Supplementary Information

Hexagonal Ring Origami – Snap-folding with Large Packing Ratio

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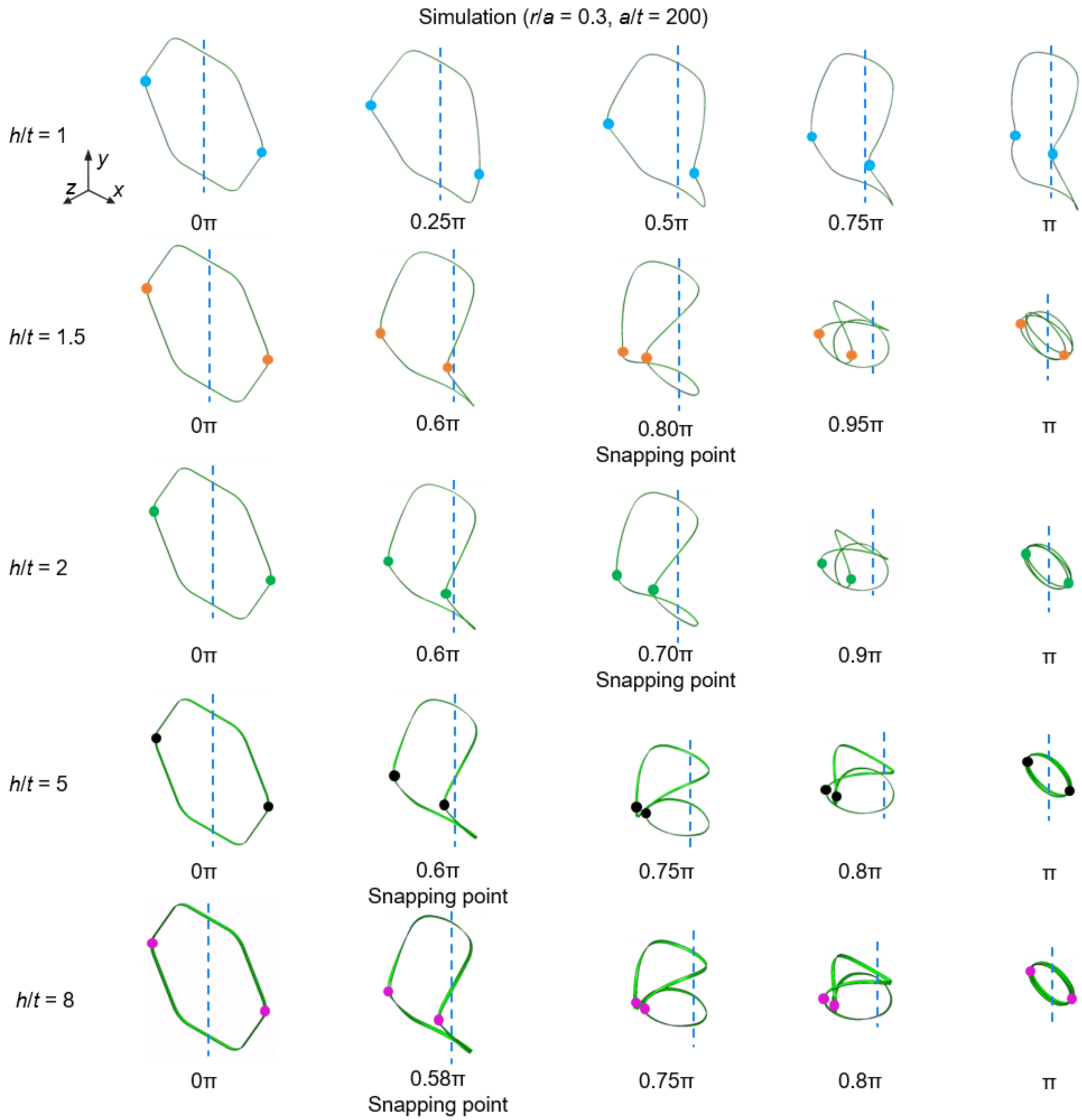

Fig. S1. Bending-induced snap-folding processes of hexagonal rings with varied cross-section aspect ratios (h/t = 1, 1.5, 2, 5, and 8). Bending is applied at two corners that pass the centerline of the ring.

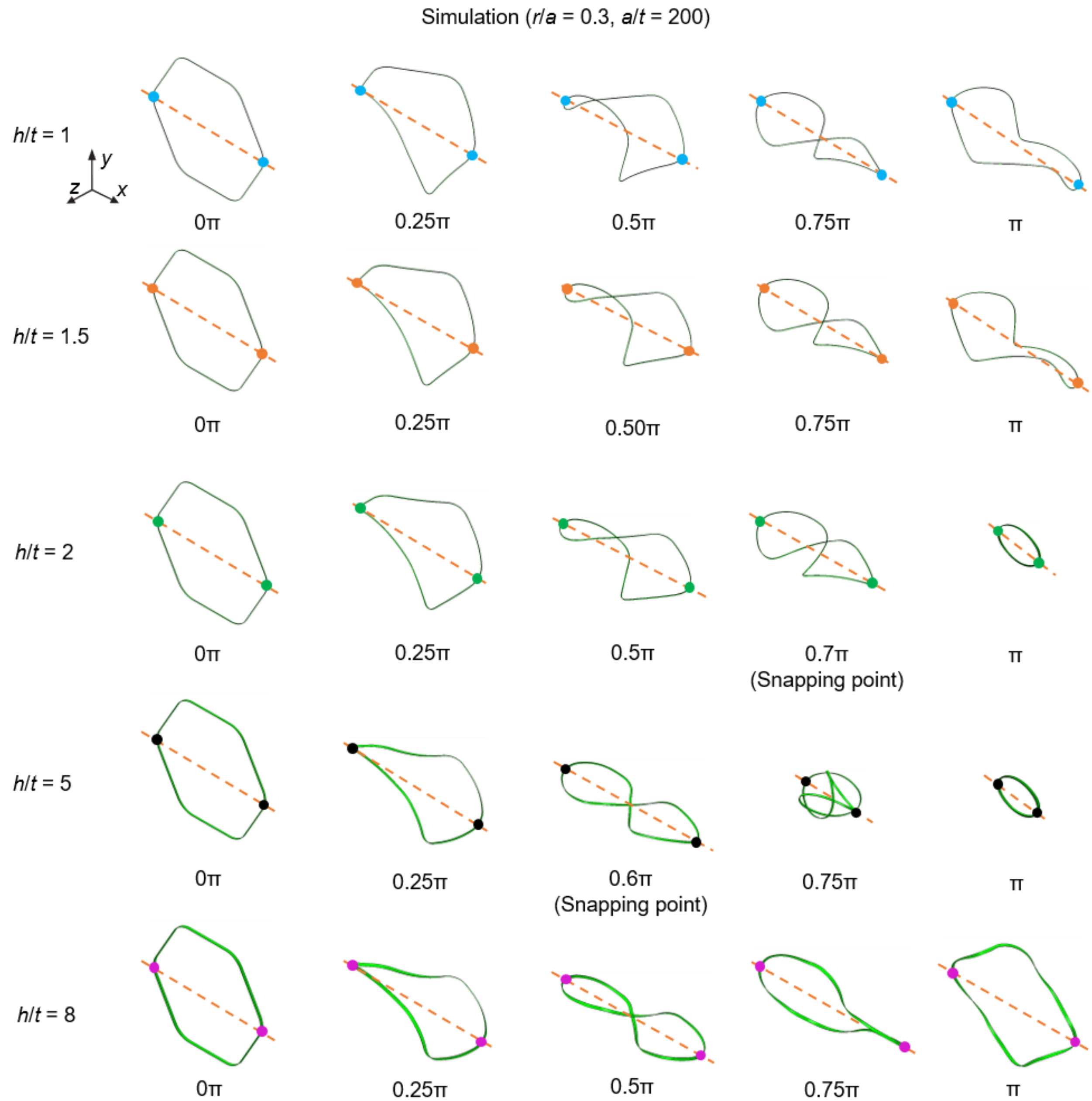

Fig. S2. Twisting-induced snap-folding processes of hexagonal rings with varied cross-section aspect ratios (h/t = 1, 1.5, 2, 5, and 8). Twisting is applied at two corners that pass the centerline of the ring.

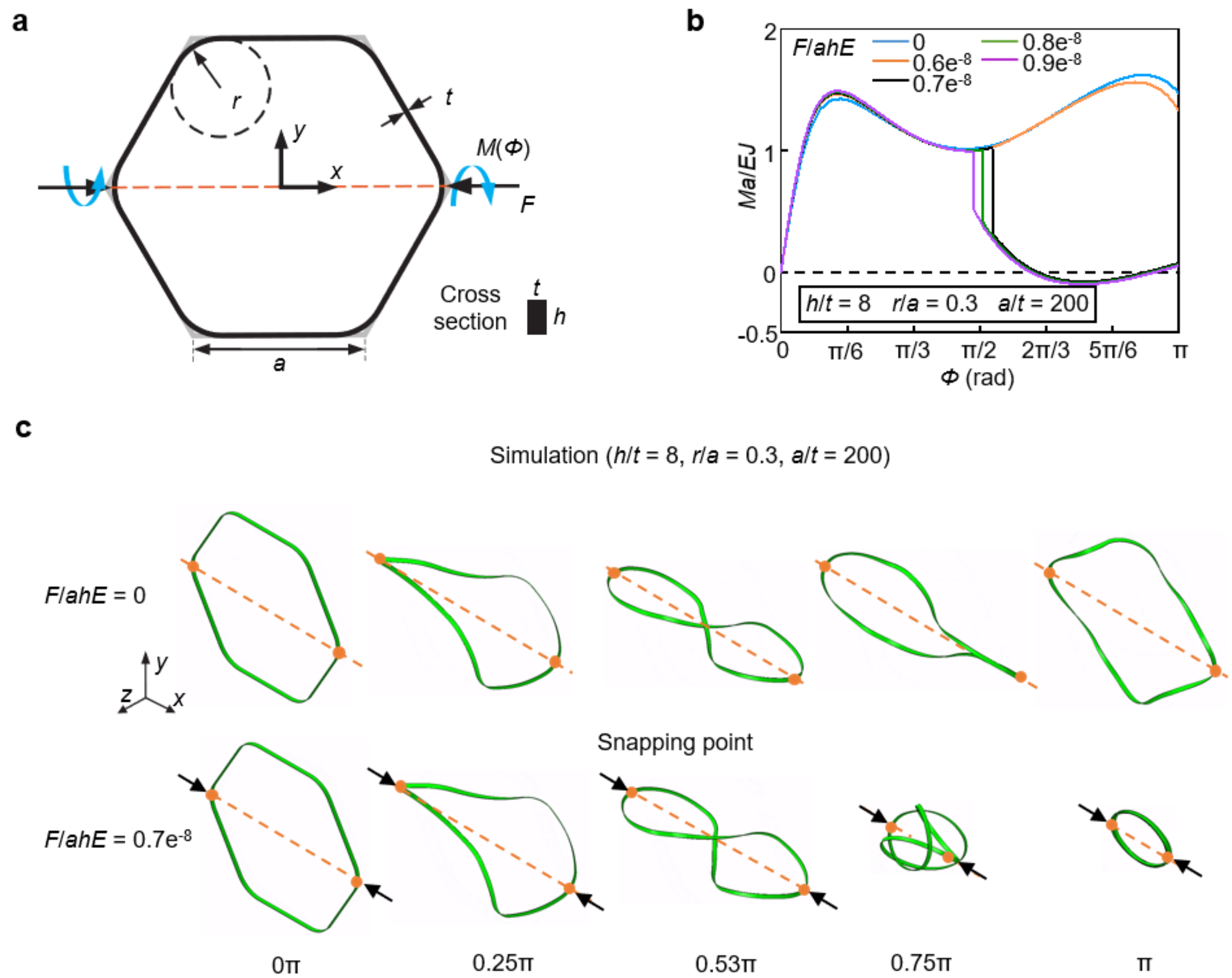

Fig. S3. Twisting of a hexagonal ring ($h/t = 8$, $r/a = 0.3$, $a/t = 200$) without and with a small bending component. (a) Geometric parameters and loading conditions. The bending component is induced by adding a pair of modest pushing forces F on the corners where twisting is applied. The force is normalized as F/ahE, where a is hexagonal ring edge length, h is cross-section height, and E is the Young's modulus of ring material. (b) Normalized moment-twisting angle curves of folding the hexagonal ring with different pushing forces. (c) Folding processes of a hexagonal ring without and with adding the bending component.

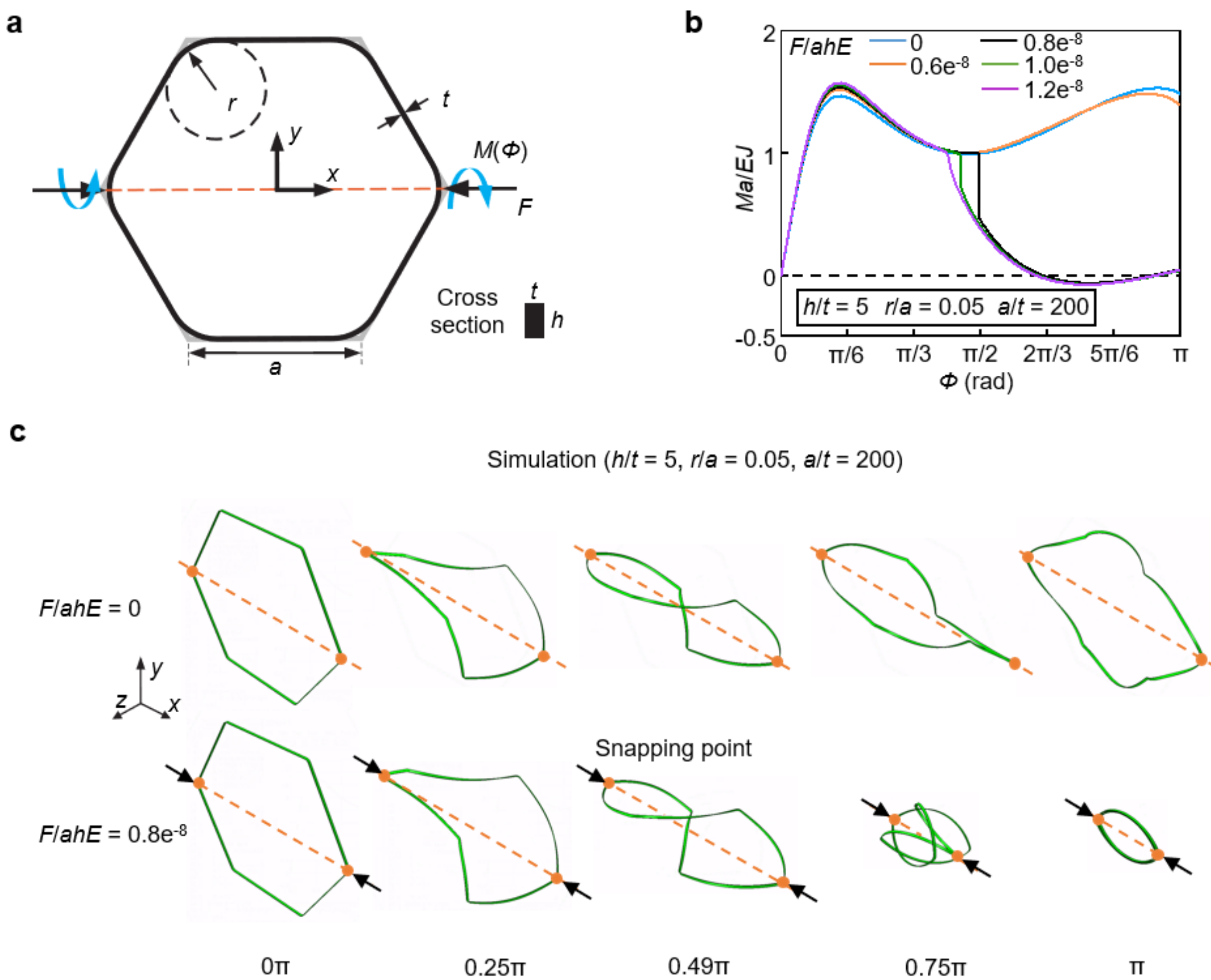

Fig. S4. Twisting of a hexagonal ring (h/t = 5, r/a = 0.05, a/t = 200) without and with a small bending component. (a) Geometric parameters and loading conditions. The bending component is induced by adding a pair of modest pushing forces F on the corners where twisting is applied. The force is normalized as F/ahE, where a is hexagonal ring edge length, h is cross-section height, and E is the Young's modulus of ring material. (b) Normalized moment-twisting angle curves of folding the hexagonal ring with different pushing forces. (c) Folding processes of a hexagonal ring without and with adding the bending component.

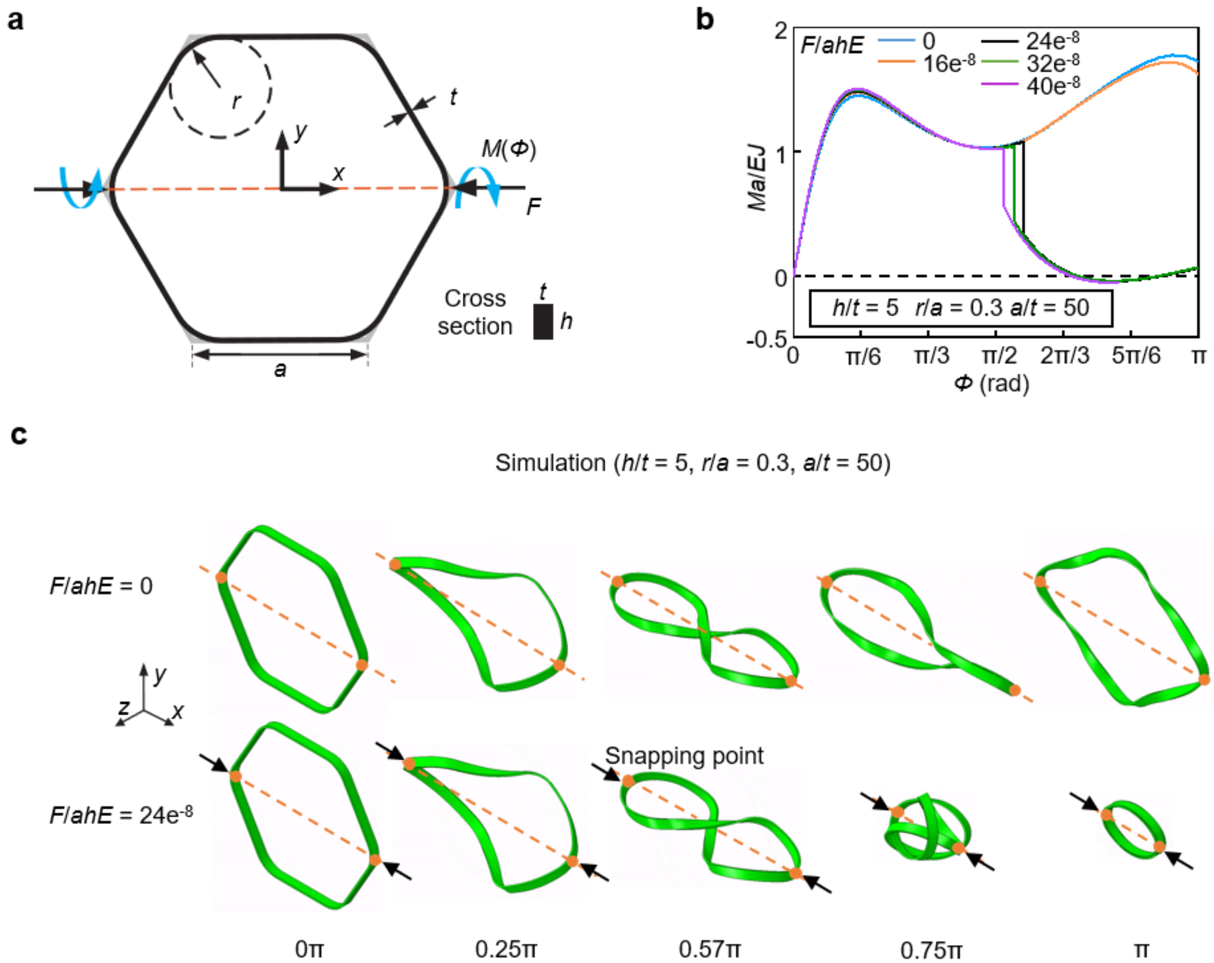

Fig S5. Twisting of a hexagonal ring ($h/t = 5$, $r/a = 0.3$, $a/t = 50$) without and with a small bending component. (a) Geometric parameters and loading conditions. The bending component is induced by adding a pair of modest pushing forces F on the corners where twisting is applied. The force is normalized as F/ahE, where a is hexagonal ring edge length, h is cross-section height, and E is the Young's modulus of ring material. (b) Normalized moment-twisting angle curves of folding the hexagonal ring with different pushing forces. (c) Folding processes of a hexagonal ring without and with adding the bending component.

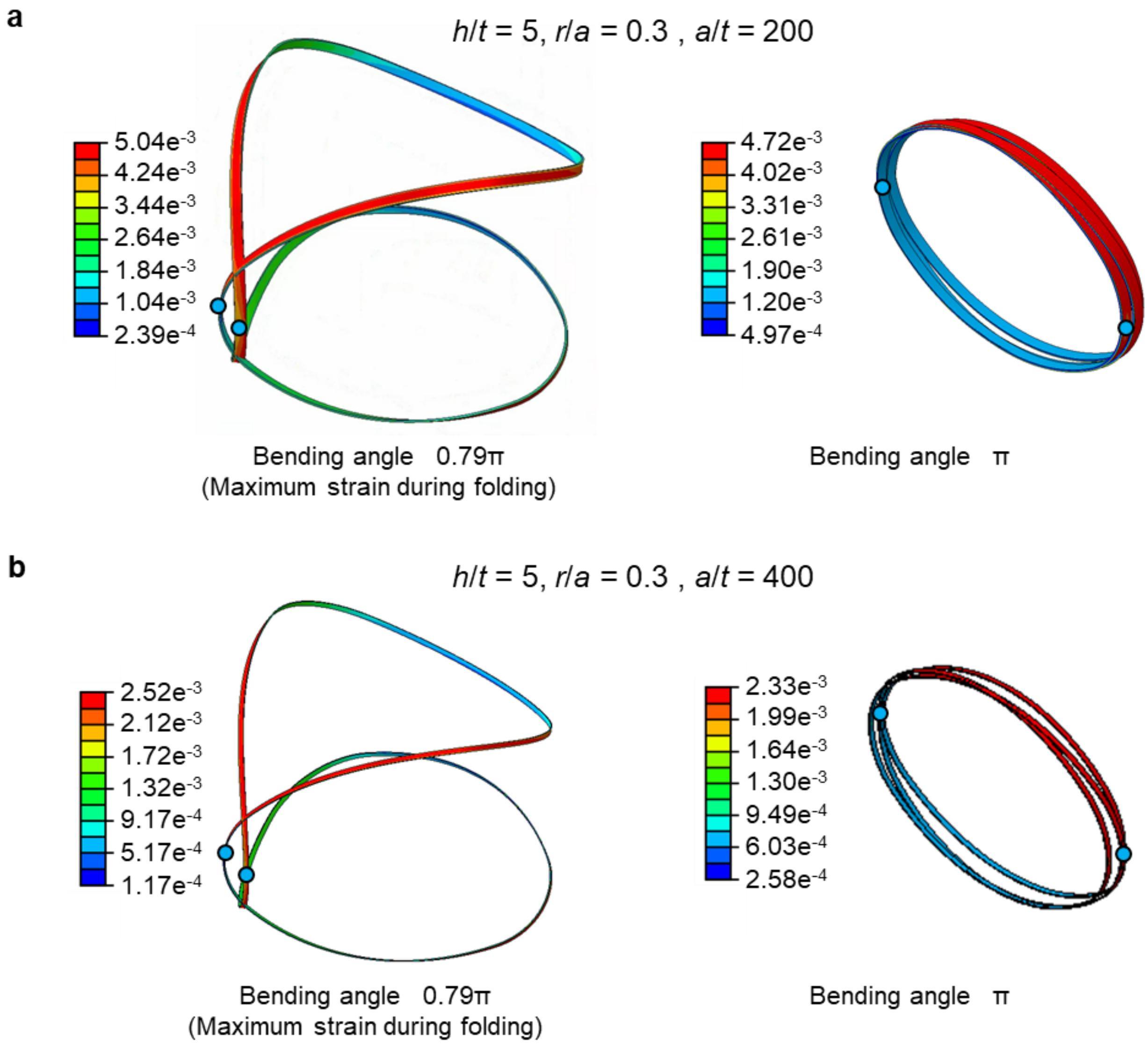

Fig. S6. Maximum principal strain contours of hexagon rings with a fixed cross-section and corner radius (h/t = 5, r/a = 0.3) and different sizes (a/t = 200 and 400) under bending at two corners (Blue dots). (a) Strain contours of the hexagon ring (a/t = 200) during the folding with the maximum strain 0.504%, and at the folded state with an average strain about 0.472%. (b) Strain contours of the hexagon ring (a/t = 400) during the folding with the maximum strain 0.252%, and at the folded state with an average about 0.233%. For both rings, the maximum strain locates at the loading location during the initial folding. Strain distributes uniformly across the ring with a decreased value at the folded state.

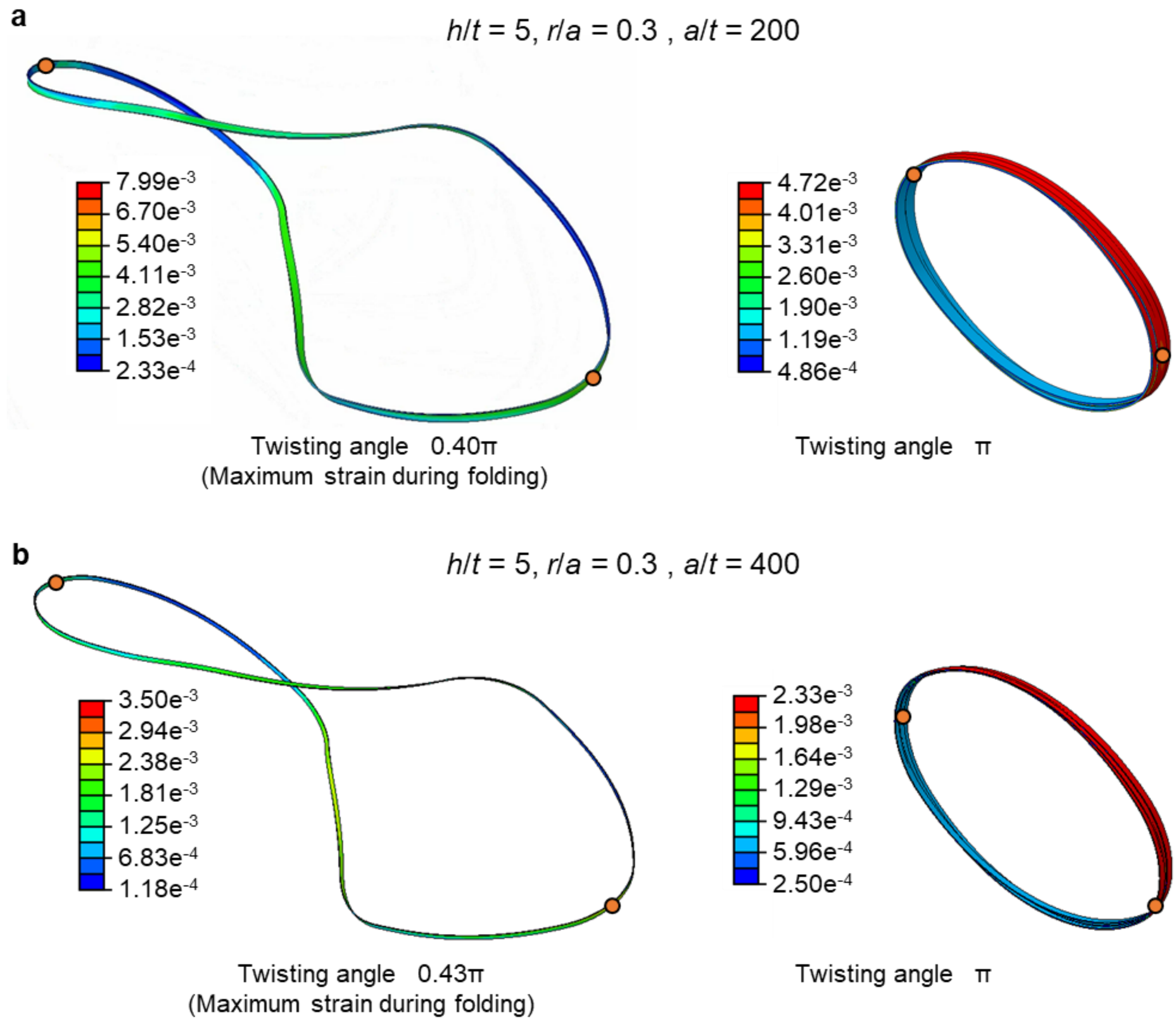

Fig. S7. Maximum principal strain contours of hexagon rings with a fixed cross-section and corner radius (h/t = 5, r/a = 0.3) and different sizes (a/t = 200 and 400) under twisting at two corners (Orange dots). (a) Strain contours of the hexagon ring (a/t = 200) during the folding with the maximum strain 0.799%, and at the folded state with an average strain about 0.472%. (b) Strain contours of the hexagon ring (a/t = 400) during the folding with the maximum strain 0.350%, and at the folded state with an average strain about 0.233%. For both rings, the maximum strain locates at the loading location during the initial folding. Strain distributes uniformly across the ring with a decreased value at the folded state.