Electronic Supplementary Material (ESI) for Soft Matter.

Supplementary Information for the paper: Programmable mechanics in confined biholar metamaterials

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I. SUPPLEMENTAL MATERIAL

In the following document we provide details accompanying the paper *Programmable Mechanical Metamaterials: the Role of Geometry.*

To understand the effect of the rate of deformations, we have performed a range of experiments with strain rates varying from 10^{-4} to 5 mm/s (Fig. S1). The results show that in a broad range of strain rates around 10^{-2} mm/s, spurious hysteresis is minimal. In experiments, a strain rate of 10^{-1} mm/s is chosen to minimize both the spurious hysteresis as well as the time it takes to perform a single experimental run. Moreover, the difference between the up and down sweep peaks when the samples quickly change their configuration, which suggest that viscous effects are responsible for this spurious hysteresis.

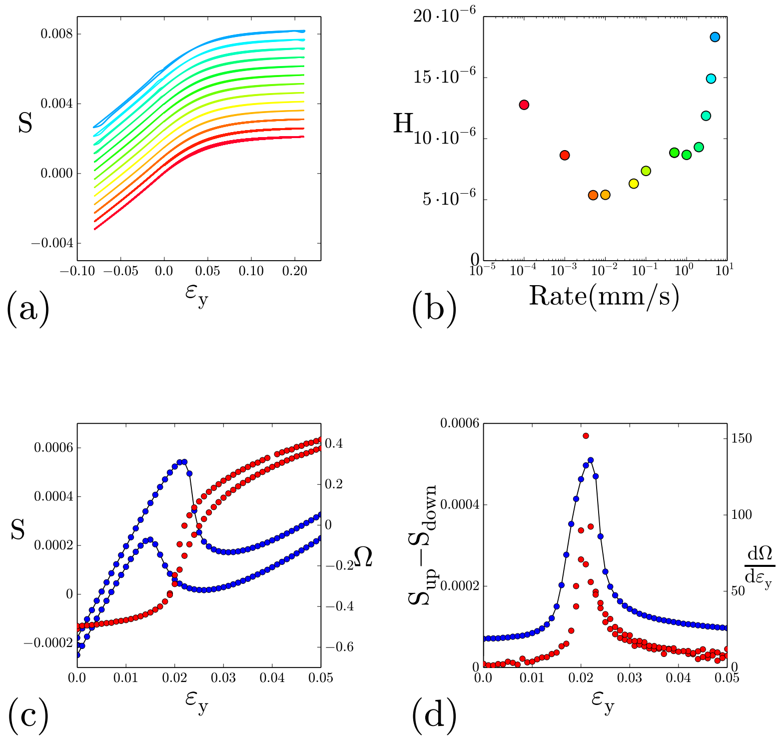

FIG. S1: (a) Effective stress-strain curves for samples with 5×5 holes, dimensionless thickness $\tilde{t} = 0.15$ and biholarity $\chi = 0.2$, for deformation rates varying between 10^{-4}- 5 mm/s (bottom to top). Curves are shown with a vertical offset for clarity. (b) Calculated hysteresis (area of the loop) as a function of deformation rate. (c) In blue the effective stress-strain curve for a samples with 5×5 holes, dimensionless thickness $\tilde{t} = 0.15$, biholarity $\chi = 0.2$ and $\varepsilon_x = 0.15$ (regime *ii*), measured at a strain rate of 10^{-1} mm/s. In red the polarization Ω of the central hole as a function of ε_y. (d) In blue the absolute difference in S during compression and decompression as function of ε_y, for the blue curve in (c). In red the derivative of the polarization $\frac{d\Omega}{d\varepsilon_y}$, for the red curve in (c), as a function of ε_y. The good correspondence of the peaks in both datasets strongly suggests that hysteresis is maninly due to weak viscous effects, which are most prominent when the sample quickly changes its configuration.

In the numerical simulations we apply horizontal confining strains to our samples by fixing the x-coordinates of a segment of the boundary holes of every even row. In Fig. S2, we show the effect of the arc length, S_c, of this segment. Increasing the arc length of the segment shifts the various regime transitions to lower values of ε_x. By a comparison to our experimental data, we find that an arc length of 1.1 mm (as used subsequently) gives the best fit, close to the actual dimension of the clamping rods used in the experiments, which have a diameter of 1.2 mm.

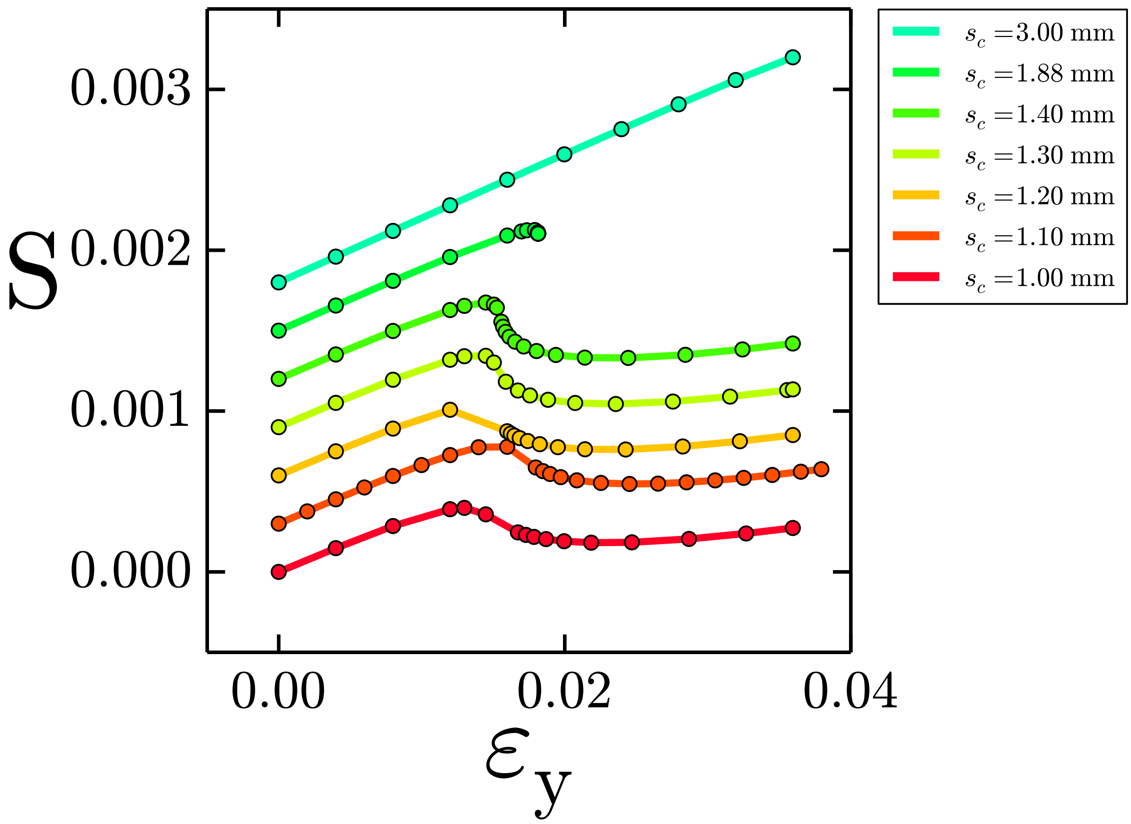

FIG. S2: Numerically simulated S(ε_y)-curves for a biholar sample with $\chi = 0.2$ and $t = 0.15$ with fixed $\varepsilon_x = 0.1584$. The arc length S_c of the segment of the boundary holes used to confine the sample is varied; $Sc = 1.10, 1.20, 1.30, 1.40, 1.88, 3.00$.