Curvature of Light Responsive, Shape Memory Polymers for the Production of Biologically-Inspired, Functional Devices

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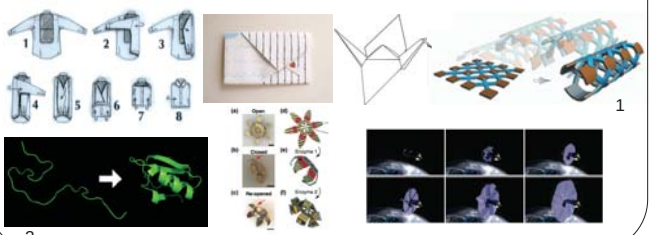
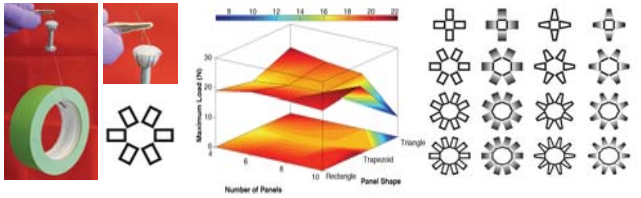
Folding Examples and Applications



Natural Materials Inspiration

Functional Grippers

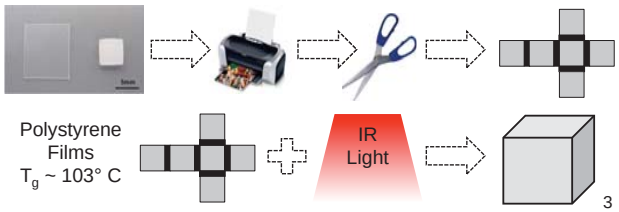
General shape recovery response is independent of array count.



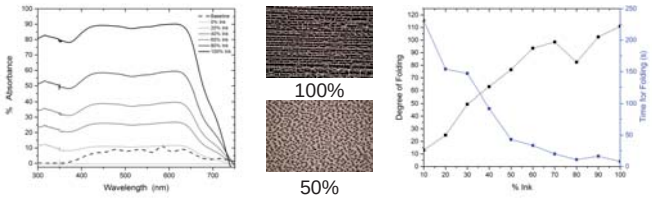
Structures have been shown to maintain > 17,000x their own mass!

Folding Mechanism & Ink Contribution

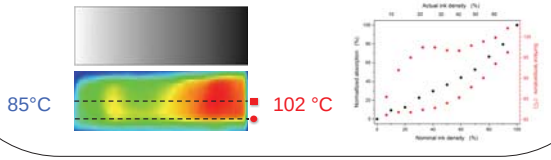
Folding is achieved readily and with common materials.



Ink density is directly related to folding response.

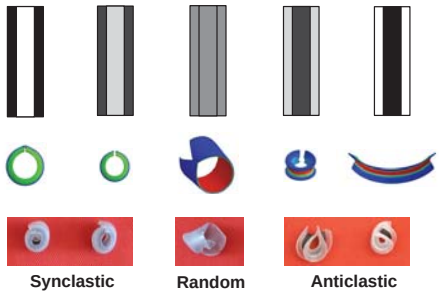


Ink density and sample temperature are directly related.

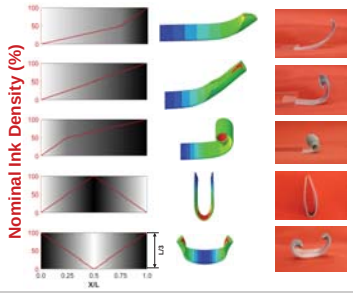


Global Curvature Control

Indirect Mechanism for Out-of-Plane Deformation



Direct Mechanism for Out-of-Plane Deformation

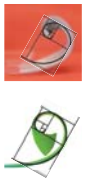


Conclusions

1. Ink density and distribution directly impacts light absorbance, final degree of folding, and onset time of folding.
2. Global curvature control is achieved by manipulation of aspect ratio and distribution of shrinkage.
3. Functional devices, such as grippers, are generated demonstrating applicability and overall strength of materials.
4. Excellent qualitative and quantitative agreement between experimental and computational outcomes demonstrate the predictive capabilities of our system.

Future Work

- Perform a systematic study to determine the impact of sample geometry, ink distribution, and ink density upon the strength of functional grippers.
- Determine critical features required for Golden Spiral production.
- Determine the critical inked surface area coverage required for two-step curvature.
- Generate and optimize the production of spherical objects.



Hypothesis and Goals

- Global curvature is dependent upon sample geometry, ink distribution, and ink density.
- Controlled global curvature will allow for the production of functional, strong devices.
- Finite element modeling provides a predictive tool for bio-inspired and functional devices.

Bio-Inspired Structures

Three-dimensional point clouds confirm excellent qualitative agreement between computational and experimental results.

Acknowledgements

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1. Randall *et. al.*, Trends in Biotech., 2012
2. Images from WWW
3. Liu *et. al.*, Soft Matter, 2011
4. Hubbard & Mailen *et. al.*, Soft Matter, 2017