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# A nano-graphite/paraffin phase change material with high thermal conductivity

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## HIGHLIGHTS

- ▶ Paraffin and NG formed a nanoscale compound.
- ▶ The thermal conductivity increased gradually with the content of NG.
- ▶ The thermal conductivity of the material containing 10% NG were 0.9362 W/m K.

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## ABSTRACT

Nano-graphite (NG)/paraffin composites were prepared as composite phase change materials. NG has the function of improving the thermal conductivity of the composite. The microstructure and thermal properties of the materials were examined with environmental scanning electron microscopy and differential scanning calorimetry. The results indicated that the NG layers were randomly dispersed in the paraffin, and the thermal conductivity increased gradually with the content of NG. Thermal conductivity of the material containing 10% NG were 0.9362 W/m K.



## 1. Introduction

Storing latent heat through phase change materials (PCMs) requires a much smaller volume of material in comparison with storing the same amount of energy using sensible heat storage. Moreover, the temperature does not change during the latent heat storage process [1–7]. Therefore, the utilization efficiency of heat is improved by using PCMs for storage instead of sensible heat storage. PCMs have been the research hotspot in recent years.

Organic PCMs are more chemically stable than inorganic PCMs; they melt congruently, and supercooling is not a significant problem. However, the thermal conductivity of organic PCM is low. The heat storage/release rate of organic PCM is low consequently [8–12], which blocks the effect of practical application in solar energy storage, waste heat recovery and so on. For phase change heat storage in a building, only when the heat release rate during phase change is higher than the heat dissipation speed to the environment, can the ambient temperature be changed. So, the low thermal conductivity of organic PCM should be improved to increase the utilization coefficient of the stored energy. Researchers have taken measures to overcome this shortcoming such as adding metal fillers, metal structures, fin tubes or aluminum sheets [13,14].

Some researches proposed a method of compounding carbon materials with PCMs to raise the heat storage rate. The carbon materials are introduced into organic PCMs to form PCM composites and improve the thermal conductivity [15–17]. Thermal conductivity of PCM was enhanced using different graphite matrix, such as exfoliated graphite and expanded graphite. Mhike et al. [18] developed a method of improving thermal conductivity with exfoliated graphite. Thermal conductivity of wax/LDPE got 200% increase when 10% exfoliated graphite was incorporated. The study of Zhengguo [19] showed that the transfer rate of paraffin was enhanced by expanded graphite. Ahmed [20] conducted an experimental study and built an analysis model. The study indicated that carbon nanofibers improved thermal conductivities of paraffin wax significantly. Kalpana et al. [21] prepared a nanofluid containing multi-walled carbon nanotubes and PCM, which exhibited a 20% of heat transfer enhancement. Jifen [22] filled 1% carbon nanotubes in palmitic acid and raised thermal conductivity of palmitic acid by about 30%.

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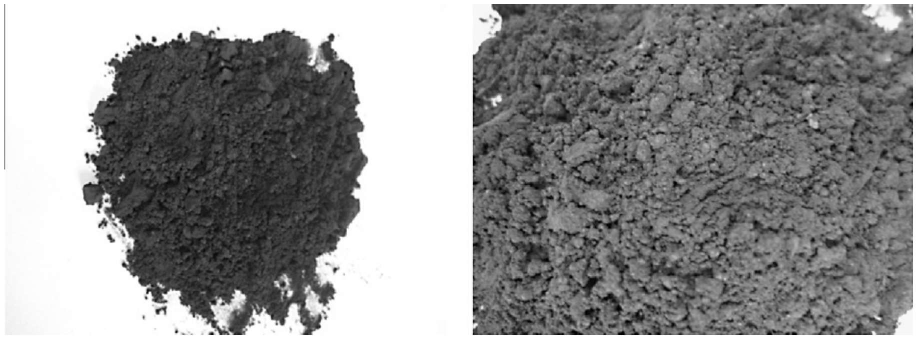
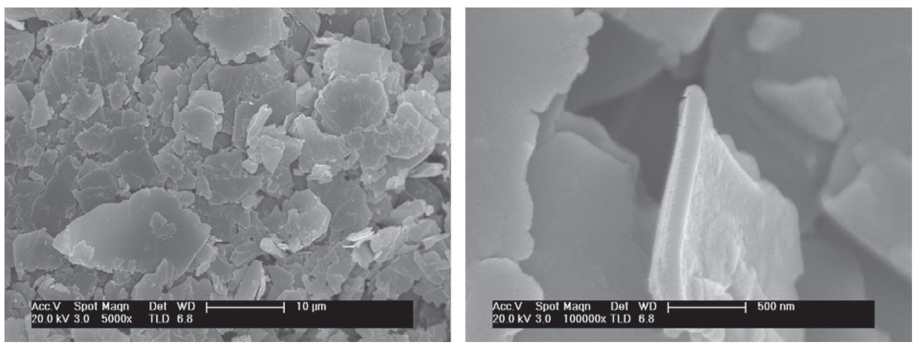
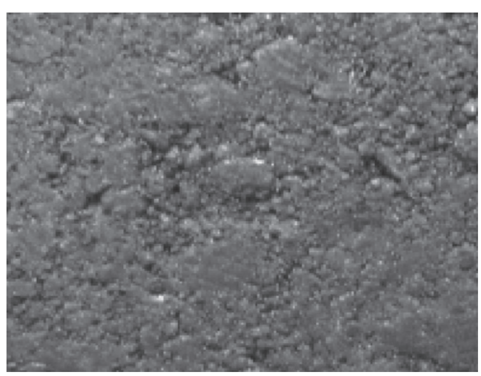


**Fig. 1.** Appearance of the NG.

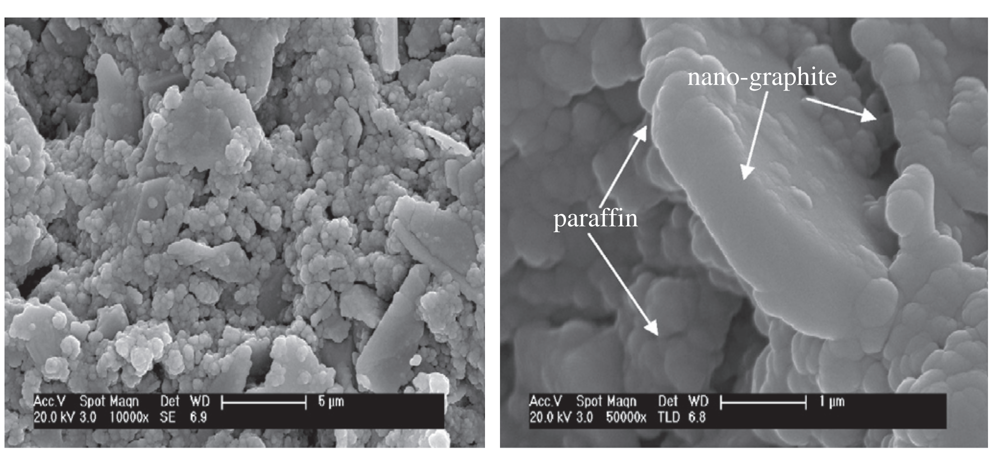



(a) x 5000 magnification (b) x 100000 magnification

**Fig. 2.** Microstructure of the nano-graphite: (a) ×5000 magnification; (b) ×100,000 magnification.



(a) The appearance of the composite




(b) x 10000 magnification (c) x 50000 magnification

**Fig. 3.** The microstructure of the paraffin/nano-graphite composite: (a) macromorphology; (b) ×10,000 magnification; (c) ×50,000 magnification.