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Advanced Carbon-Based Composite Foams for Enhanced Dehumidification: A Novel Materials Approach

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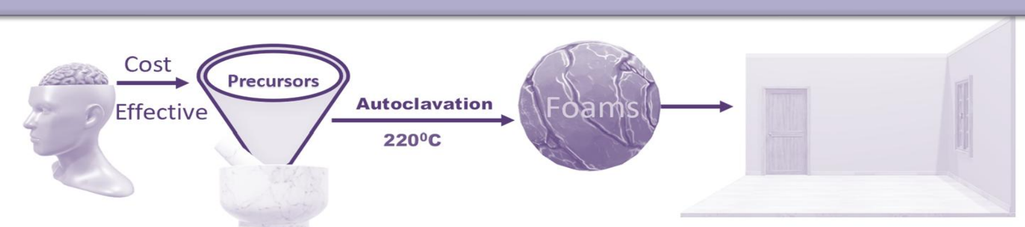
INTRODUCTION & AIM

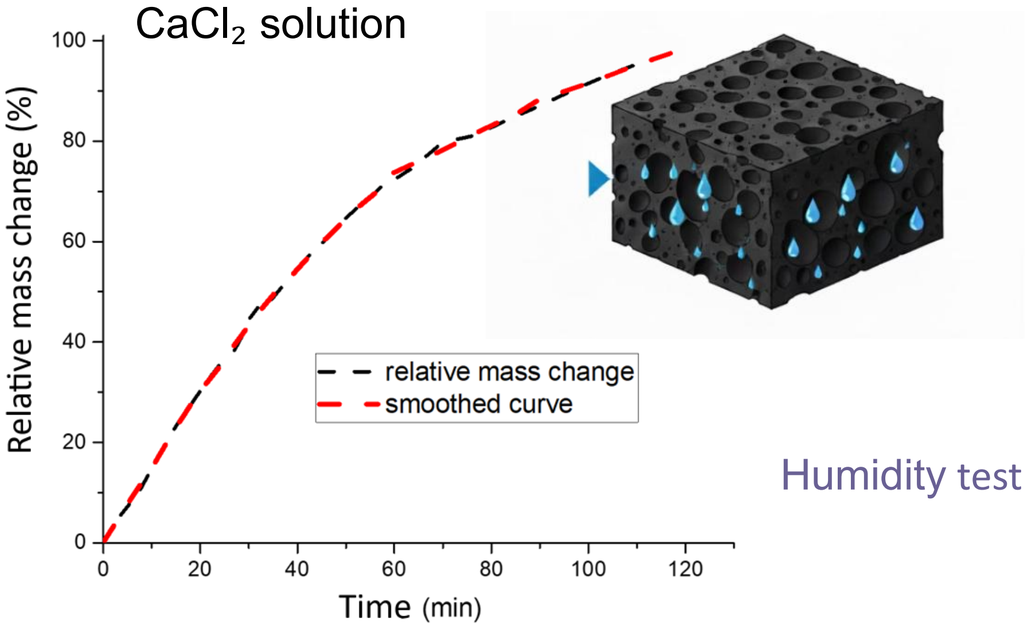
Dehumidification is essential for maintaining air quality, yet conventional technologies remain energy-intensive and inefficient. This research proposes a cost-effective alternative: novel carbon-based foams synthesized from glucose under autoclaving conditions, with calcium chloride ($CaCl_2$) incorporated as a hygroscopic agent. The resulting foams were characterized using thermogravimetric analysis (TG), scanning electron microscopy (SEM), and Fourier-transform infrared spectroscopy (FTIR) to evaluate their morpho-structural suitability for passive dehumidification.

Aim: To develop and characterize glucose-derived carbon foams with integrated $CaCl_2$, and assess their performance in ambient humidity absorption.

METHOD AND HUMIDITY TEST



- Humidity Absorption Performance
- Tests conducted at ambient temperature using a concentrated $CaCl_2$ solution

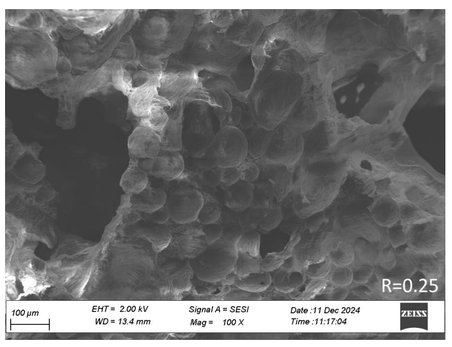


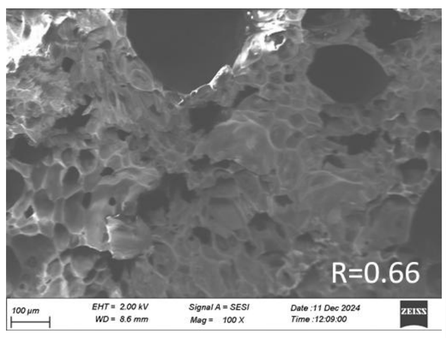
Humidity test

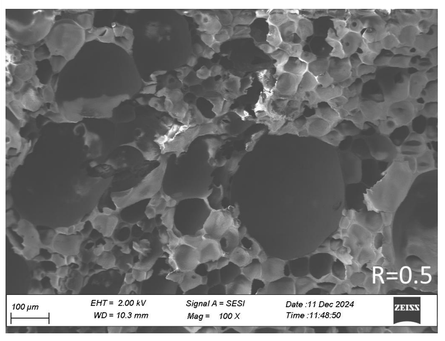
- 98% water vapor absorption within 2 hours under 300 cm³/min airflow.

RESULTS & DISCUSSION

SEM of all ratios

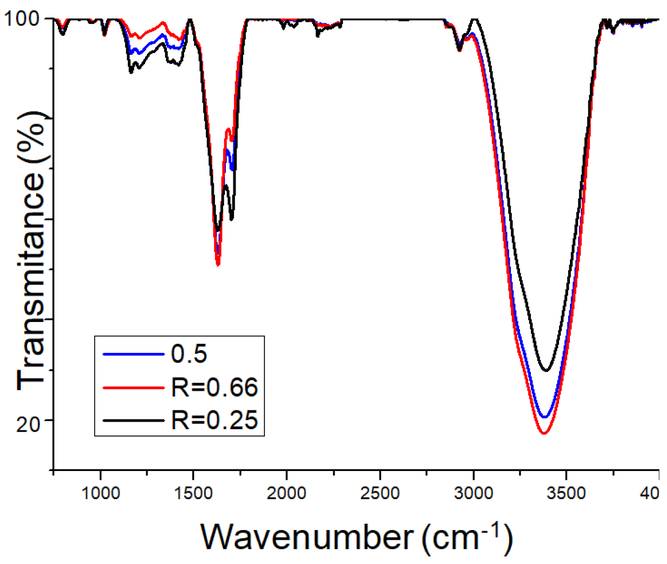






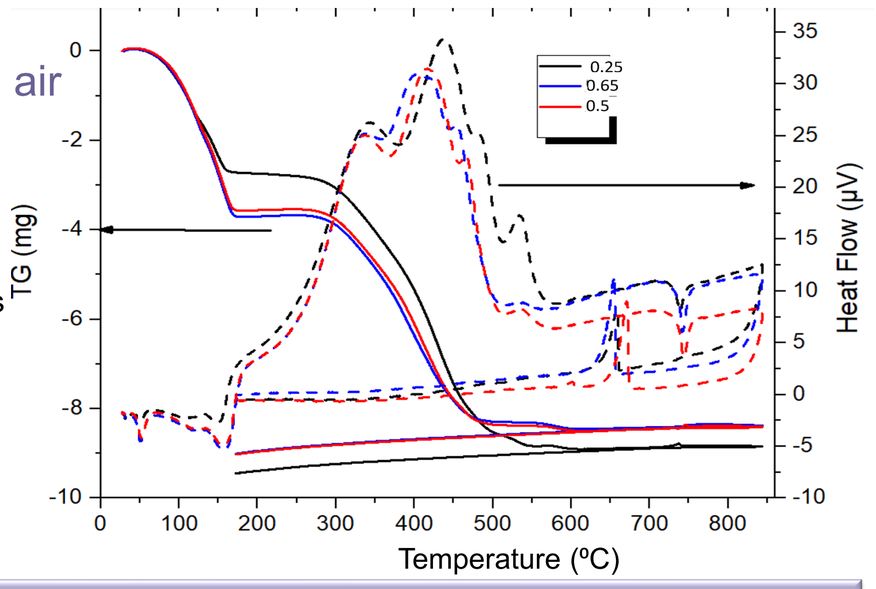
FT-IR of all ratios recorded in air

FTIR spectroscopy validates the hydrophilic nature of the foam walls through prominent O–H stretching vibrations



TG/DTA of all ratios recorded in air

- Thermogravimetric analysis confirms the thermal stability of the carbon-based foams and reveals distinct mass loss stages associated with glucose decomposition and $CaCl_2$ transformation.



CONCLUSION

- ❑ Formation of liquid water that wets the foam's cellular walls, increasing the liquid–gas interface and enhancing absorption rate.
- ❑ These findings confirm the material's high affinity for water vapor and its potential for passive, energy-efficient dehumidification.

Acknowledgments

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FUTURE WORK

Environmental and lifecycle assessment

Evaluating the ecological footprint, recyclability, and end-of-life pathways to ensure the material's viability for green building applications.