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Thermally Actuated Planar Lattices with High Fractal Stiffness

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Thermally actuated planar lattices with high fractal stiffness

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Thermally-responsive materials appeal to a variety of applications, yet continue to fall short under strict practical requirements. Structural efficiency is one of them, as the quest of high specific stiffness often appears incompatible with the need to provide large deformation [1,2]. This work presents minimal stretch-dominated lattices that can reduce the inherent trade-off between elastic stiffness and thermally-induced actuation. Planar bi-material lattices are proposed with self-repeating units to provide unconfined thermal expansion upon prescribed changes of temperature, and to attain either large unidirectional or rotational thermal expansion with almost no impact on specific stiffness. Proof-of-concepts are built and tested to validate closed-form expressions of thermo-elastic performance, which are further verified through numerical simulations. The class of architected materials introduced here takes one step closer to meeting the demands of thermally functional materials that are stiff and strong and can be engineered to provide customized levels of large deformation.

References

[1] Xu H., Farag A., Pasini D., 2017. Multilevel hierarchy in bi-material lattices with high specific stiffness and unbounded thermal expansion. *Acta Materialia, 134*, pp.155-166.
[2] Xu H., Pasini D., 2016. Structurally efficient three-dimensional metamaterials with controllable thermal expansion. *Scientific Reports, 6:34924*.