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Thermal Energy Storage Properties of Gelatin-Gum Arabic Microcapsules Containing Lauric Acid

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Abstract

In this study, gelatin-gum arabic microcapsules containing lauric acid were prepared for thermal energy storage applications. Lauric acid and gelatin-gum arabic were used as the core material and shell material, respectively. The synthesized microcapsules were analyzed using differential scanning calorimetry (DSC) for thermal characterization. DSC analysis revealed that the melting and freezing points of the synthesized microcapsules were determined to be 41.35°C and 39.76°C, respectively, with a latent heat storage capacity of 171-173 J/g. The thermal analyses confirm the successful microencapsulation of lauric acid and its suitability for thermal energy storage applications.

Keywords: Phase change materials, Thermal energy storage, Lauric Acid, microcapsule

1. Introduction

Thermal energy storage methods can be categorized into two main method: the sensible heat method and the chemical heat method. The sensible heat method involves the storage of heat as both sensible heat and latent heat, whereas the chemical heat method encompasses the utilization of reaction heat, chemical heat pumps, and thermochemical heat pumps.

Phase change materials (PCMs) are substances that effectively store thermal energy in the form of latent heat(Kulish et al. 2023, Yu et al. 2023, Sharma et al.2009, Upadhyay et al. 2023) . Latent heat refers to the heat absorbed or released by a substance during a phase change process.

One of the major disadvantages of phase change materials (PCMs) during their application is the problem of leakage that occurs during the melting process(Chang et al, 2023). As the PCM undergoes a phase change, it can melt and escape from the application environment, presenting a significant challenge for users. Leakage occurring at temperatures higher than the melting point of the PCM can lead to storage issues. To tackle these challenges, this study focuses on the encapsulation of phase change materials through microencapsulation. Microencapsulation involves the process of surrounding small portions of a substance with natural or synthetic polymers (Konuklu, 2014).

In this study lauric acid microcapsule were prepared with gelatine-gum Arabic. The prepared microcapsules characterized using thermal analyses.

2.MATERIALS AND METHOD

In this study, lauric acid (melting point: 42-44 °C) was used as the phase change material. The properties of the lauric acid used in this study are presented in Table 1.

Table 1. properties of lauric acid

	Lauric acid
Molecule formula	$C_{12}H_{24}O_2$
Molar mass	200.32 g/mol
Colour	Beyaz
Melting temperature	42-44 °C

In the first step of microencapsulating lauric acid, a 10% gelatin solution was added to a beaker. In the second step, water, gum arabic, and an emulsifier were added to the lauric acid in the high-speed mixer and mixed until a homogeneous mixture was obtained. The pH was lowered to 4 using a 10% acetic acid solution, and formaldehyde as a cross-linking agent was added to the mixture while stirring continued. The process was concluded by cooling the suspension to room temperature after 3-4 hours of stirring.

The thermal properties of the microencapsulated phase change materials were determined using Differential Scanning Calorimetry (DSC) analysis.

3. RESULTS AND DISCUSSION

Lauric acid is a phase change material (PCM) that can be utilized in various thermal energy storage applications. In

the first stage, microcapsules of lauric acid with gelatin-gum arabic were prepared.

The macroscopic images of the synthesized microcapsules were examined in the initial stage. As shown in Figure 8, the microcapsules of lauric acid appear as white powdery structures.

Figure 1. Lauric acid, gelatin, gum Arabic, lauric acid@gelatin-gum Arabic microcapsules

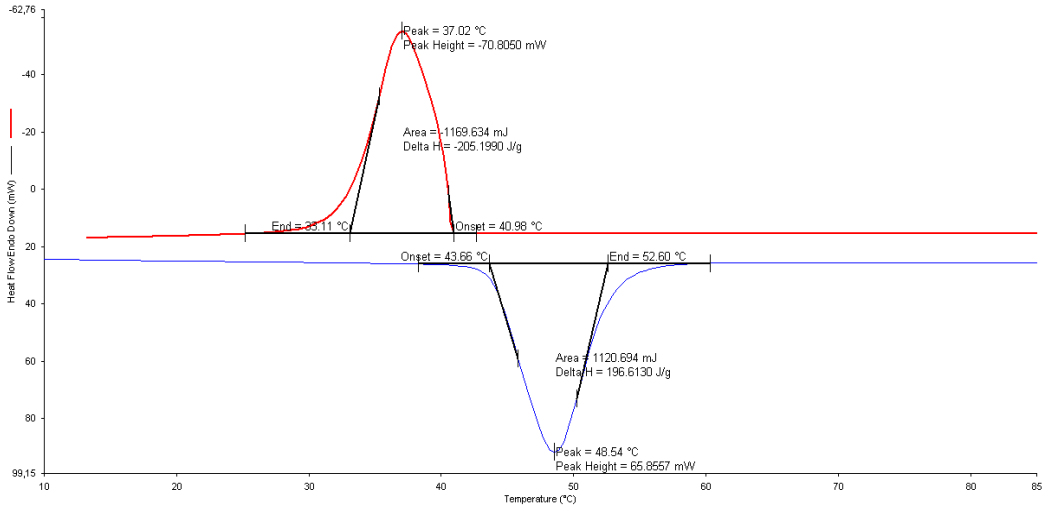

Figure 2. DSC analyses of the lauric acid

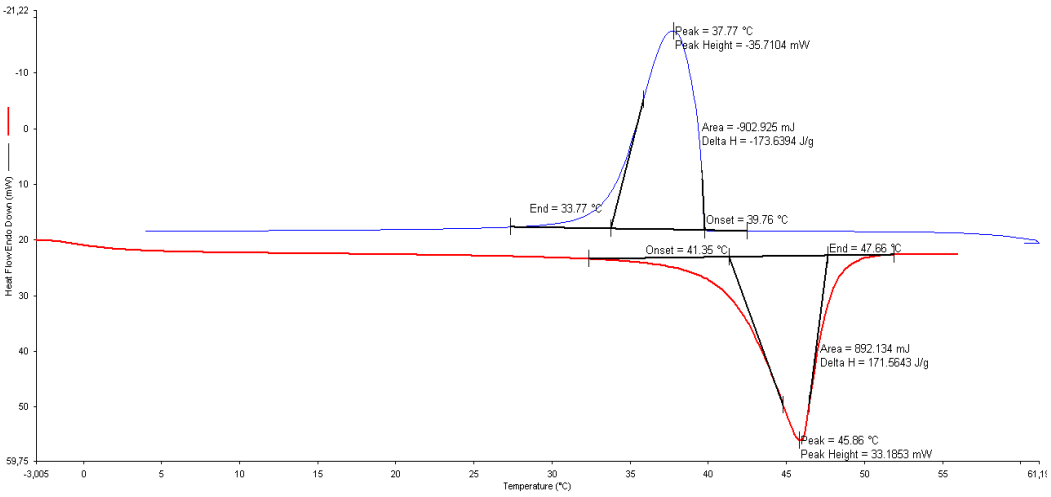

Figure 3. DSC analyses of the lauric acid@gelatin-gum Arabic microcapsules

The thermal properties of lauric acid microcapsules were examined using Differential Scanning Calorimetry (DSC). The thermograms of lauric acid and its microcapsules, depicting their phase transition temperatures and latent heat storage capacities, are shown in Figures 2 and 3.

4. CONCLUSIONS

This study focuses on the microencapsulation of lauric acid with a gelatin-gum Arabic shell using the coacervation technique. The DSC results provide confirmation of the successful encapsulation of lauric fatty acid in this research. The encapsulated lauric acid exhibits promising potential for energy storage.

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