Encapsulated Salt Hydrates - Highly Stable Heat-Storage Materials

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Phase change materials (PCM) are used for accumulation, storage and transfer of thermal energy due to the first-order phase transitions occurring with a significant enthalpy change. PCM can be applied in industry and in the household items to smooth out temperature fluctuations and reduce the heating and air conditioning costs. Salt hydrates favorably differ from organic PCM in their high thermal conductivity, low toxicity, incombustibility, and high melting enthalpy change. The drawback of salt hydrates is the low stability during multiple melting/crystallization cycles due to incongruent melting and phase separation, leading to a decrease in the melting enthalpy. Encapsulation of the PCM is the key to solve the problem of their stability. Aluminosilicate nanomaterials enable the encapsulation of PCM within pores and nanotubes cavities. The advantages of aluminosilicate nanocontainers are high specific area, non-toxicity, and low cost.

In this work, we obtained composites consisting of salt hydrates mixtures ($CH_3COONa \cdot 3H_2O/Na_2SO_4 \cdot 10H_2O$, and $CH_3COONa \cdot 3H_2O/Na_2CO_3 \cdot 10H_2O$) encapsulated in halloysite nanotubes. The samples were prepared by treatment of halloysite with concentrated aqueous solutions of salts with simultaneous sonication and subsequent vacuum impregnation. With varied salt ratios, we prepared samples with a wide range of melting points (20 – 60 °C) and various salt loading into the halloysite nanotubes. The samples were characterized by the transmission and scanning electron microscopy, elemental analysis, IR-, Raman spectroscopy, X-ray diffractometry, and differential scanning calorimetry. The optimal salt hydrates loading into the halloysite was determined, which ensures the high value of the melting enthalpy change and the stability of the thermal properties of the samples during prolonged thermal cycling.

This work was supported by Russian Science Foundation, Grant № 19-79-30091.