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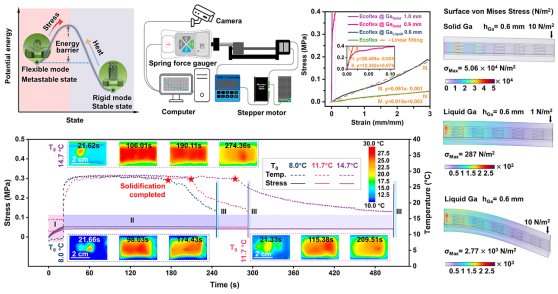
A multi-layer system featuring supercooled gallium can adjust its stiffness without bulky magnetic or refrigeration equipment.



Stiffness-tunable materials could enable new material designs and functional applications like advanced robotic exoskeletons and flexible electronics. These unique materials have the ability to alter their stiffness on demand, offering an adjustable balance between rigidity and flexibility. However, stiffness tuning is typically accomplished through either a phase change in the material via cooling or by applying a magnetic field on magnetorheological fluids, both of which can be energy intensive and require bulky equipment.

Wang et al. developed a more efficient stiffness-tunable material by incorporating homocrystal seeds into supercooled gallium-based liquid metal. The resulting system exhibits rapid crystallization and solidification without the need for refrigeration equipment.

“We developed a multi-layer system comprising supercooled liquid metal and elastomer,” said author Jing Liu. “Upon contact with homocrystal seeds, the supercooled liquid metals exhibit a propensity to surpass the energy barrier for rapid crystallization and solidification.”

In addition to facilitating crystallization, the homocrystal seeds ensure the system can return to the supercooled state after solidifying by preventing contamination caused by heterogeneous seeds after diffusion.

This multi-layered structure can be tailored to meet many different needs. The team demonstrated potential uses for this system as a shape memory material, a temperature-sensitive switch, and a controlled circuit. They plan to incorporate more complex structures and components for a wider range of features.

“In future research, we can explore more customized structures and assess their functionalities based on specific application scenarios,” said Liu. “Additionally, future research may explore the integration of liquid metal and elastomer to design a composite material with stiffness tuning, thereby expanding the application scope.”

Source: “Stretchable stiffness-tuning of liquid metal elastomer triggered by homocrystal seeds,” by Ju Wang, Yangtai Hao, Yuchen Yao, Jingyi Li, Yujia Song, Jianye Gao, and Jing Liu, *Applied Physics Reviews* (2024). The article can be accessed at https://doi.org/10.1063/5.0185725.