New, efficient phase change microcapsules for storing solar energy

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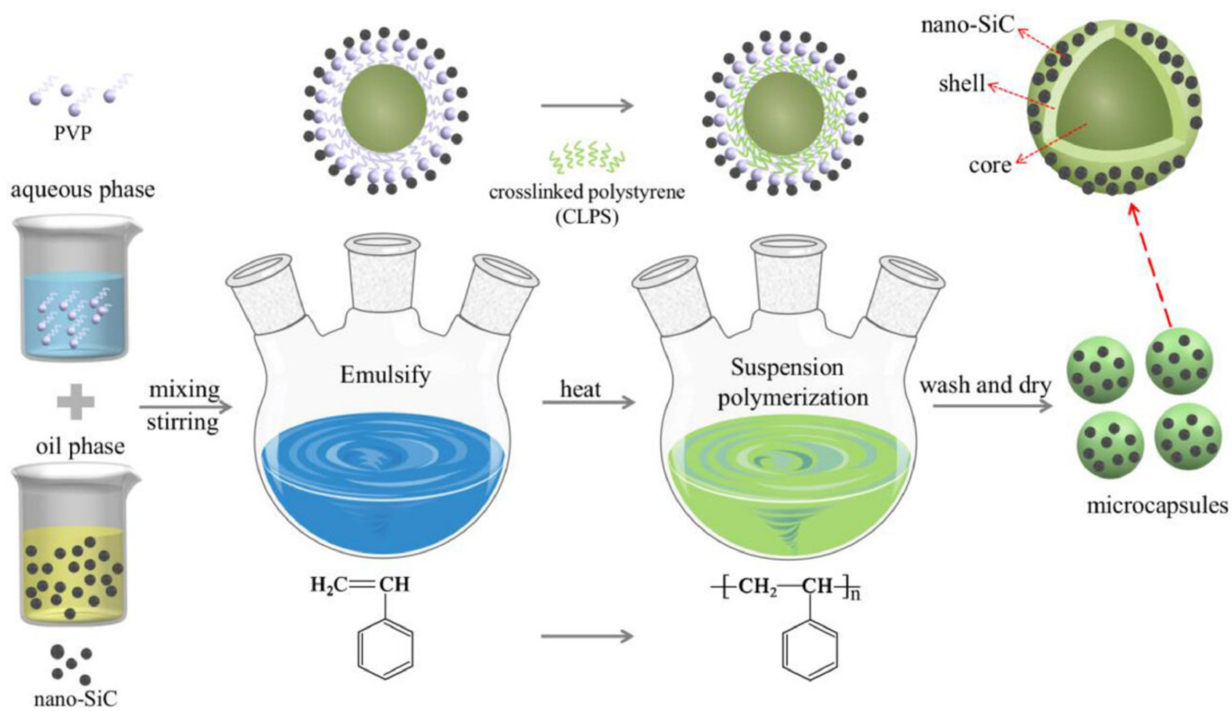

Synthesis of the microcapsules. Credit: *Energy Storage and Saving* (2022). DOI: 10.1016/j.enss.2022.09.003

It is no news that society's dependence on non-renewable fossil fuels has led to the ongoing global energy and climate crisis. The emissions from coal, natural gas, and petroleum-based fuel are major contributors to air pollution and, in turn, global warming. In society's attempt to shift to a sustainable, carbon-neutral energy economy, solar energy holds much promise. Abundant and eco-friendly, solar energy, if harnessed efficiently, can reduce our dependence on conventional sources of energy.

In this regard, phase change materials (PCMs), substances which release/absorb sufficient energy at phase transition (in the form of latent heat) to provide useful heating/cooling, are a popular candidate as solar energy storage devices. Studies have shown that a solar-powered PCM-based cooling system can reduce the ambient temperature by 30 degrees Celsius. Unfortunately, practical PCMs suffer from leakage and corrosion issues. Moreover, they show poor heat transfer properties owing to low thermal conductivity. While this can be solved by using metal PCMs, it makes the PCMs costlier and bulkier.

One way around these issues, as studies have shown, is to encapsulate the PCMs in microcapsules with high-conductivity fillers, such as nanoparticles. This can protect them from the damaging effects of light, heat, moisture, and oxygen as well as improve their heat transfer properties. Additionally, many researchers have resorted to low-density, non-metallic, high thermal conductivity nanoparticles for this purpose, which avoid the issues of metallic nanoparticles.

In a recent breakthrough, researchers from China and U.S. synthesized PMC microcapsules showing unprecedented photothermal conversion and heat transfer by using n-Octadecane (ODE) as the PCM core and a silicon carbide (SiC) nanoparticle-doped crosslinked polystyrene (CLPS) as the outer shell.

"Phase change microcapsule materials have been the focus of our research. In a previous study, we found that a single organic shell has defects in thermal conductivity and stability, while a single inorganic shell is not satisfactory in compactness and coverage. Therefore, we began to focus on doping organic shells with inorganic nanoparticles to obtain organic-inorganic hybrid shells," explains Prof. Jifen Wang from Shanghai Polytechnic University, China, one of the authors of the study, which was published online on September 29, 2022 in *Energy Storage and Saving*.

In their work, the team prepared a series of four microcapsules using a method called "suspension polymerization." They then characterized the microcapsules using scanning electron microscopy, energy-dispersive X-ray spectroscopy, and Fourier transform infrared spectroscopy. The results indicated that the microcapsules were spherical and the nano-SiC particles were embedded in the CLPS shells, aiding the heat transfer and photothermal conversion efficiency of the microcapsules.

The team next tested the thermal properties of the microcapsules and found that they showed superior photothermal conversion and thermal conductivity compared to the non-doped samples. Among the four types of doped microcapsules, the one with 1.25 wt% nano-SiC doping demonstrated the best performance, with a 54.9% photothermal conversion efficiency, 146% higher its non-doped counterpart.

With such encouraging results, the novel PCM microcapsule shells could provide a solid framework for further research on energy materials with excellent solar energy storage and conversion efficiency. The study also opens new doors to the practical application of multifunctional phase change microcapsules.

"These microcapsules can have significant potential applications as energy storage materials in solar energy devices, intelligent thermal insulation equipment, and energy-saving buildings," says Prof. Wang.

More information: Kuan Zhao et al, Enhanced photothermal conversion and thermal conductivity of phase change n-Octadecane microcapsules shelled with nano-SiC doped crosslinked polystyrene,

Energy Storage and Saving (2022). DOI: 10.1016/j.enss.2022.09.003

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