## 1. Stimuli responsive microscale architectures: Two-photon lithography with shape memory polymers

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### Abstract

3D architectures with nearly arbitrary geometry and features on the submicron scale can be fabricated using direct laser writing, which gives rise to unique combinations of properties, such as high strength-to-wt. ratios and superior mech. resilience of micro- and nanolattices. Inducing a shape transformation of the constituent solid that comprises such architected materials in response to external stimuli could lead to a controllable and substantial change in the mech. response of the structure. One class of such solids is shape memory polymers, in which crosslinked elastomer shape memory networks can be deformed in the rubbery state and maintain the deformed shape when cooled to the glassy state. The original shape is then recovered in response to heat. We developed a benzyl methacrylate-based resist that can be polymd. into such networks via direct laser writing. We then conducted a suite of dynamic mech. anal. (DMA) nanomech. expts. at 22°C to 90°C on individual microscale pillars, which measured their storage and loss moduli, to det. glass transition temp. We obsd. a shape memory phenomenon in all fabricated 3D architectures with submicron features and arbitrary geometries. Programming was accomplished by first deforming the samples at 77°C and cooling them to glassy state at 30°C. After load removal, the structures remained deformed until heated to 90°C, when they recovered >95% of the original height.