Supporting Information

Fast digital patterning of surface topography toward three-dimensional shape changing structures

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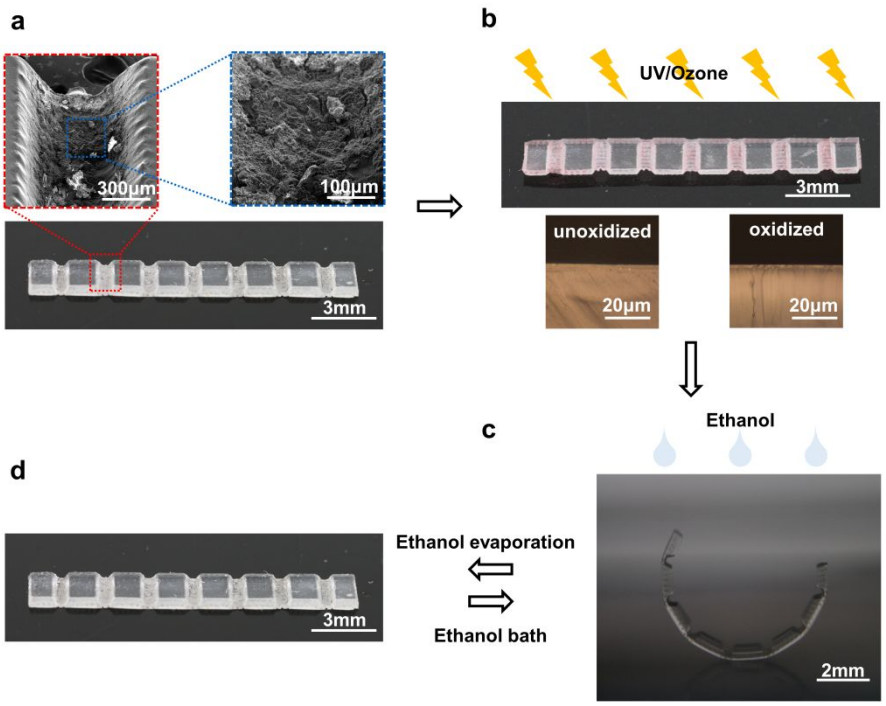

Figure S1. Illustration of preparation process of 3D shape changing structures. (a) An engraved PDMS ribbon with uniformly distributed grooves (in-plane dimension: 15 mm×2 mm, UVO treatment time: 40 min, T=500 μm, L_1=867 μm, L_2=316 μm, H=326 μm, D=2 mm). The insets are SEM images of a typical groove. The laser power and velocity are 12 W and 1270 mm/s in a raster mode. (b) UVO treatment of the bottom surface of PDMS ribbon introduces a thin oxidized layer to absorb ethanol. The insets labeled unoxidized and oxidized are optical images of cross sections of ribbons without and with UVO treatment, respectively. A thin oxidized layer can be observed after UVO treatment. (c) Ethanol bath of the ribbon induces bending deformations. (d) Ethanol evaporation recovers the bent ribbon to be flat.

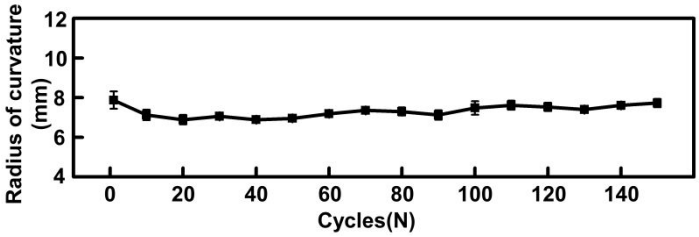

Figure S2. Cyclic deformation stability of engraved PDMS ribbon (in-plane dimension: 15 mm×2 mm, UVO treatment time: 40 min, T=500 μm, L_1=349 μm, L_2=50 μm, H=326 μm, D=3mm) in ethanol bath. The laser power and velocity are 18 W and 240 mm/s in a vector mode.

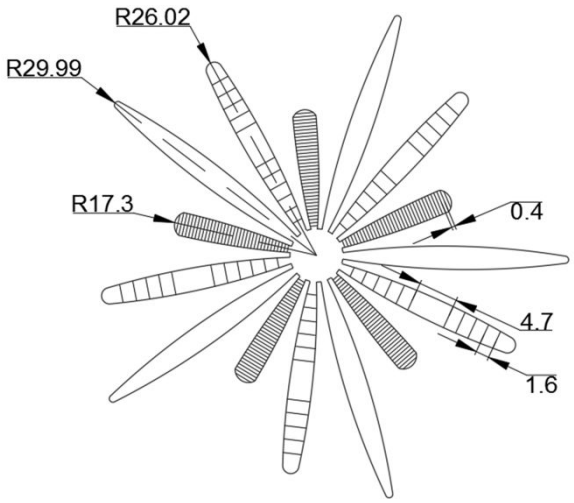

Figure S3. Schematic illustration of 2D sheet design for the flower. The short solid lines correspond to grooves with parameters given by T=500 μm, L_1=224 μm, L_2=59μm, and H=322 μm. The whole backside of sheet is UVO treated for 40 min. Unit: mm.

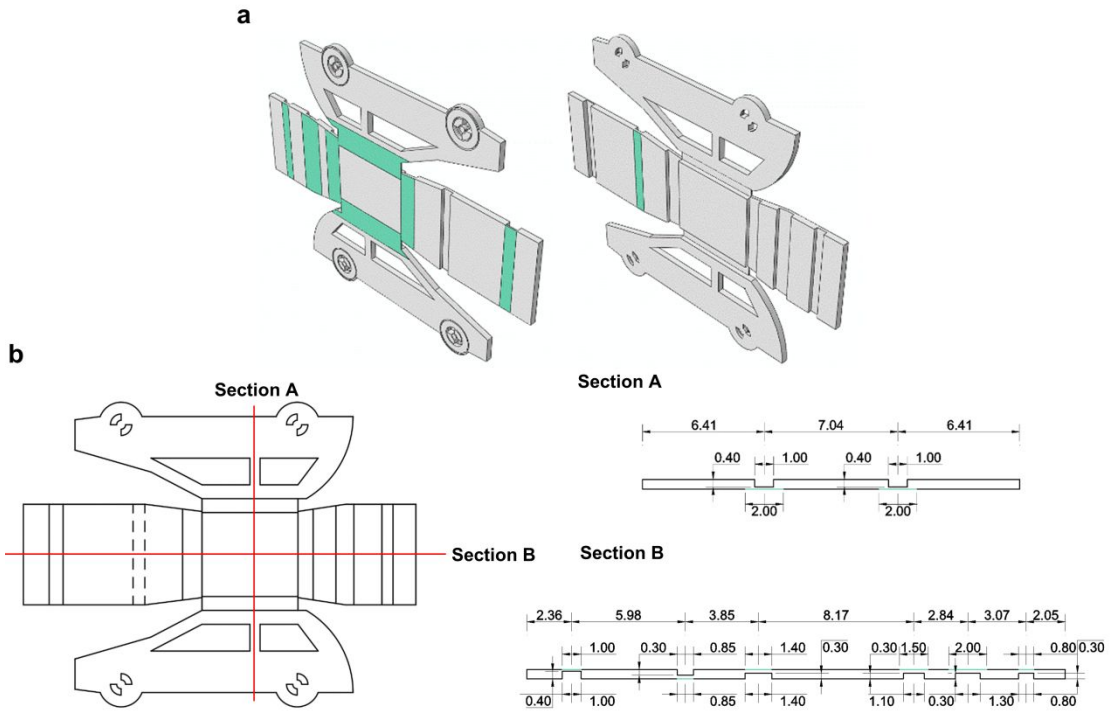

Figure S4. Schematic illustration of 2D sheet design for the car. (a) Schematic diagram of 2D sheet design with only the light green region UVO treated for 40 min and the other regions not UVO treated. (b) Details of 2D sheet design showing dimensions of grooves. Unit: mm.

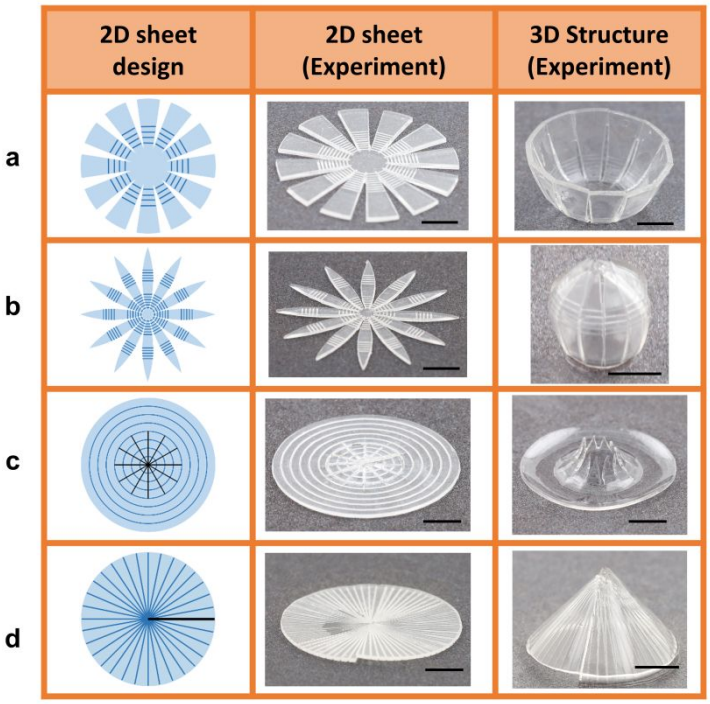

Figure S5. Illustrative examples of complex 3D shape changing structures from corresponding engraved 2D PDMS sheets. Schematic designs, optical images of 2D PDMS sheets, and optical images of 3D PDMS structures for (a) a bowl, (b) a fusiform body, (c) a hat, and (d) a cone. The blue lines denote the engraved grooves and the black lines denote the cut lines. The laser power and velocity are 18 W and 240 mm/s in a vector mode. Scale bars: 5 mm.

Supplementary movies

Movie S1. The engraved ribbon twists to a helix tube in ethanol bath

Movie S2. The engraved sheet transforms to a flower in ethanol bath

Movie S3. The engraved sheet transforms to a flower with ethanol vapor