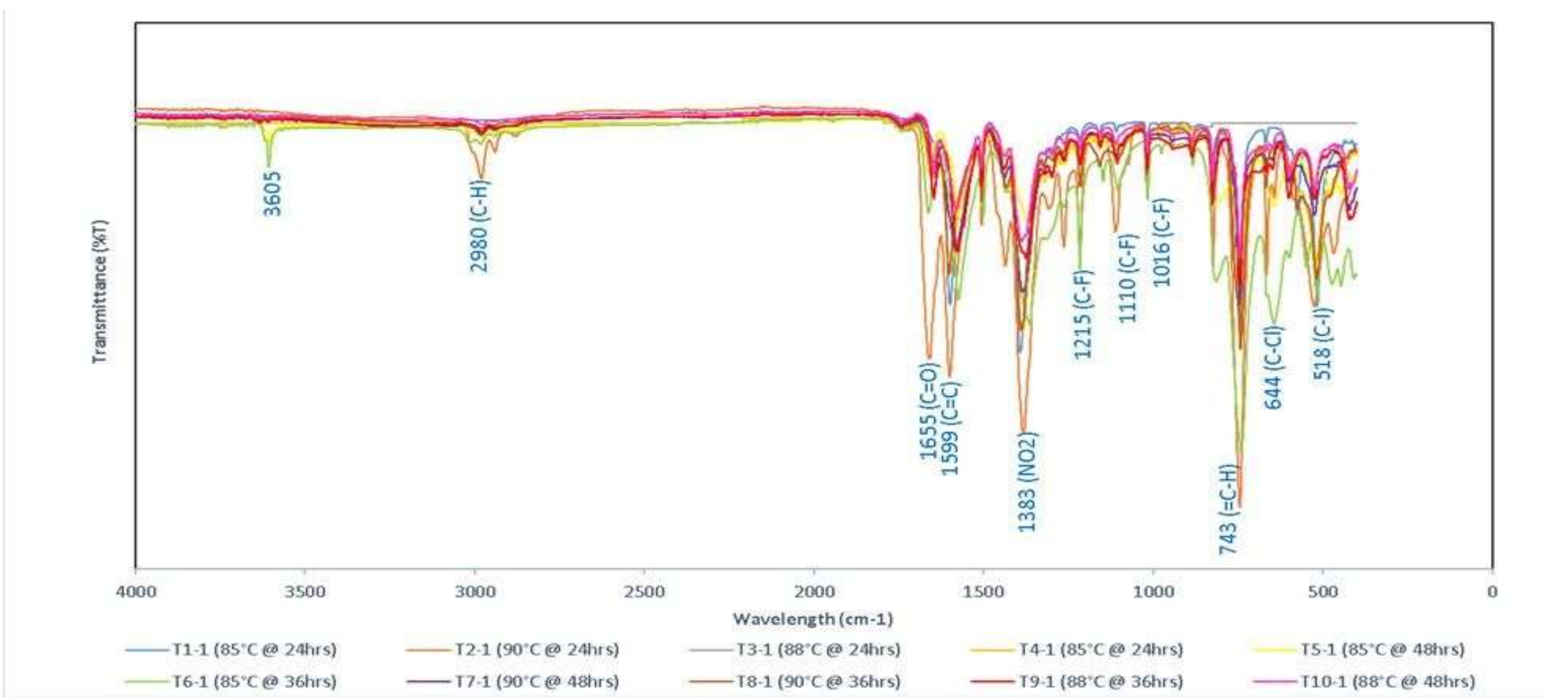

Figure 4: FTIR spectrum of Zn-MOF-5.

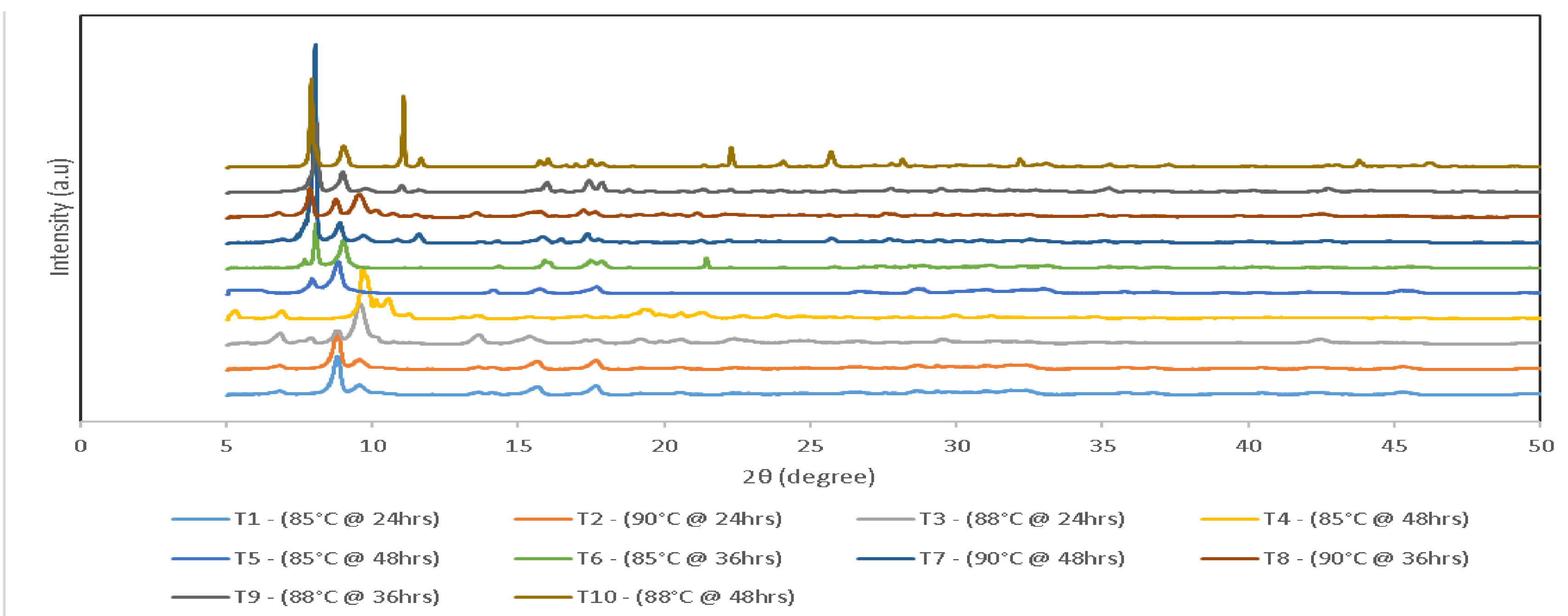

Figure 5: XRD patterns of Zn-MOF-5.

CONCLUSION/ FUTURE WORK

- The Zn-MOF-5 was synthesized using solvothermal technique; employing diethyl formamide solvent and this MOF structure was obtained from the Zn(BDC) by DEF as a solvent system where BDC=1,4-benzodicarboxylate.
- FTIR results obtained broad bands which are attributed to the C-H stretching vibrations of the methylene (alkane's) group in DEF molecule and asymmetric stretching vibration of the C=O group linked to Zn.
- XRD obtained broad peaks which indicated an increasing regularity of crystalline structure and better alignment layers.
- **FUTURE WORK:** To evaluate Zn-MOF-5 potential suitability to capture methane released from landfills.

REFERENCES

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