Temperature Shock-Induced Recovery in Jammed Microgels

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Why in News?

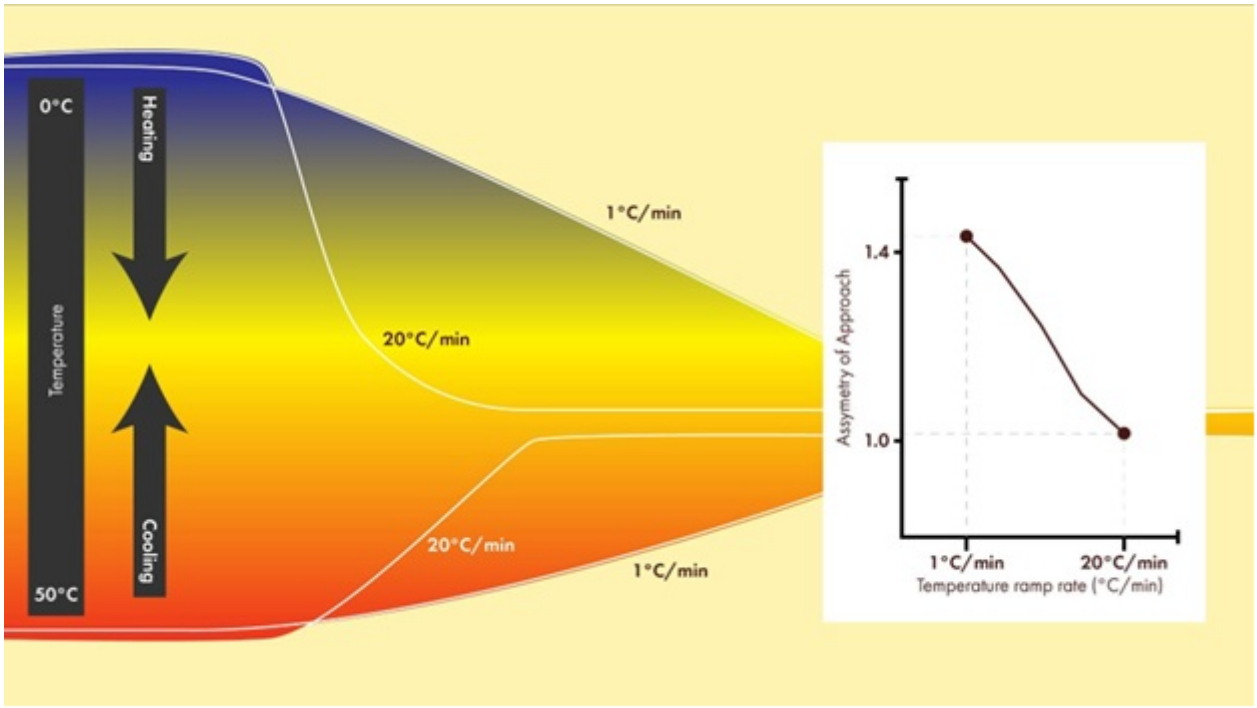
Scientists from the Raman Research Institute (RRIdiscovered that applying sudden thermal shocks (rapid temperature ramps) can temporarily liquefy dense "jammed" glass-like systems.

Key Highlights of the Discovery

- **Erasing Structural Memory-** Jammed systems, materials that behave mechanically like solids while maintaining disordered, liquid-like internal particle structures, normally retain "memory imprints" of past thermal paths.
- **Thermal Shock Mechanism -** By suddenly increasing the temperature ramp rate, the jammed microgel particles are forced to rearrange, momentarily converting the solid-like matrix into a flowing liquid state.
- **Eliminating Path Asymmetries -** In standard heating and cooling cycles, jammed microgel suspensions follow asymmetrical relaxation paths.
- Rapid thermal shocks eliminate these path-dependent asymmetries, enabling precise structural control.
- **Experimental Methodology-** Lead researcher synthesized microgel particles, suspended them in water, stirred and sonicated the mixture, and subjected the suspension to controlled temperature ramps while observing particle dynamics.

Thermoresponsive Microgels & Drug Delivery

- **Swelling Capability -** Microgels are soft, deformable polymer networks capable of absorbing **300 to 500 times** their dry weight in water.
- **Temperature-Triggered Release**
  - **Cool State-** Microgels remain swollen like puffed-up jelly at lower temperatures, allowing pharmaceutical molecules to be easily loaded inside.
  - **Warm State -** Upon reaching a critical transition temperature—specifically above **34°C** (just below normal human body temperature)—the microgels rapidly collapse, squeezing out and releasing the drug payload at targeted physiological sites (e.g., hyperthermic tumor environments).
- **Clinical Significance -** Understanding how external thermal perturbations influence structural recovery ensures predictable drug release kinetics, minimizing off-target toxicity.



Reference

DST | New study on temperature changes induced structure recovery

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