Electronic Supplementary Material (ESI) for Soft Matter.

Supplementary Information

Effect of internal architecture on microgel deformation in microfluidic constrictions

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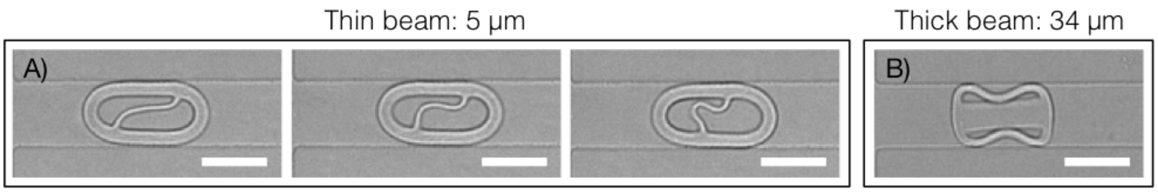

Figure S1. Altered deformation of particles with very thin and thick beams. A) Particle with 5 μm beam shows inconsistent deformation at ΔP = 1 psi. Images show three experiments with the same initial particle geometry, but different deformed beam configurations. B) Particle with 34 μm beam shows consistent deformation of the ring into a dumbbell shape. Scale bars are 75 μm.

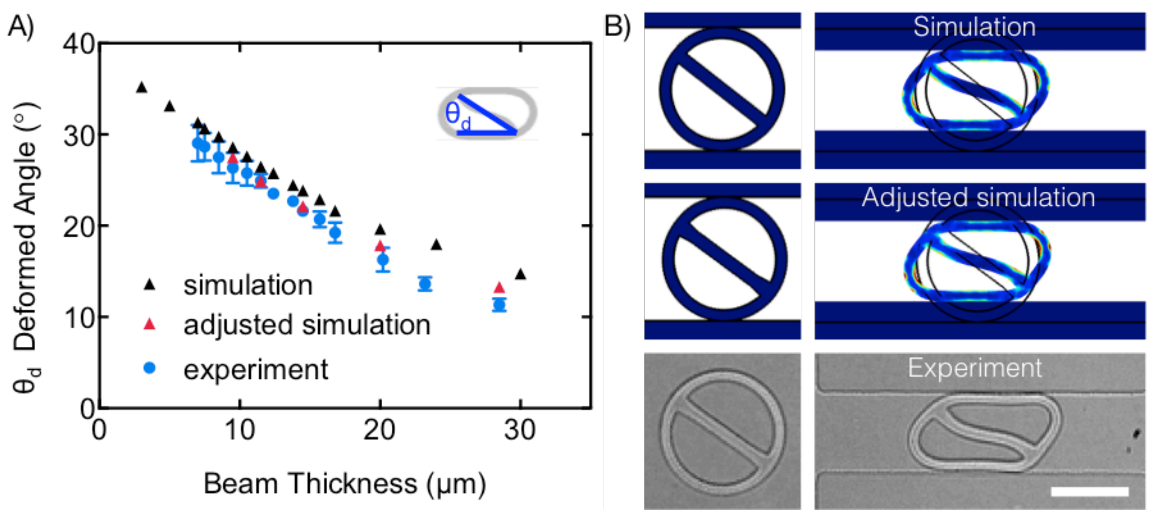

Figure S2. Adjusted simulation with thicker beam ends. A) Adjusted simulations account for the slight increase in beam thickness near the connection points with the ring, matching experimental geometries more closely. The plot shows that adjusted simulation results are a better match for experimental results. B) Corresponding images showing initial and deformed states for a particle with beam thickness of 11.5 μm. Scale bar is 75 μm. The following figure, S2-1, shows dimensions of the modified beam ends in the adjusted simulations.

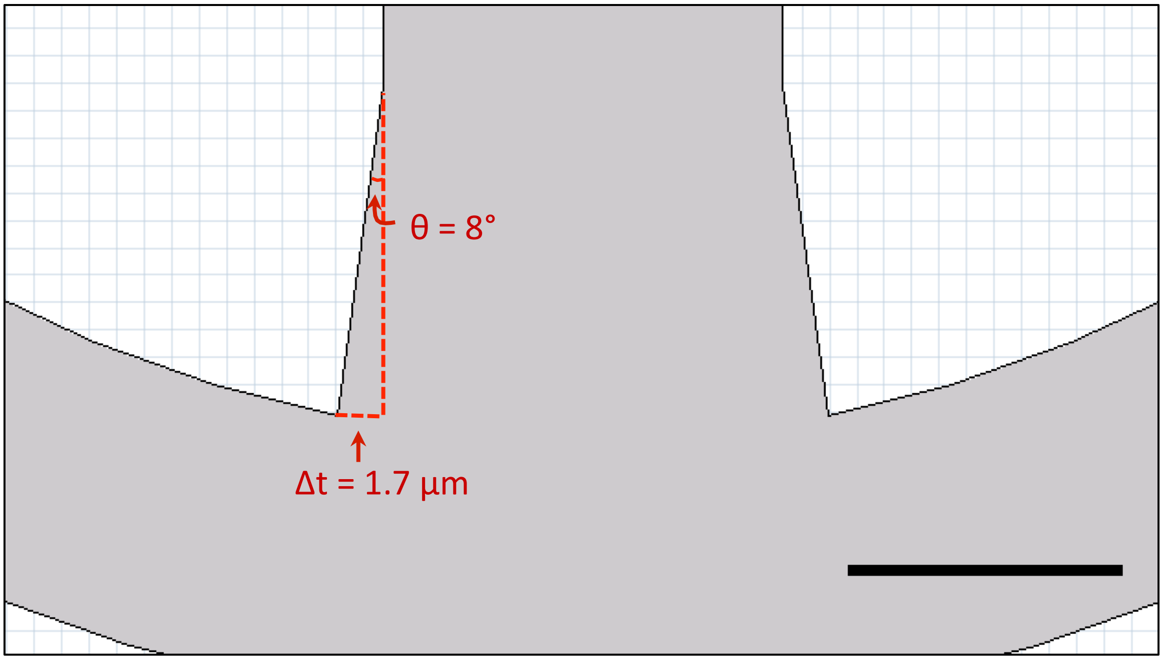

Figure S2-1. Close-up of beam end geometry in adjusted COMSOL simulations. The beam was described by a rectangle with flared ends at the connection points with the ring, compared to a simple rectangle in the original simulation. The angle and maximum thickness of the flared section was the same for all beam thicknesses, as determined by measurements from microscopy images. Scale bar is 10 µm.

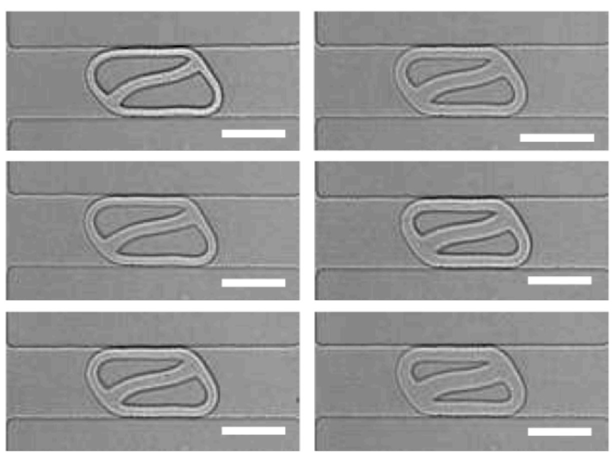

Figure S3. Overall particle shape depends on beam to ring ratio. Particles with the same beam to ring thickness ratio maintain the same overall deformed shape (rounded parallelogram), despite increasing feature thicknesses. Scale bars are 75 µm.

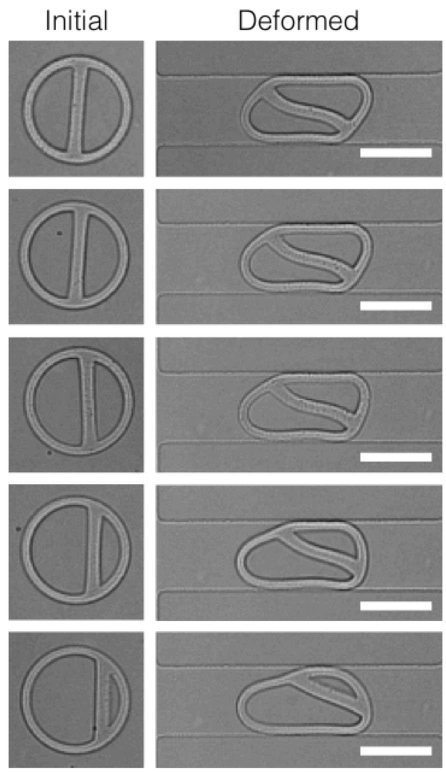

Figure S4. Beam offset controls deformed particle shape. Changing the offset of the internal beam can be used to tune the deformed particle shape. The contacting area between the particles and the sidewalls of the microfluidic constriction also changes. Scale bars are 75 µm.

Video S1. Latching particle “spring” design. Non-uniform outer ring design enables particle to maintain correct orientation for latching.

Video S2. Non-latching particle design. Uniform outer ring design does not help orient particle and no latching occurs.

COMSOL Model Detailed Workflow

1. **Set up**

- 3D
- Structural Mechanics | Solid Mechanics
- Stationary Study

2. **Create geometric objects**

- Use plane geometry to draw two-dimensional particle structure and PDMS walls using circle and rectangle shapes. Specify appropriate size, position, and rotation angle.
- Use boolean operations to create empty spaces (difference) or join multiple shapes (union).
- Extrude to desired height (i.e. particle height).
- Form an assembly.

3. **Specify material properties**

- Select appropriate domains and create a new material by manually inputting material properties (Young's modulus, Poisson's ratio, density), or select a predefined material.
- Select nearly incompressible material (since Poisson's ratio is > 0.45).

4. **Define physics and boundary conditions**

- Specify movement of compressing PDMS walls by adding a prescribed displacement.
- Define contact pairs for contacting boundaries between the particle and the PDMS walls. The stiffer material (i.e. PMDS) is the source and the less stiff material (i.e. hydrogel particle) is the destination.
- Add static coulomb friction to the contacting boundaries and specify the friction coefficient.
- All remaining boundaries are free (no constraints and no loads).
- Initial values for displacement and velocity are set to zero.

5. **Create mesh**

- Physics-controlled mesh
- Finer element size

6. **Run the simulation**