IOCM 2025 Conference
The 4th International Online Conference on Materials
3–6 November 2025 | Online
MDPI

Enhanced PCM Microencapsulation Using Cellulose Nanofibrils for Thermal Energy Storage

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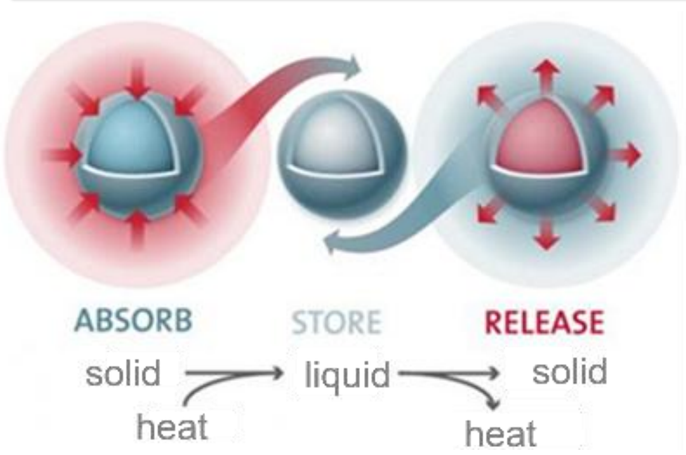
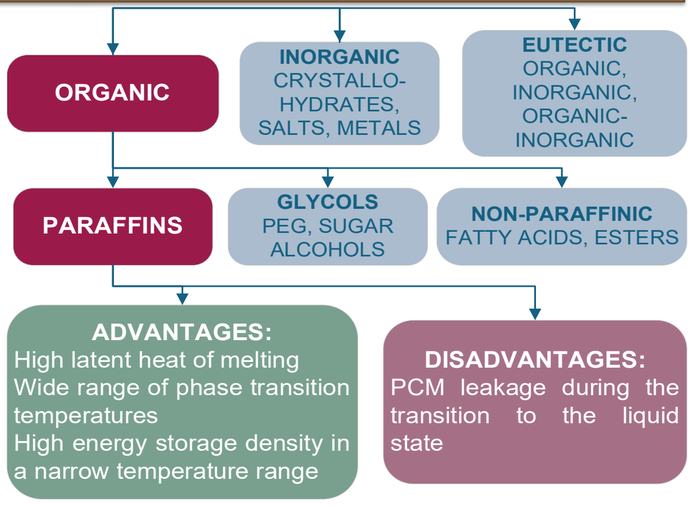
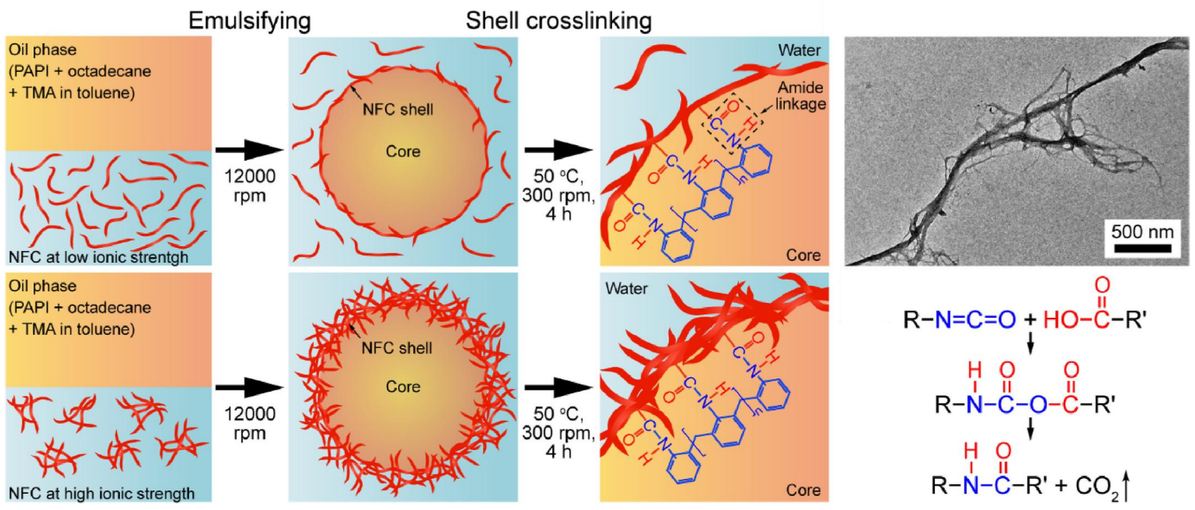
INTRODUCTION & AIM



Phase change materials (PCM) are of significant interest for the development of coatings with enhanced thermoaccumulative characteristics due to their capability to store, retain, and release excess thermal energy during reversible phase transitions such as melting and crystallization. However, their application as functional additives in traditional construction materials in their pure form is **significantly restricted by issues such as leakage of molten PCM and deterioration of their properties** upon interaction with the environment. We present a method for producing stable thermoaccumulating additives through the polymerization of Pickering emulsions stabilized with nanofibrillar cellulose (NFC) and contain organic PCM (octadecane) in the oil phase.

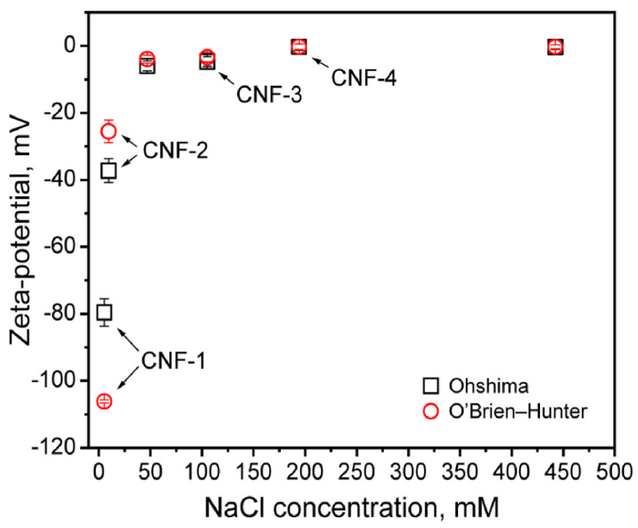


METHOD

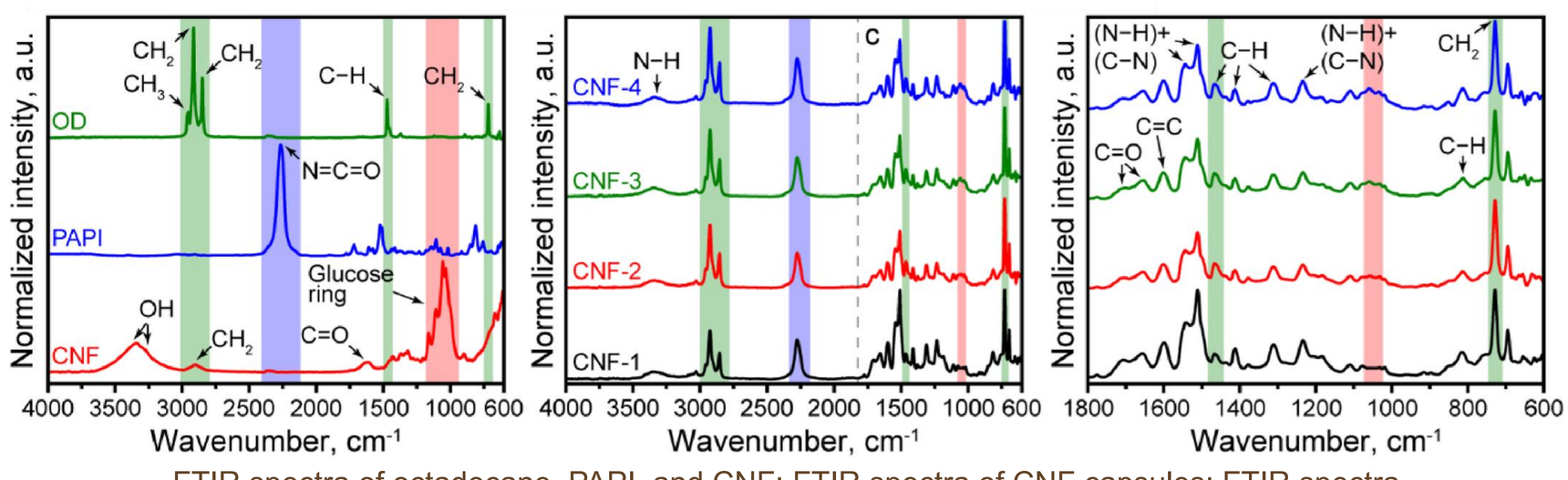


The synthesis of the n-Octadecane-loaded microcapsules with a PU shell was performed via **emulsion interfacial polymerization technique.** The first step involved the creating of CNF-stabilized oil-in-water emulsion with the oil phase consisting of PAPI and n-Octadecane dissolved in toluene. Further, PEG 1000 and TMA were introduced, and the mixture temperature was increased to 70 ºC to start the polymerization. heating is a necessary condition to eliminate a steric factor and improve the reactivity of isocyanate groups in various MDI isomers. The formation of the PU shell is driven by the moving boundary mechanism. This implies the diffusion of polyol to the reaction site at the oil/water interface through the initially formed polymeric membrane layer.

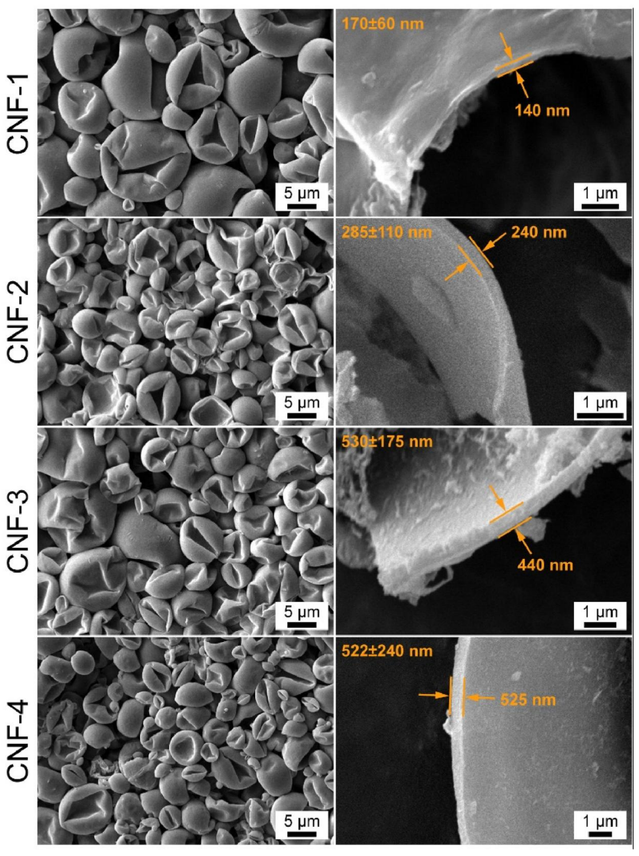
RESULTS & DISCUSSION

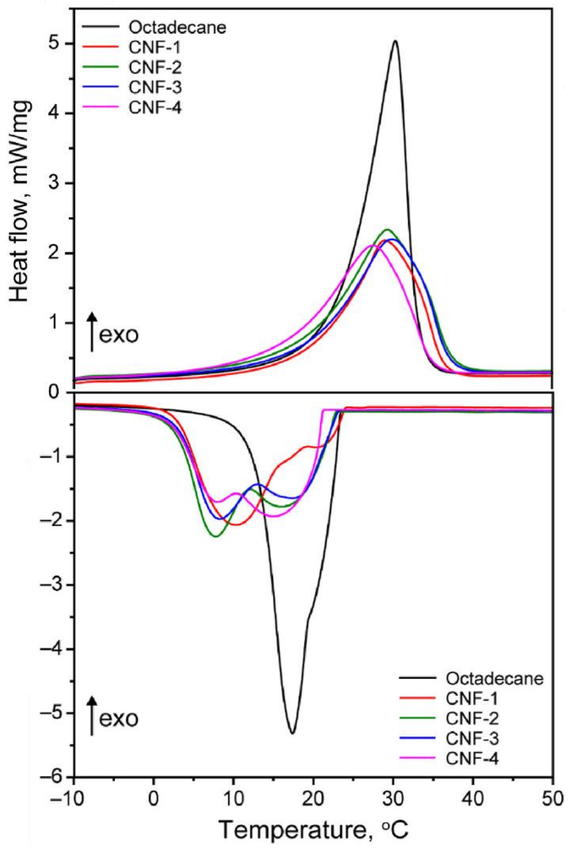


Dependence of CNF zeta-potential on NaCl concentration



FTIR spectra of octadecane, PAPI, and CNF; FTIR spectra of CNF capsules; FTIR spectra of CNF capsules in the 1800–600 cm-1 band confirming the formation of amide linkages





CONCLUSION

- Unlike traditional emulsion polymerization, this method does not require the use of surfactants to stabilize the interface of the emulsion phases.
- It is possible to control the nature of NFC adsorption at the interface depending on the ionic strength of the dispersion medium. At low ionic strength (5 mM NaCl) NFC is adsorbed as individual fibers, and at high ionic strength (100-200 mM NaCl), the electrostatic repulsion between the fibrils is leveled, and NFC is adsorbed as fibrillar clusters.
- As a result of polymer crosslinking, the average thickness of the container shell increases from 170 to 530 nm. This increases the thermal stability of the FPM and prevents leaching and leakage more effectively.
- The specific value of stored thermal energy was 143-156 J/g, which corresponds to the octadecane encapsulation efficiency of 71-78%.

FUTURE WORK / REFERENCES

In this work, we focused on dependence of cellulose adsorption on the ionic strength of the solution. Future research could expand the scope to include emulsion polymerization with other salts in aqueous media for a more comprehensive understanding of the polymerization mechanism and for the shell *in situ* modification with inorganic nanoparticles.