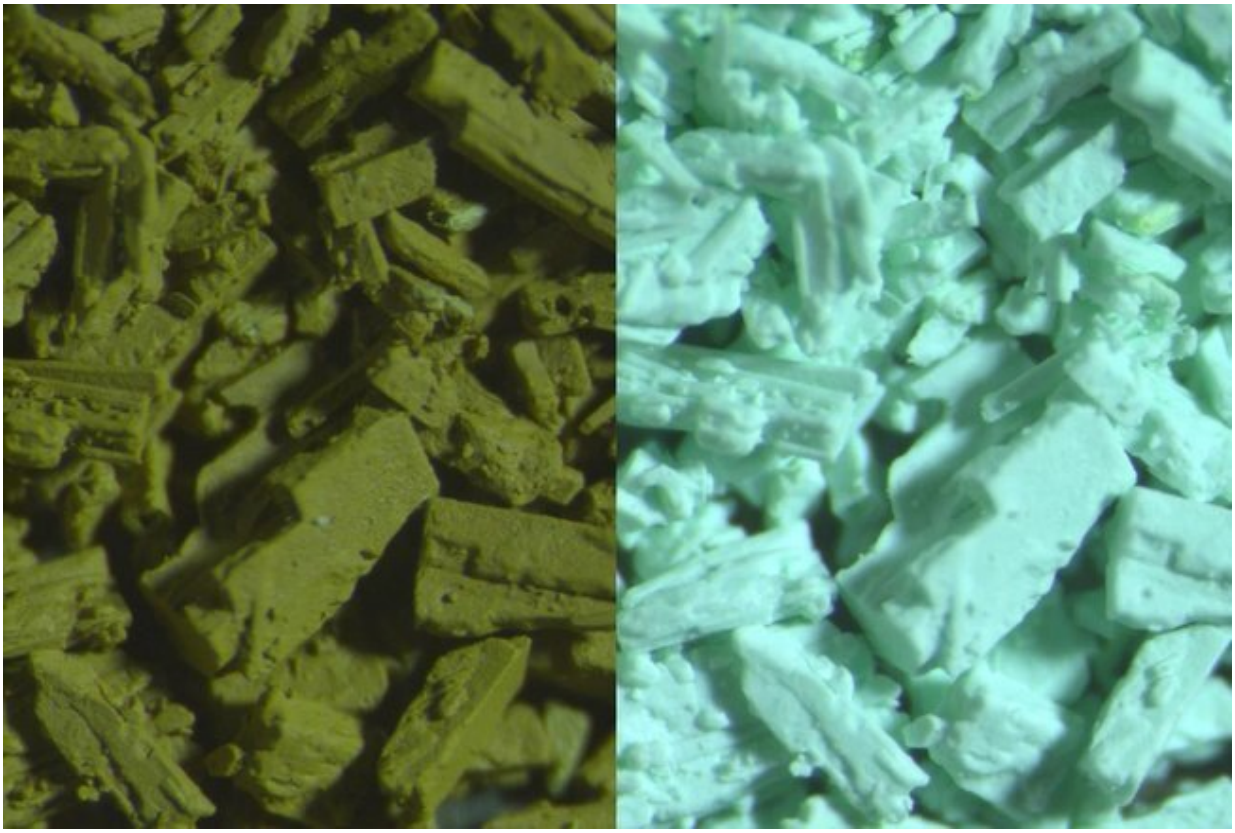
Closer to a heat battery: Understanding the atomistic processes

June 10 2020



Credit: Eindhoven University of Technology

Salts are cheap and sustainable materials that can be used to store energy (heat) over periods ranging from hours to years without loss. This works via so-called hydration-dehydration processes. Energy release

(discharge) occurs when a salt incorporates water molecules in its crystal structure (hydration). Energy is stored in the reverse process (dehydration), when water molecules are driven out of the crystal lattice with help of available heat. Power input and output are important characteristics of an energy storage device. Therefore, the kinetics of the hydration and dehydration process needs to be understood.

In collaboration with the H2020 CREATE consortium Leyla identified new candidates salts, that could act as base material for salt-based heat batteries. Especially K2CO3 turned out to be very promising and was chosen by the CREATE consortium for further development. Based on Leyla's work the company Caldic (partner in the CREATE consortium) demonstrated a proof of principle of an industrial scale process for K_2CO_3-based composites.

In her work, Leyla showed that the kinetics of salt hydration is dictated by two important factors: the nucleation rate and the presence of a mobile intermediate state. She has found that it takes a while before a small cluster (nucleus) of hydrated salt is stable enough. This nucleation process slows down the reaction rate and therefore the power output. In her work she also has found evidence for a mobile intermediate state that facilitates the process. Water not only incorporates in the solid matrix of the salt, but also mobilizes the atoms at surfaces and in the cracks in the salt particles. This facilitates the reaction and in this way the power output.

Her findings have accelerated the search for additives and dopants that speed up hydration/dehydration reactions. As such, her work has opened the door to a more targeted development process of salt-based heat storage materials and has speeded up the development of a heat battery.

More information: P.A.J. Donkers et al. A review of salt hydrates for seasonal heat storage in domestic applications, *Applied Energy* (2017).

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