Journal of Fiber Bioengineering & Informatics 5:1 (2012) 51–58
http://www.jfbi.org | doi:10.3993/jfbi03201204

Preparation and Characterization of Microencapsulated n-octadecane as Phase Change Materials

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Abstract

In this paper, a kind of microcapsule containing phase change material of n-octadecane was successfully synthesized based on in situ polymerization where trimethylol melamine and hexamethylol melamine were shell materials. We used different emulsification time, reaction time and different treatment to improve the quality of the microcapsules. The microcapsule and coated fabric were characterized by the optical microscope, Scanning Electronic Microscope (SEM), laser diameter distribution machine and Differential Scanning Calorimeter (DSC). The optical microscope and SEM pictures showed that this microcapsule has good surface configuration. Particle size with laser diameter distribution machine displayed that grains of the microcapsule were distributed evenly. The DSC results revealed the phase-changing temperature and enthalpy of the microcapsule.

Keywords: Phase Change Materials; Fabric; Microcapsule; Heat Regulation

1 Introduction

In recent years, functional textiles have been developed to enhance and broaden textile performance [1]. Among these, the demands of dynamic heat regulation fabric have attracted more and more attention [2]. Thermoregulated textile is a type of intelligent textile, which can change its temperature according to the environment.

Phase Change Materials (PCMs) have been used to manufacture thermoregulated textiles to improve thermal comfort of the wearer [3]. PCMs are entrapped in a microcapsule to prevent their leakage during their liquid phase [4]. These compounds possess the ability to absorb and store large amounts of latent heat during the heating process and can release this energy during the cooling process.

The selection of a PCMs formulation depends typically on the final required phase change temperature. PCMs will change phase with the temperature between the body and the outer garment

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layer. Indeed, for textile applications [5], PCMs should have a temperature range to make the human body feel comfortable, i.e. from 18℃ to 35℃. To avoid any liquid PCMs diffusing within a fibrous substrate, these compounds need to be contained in a capsule. However, the thermal stability and mechanical property of present microcapsules are not adequate, therefore many studies have been carried out to improve the microcapsules' thermal and mechanical stabilities [6].

The shell material is very important for the thermal stability of the microcapsules. There are some materials that can be used as the shell of microcapsules, for example melamine-formaldehydes [7], Methyl Methacrylate (MMA) [8] and so on. In this paper, we used trimethylol melamine and hexamethylol melamine as the microcapsules shell due to their high reactivity, as they can shorten reaction time in situ polymerization method and improve the utilization of material. In addition, melamine-amine and hexamethylol melamine have high tensile strength, compression strength, good acid-alkali resistance and better sealing.

Microcapsules can change phases in a proper temperature range. The well known microcapsules applied to textiles are n-alkanes with melting temperature (Tm) of 18-36℃, hexadecane, heptadecane, octadecane, nonadecane, and eicosane [9, 10]. Their melting temperatures are suitable to manufacture thermoregulated fabrics. Paraffin waxes are preferred due to their high latent heat, and they are chemically inert, non-toxic and non-corrosive. Herein pure compound octadecane was used as microcapsules core material, and its melting temperature is 28℃ where people feel comfortable [11].

2 Experimental

2.1 Material

Trimethylol melamine and hexamethylol melamine used as shell materials were purchased from Shanghai Dijin Chemical Co. Ltd., China. Octadecane and paraffin were chosen as the core material. Octadecane was prepared for the encapsulation which was purchased from Sinopharm Chemical Reagent Co. Ltd., China. Paraffin was purchased from Shanghai Huayong Paraffin Co. Ltd., China.

Ammonium hydroxide and ethylic acid were used to modify pH value, which were purchased from Sinopharm Chemical Reagent Co. Ltd, China. Emulsifier XP was used as an emulsifying agent which was purchased from Shanghai Dijin Chemical Co., Ltd., China. Dispersing agent NNO was purchased from Anyang Suburb Shuanghuan Assist Agent Chemical Co., Henan, China. Absolute ethyl alcohol was purchased from Changshu Yangyuan Chemical Co. Ltd.

2.2 Microcapsule Preparation

Trimethylol melamine and hexamethylol melamine were used to encapsulate the core materials in this experiment.

Emulsifier XP was added into the distilled water as the emulsion, where the stirring rate was 10000 rpm at 55℃. The emulsion was adjusted to pH 4.0-5.0. Then trimethylol melamine and hexamethylol melamine were added separately into the emulsion, in which the stirring rate was