Food waste could store solar and wind energy

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Saving up excess solar and wind energy for times when the sun is down or the air is still requires a storage device. Batteries get the most attention as a promising solution although pumped hydroelectric storage is currently used most often. Now researchers reporting in ACS' *Journal of Physical Chemistry C* are advancing another potential approach using sugar alcohols—an abundant waste product of the food industry—mixed with carbon nanotubes.

Electricity generation from renewables has grown steadily over recent years, and the U.S. Energy Information Administration (EIA) expects this rise to continue. To keep up with this expansion, use of battery and flywheel energy storage has increased in the past five years, according to the EIA. These technologies take advantage of chemical and mechanical energy. But storing energy as heat is another feasible option. Some scientists have been exploring sugar alcohols as a possible material for making thermal storage work, but this direction has some limitations. Huaichen Zhang, Silvia V. Nedea and colleagues wanted to investigate how mixing carbon nanotubes with sugar alcohols might affect their energy storage properties.

The researchers analyzed what happened when carbon nanotubes of varying sizes were mixed with two types of sugar alcohols—erythritol and xylitol, both naturally occurring compounds in foods. Their findings showed that with one exception, heat transfer within a mixture decreased as the nanotube diameter decreased. They also found that in general, higher density combinations led to better heat transfer. The researchers say these new insights could assist in the future design of sugar alcohol-based energy storage systems.

More information: Huaichen Zhang et al. Nano-Scale Heat Transfer in Carbon Nanotube - Sugar Alcohol Composite as Heat Storage Materials, *The Journal of Physical Chemistry C* (2016). DOI: 10.1021/acs.jpcc.6b05466

Abstract
Nano-scale carbon structures such as graphene and carbon nanotubes (CNTs) can greatly improve the effective thermal conductivity of thermally sluggish heat storage materials, such as sugar alcohols (SAs). The specific improvement depends on the heat transfer rate across the carbon structure. Besides, the heat transfer rate is further dependent on the material and the CNT diameter. In this paper, molecular dynamics

simulations are applied to graphene/CNT-SA interfacial systems. Using erythritol and xylitol as model materials, we find the cross-plane heat transfer coefficient to decrease as the CNT diameter decreases, with an exception for CNT(7,7). A phonon mode analysis is carried out to explain the general decreasing trend. The larger phonon mode mismatch observed between the molecules on both sides of smaller diameter CNTs is found to be a finite size effect of the confinement, instead of an interfacial effect. From the molecular collision point of view, a higher molecular density promotes heat transfer. In the case of CNT(7,7), the effective density of molecules enclosed in the CNT is found much higher than that of CNT(8,8). This may be the cause of the higher heat transfer rate across CNT(7,7). Molecular orientations and hydrogen bond structures of the molecules inside the CNTs are investigated to demonstrate the finite size effect of the confinement. For graphene-SA composites, five model materials are considered and their cross-plane heat transfer coefficients all fall into the same range.

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