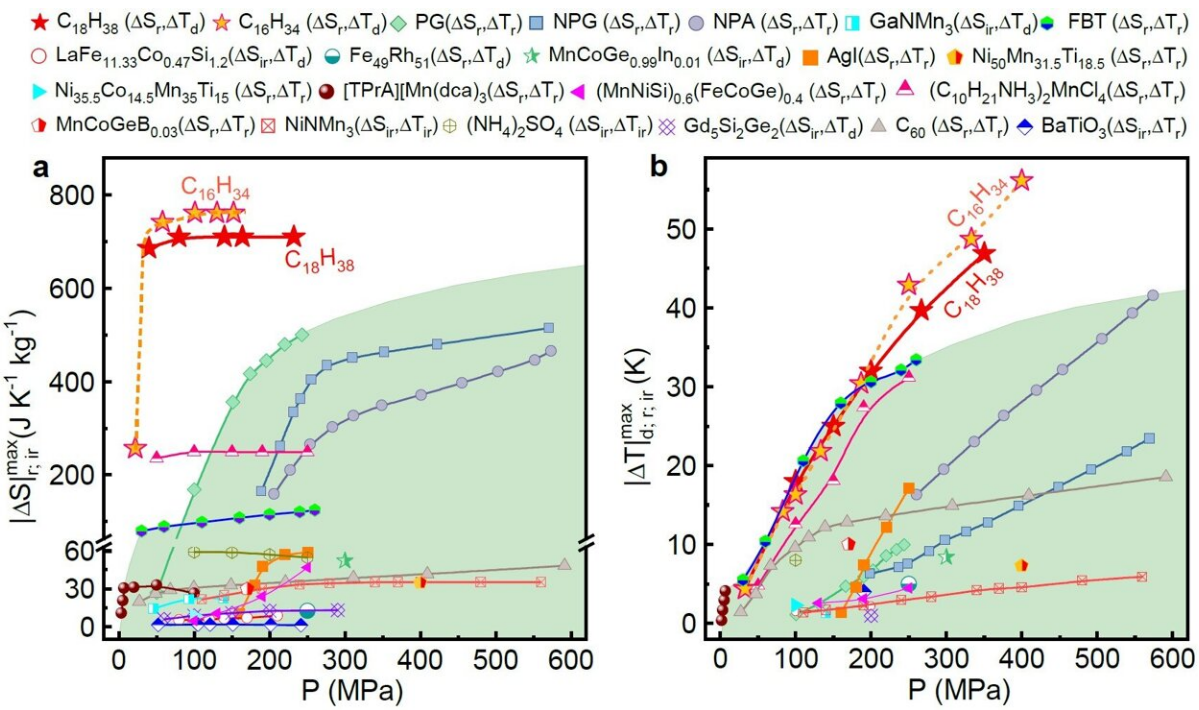
N-alkanes proved to be a safe, novel and green cooling material

February 1 2022



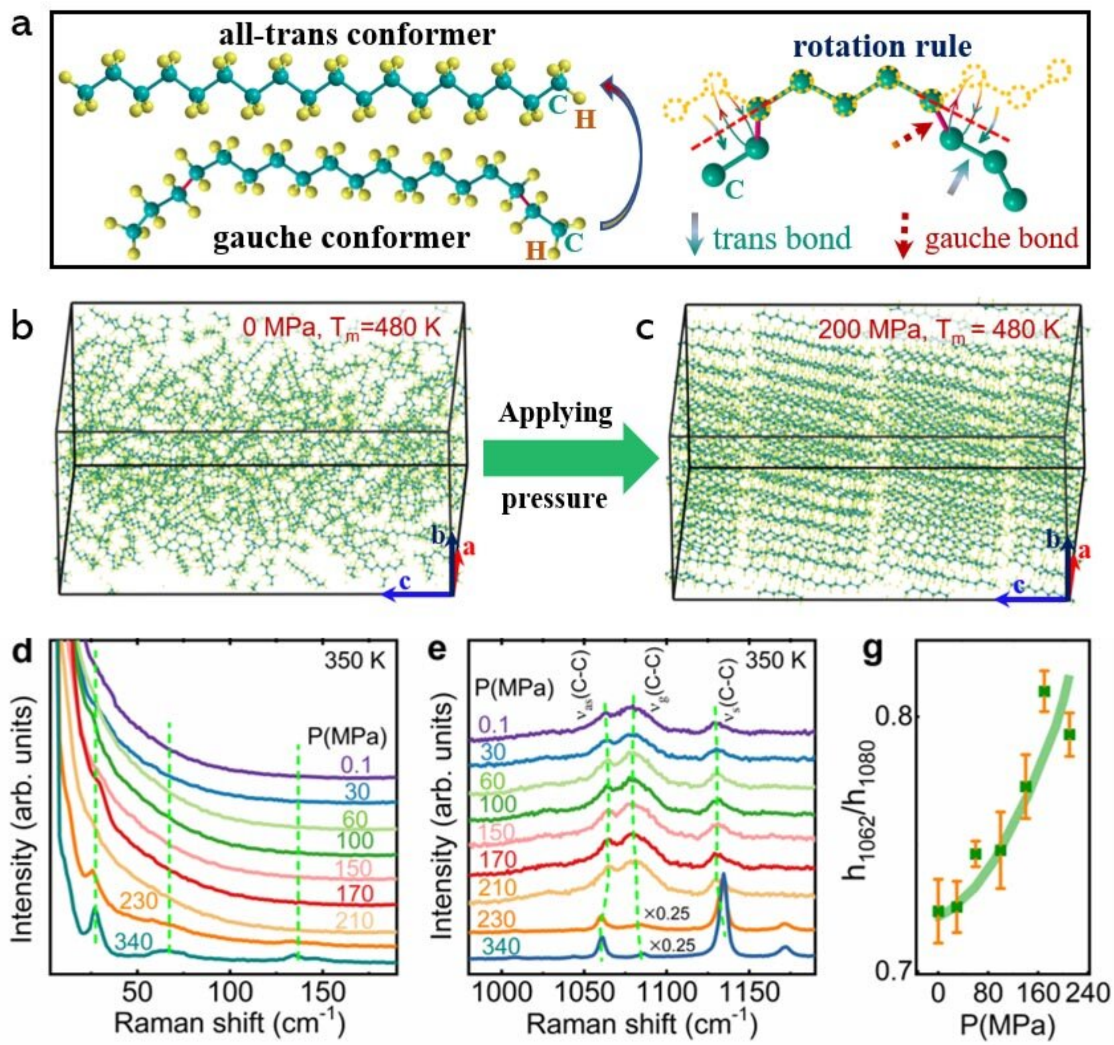
Comparision of BC performance between CnH2n+2 and the existing BC materials. The maximum adiabatic temperature change (a) and isothermal entropy change (b) as a function of pressure for C18H38 and C16H34, are shown along with the reported BC materials. Credit: Lin Jianchao

The traditional refrigerant Freon is a strong greenhouse gas that leads to serious climate problems. Stimulated by the excellent cooling performance of plastic crystal materials, barocaloric (BC) cooling received much attention recently as a promising green refrigeration technology. However, problems like high driving pressure and low thermal response remain unsolved, hindering practical applications.

In a new study published in *Nature Communications*, scientists led by Prof. Tong Peng at the Institute of Solid State Physics, Hefei Institutes of Physical Science (HFIPS), Chinese Academy of Sciences (CAS), described how they discovered excellent BC cooling performance in n-alkanes with a self-developed BC test platform. The study provided a new perspective for developing the application-oriented green refrigeration technology.

"It's safe and green," explained Lin Jianchao, first author of the paper, "and the cost is low. Current refrigerating exploration tends to use solid-state phase transition materials. Now, we have a future with solid-liquid phase transition (L-S-T) materials in mind."

The technology uses n-alkanes. Applying a low pressure of around 50 megapascals triggered a colossal entropy change of ~ 700 J kg^{-1} K^{-1}. This is comparable to those of the commercial Freon-based refrigerants and at least three times larger than the reported values of existing BC materials driven by the same pressure. Aside from that, the adiabatic temperature change driven under this pressure also reaches the highest value of the existing BC materials.



The barocaloric mechanism revealed by Molecular Dynamics Simulation (a-c) and Raman spectra under different pressure (d-g). Credit: Lin Jianchao

In this paper, they further revealed the possible BC mechanism. The Raman study and molecular dynamics simulation reveal that applying pressure to the liquid state suppresses the twisting and random thermal motions of molecular chains, resulting in a lower configurational entropy. When the pressure is strong enough to drive the L-S-T, the configurational entropy will be fully suppressed and induce the colossal BC effect.

The excellent BC properties, tunable operating temperatures, low-cost raw materials and well-known thermal properties all suggest n-alkanes are promising refrigerants for caloric cooling.

"We expect more excellent BC performance by evoking L-S-T materials in the near future," said Lin.

More information: Jianchao Lin et al, Colossal and reversible barocaloric effect in liquid-solid-transition materials n-alkanes, *Nature Communications* (2022). DOI: 10.1038/s41467-022-28229-4

Provided by Chinese Academy of Sciences

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