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High thermal conductivity in soft elastomers with elongated liquid metal inclusions.[1] NAVID KAZEM, Carnegie Mellon University, MICHAEL D. BARTLETT, Iowa State University, MATTHEW J. POWELL-PALM, XIAONAN HUANG, WENHUAN SUN, JONATHAN A. MALEN, CARMEL MAJIDI, Carnegie Mellon University — Soft dielectric materials typically exhibit poor heat transfer properties due to the dynamics of phonon transport, which constrains thermal conductivity (k) to decrease monotonically with decreasing elastic modulus (E). This is limiting for wearable computing, soft robotics, and other emerging applications that require materials with both high thermal conductivity and low mechanical stiffness. Here, we overcome this constraint with a dielectric composite that exhibits an unprecedented combination of metal-like thermal conductivity, an elastic compliance similar to soft biological tissue (E <100kPa), and extreme deformations capability (>600% strain). By incorporating liquid metal (LM) microdroplets into a soft elastomer, we achieve a ˜25x increase in thermal conductivity (4.7 0.2 W/m•K) over the base polymer (0.20 0.01 W/m•K) under stress-free conditions and a ˜50x increase (9.8 0.8 W/m•K) when strained. This exceptional combination of thermal and mechanical properties is through the deformation of the LM inclusions to create thermally conductive pathways in situ. Moreover, these materials offer new possibilities for passive heat exchange in stretchable electronics and bio-inspired robotics, which we demonstrate through the rapid heat dissipation of an elastomer-mounted extreme high power LED lamp and a swimming soft robot.

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