

Description of Additional Supplementary Files

File name: Supplementary Movie 1

Description: the 3D printed self-locking origami structure with one unit and 2×2 units can be folded under in-plane load.

File name: Supplementary Movie 2

Description: the 3D printed self-locking origami structure can be compressed more than 100 times without significant damage under cyclic compression at a compressive strain of 40%.

File name: Supplementary Movie 3

Description: the 3D printed MSO Structure I shows a consistent push-to-pull deformation mode during compression.

File name: Supplementary Movie 4

Description: the 3D printed MSO Structure II undergoes buckling deformation of units 1 and 2 sequentially in compression, while unit 3 follows a push-to-pull deformation mode.

File name: Supplementary Movie 5

Description: when the 3D printed MSO Structure III is compressed, unit 2 is deformed first, and then, unit 3 and unit 1 are compressed sequentially. They all deform in a push-to-pull deformation mode.

File name: Supplementary Movie 6

Description: the 3D printed MSO Structure IV exhibits consistent push-to-pull deformation mode when placed on a curved platform.

File name: Supplementary Movie 7

Description: the 3D printed Impact Structure III exhibits a buckling deformation mode at an impact energy of 24 J with significant secondary impacts.

File name: Supplementary Movie 8

Description: the 3D printed Impact Structure IV exhibits a push-to-pull deformation mode at an impact energy of 24 J and absorbed the impact energy significantly.