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On sugar alcohol based heat storage materials: A nanoscale study and beyond

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Batteries and pumped hydropower plants store solar energy in the form of chemical and mechanical energy. Another attractive option is storing energy in the form of heat. Probably the best-know example are the so-called heat pads that are used in outdoor activities. We investigate how to use sugar alcohols as heat batteries. Sugar alcohols are an abundant product of the food industry and they come in many different types. Xylitol for example, is often used in chewing gum. The heat is stored when the sugar alcohol melts and released again upon crystallization. This crystallization can be at much lower temperatures than the melting which is called undercooling. Undercooling thus allows to store energy without the need for insulation. However, the heat conduction in sugar alcohols is low, limiting the heat power. Also, the crystallization behavior is unpredictable which complicates the storage system design.
Using a nanoscale modeling method, the sugar alcohols are studied in full atomic detail. From the movement of atoms, many material properties are derived that were so far unknown. By adding small amounts of carbon nanostructures to the sugar alcohols, the thermal conductivity of the carbon-sugar alcohol composite was hugely increased. The research also identified two distinct nanoscale heat transfer algorithms, one of which proved to be applicable to the composite material. We also developed a novel method to calculate the solid-liquid interfacial free energy, a key parameter that controls the nucleation and crystallization processes.

References

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