Students' Diary

Additive Manufacturing of Miura Fold - An Origami Structure

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Additive Manufacturing, especially three-dimensional printing, is a method to print three-dimensional objects with the help of computer-aided design in layers. It enables us to produce very complex shapes or geometries that would be otherwise impossible to construct by hand, including hollow parts or lattice structures, or parts with internal truss structures.

But here we came up with a brand-new idea to 3D print an Origami based Deployable structure, which can reconfigure its shape and change its volume through folding and unfolding in a controllable manner. Recently, there has been a growing interest in creating novel deployable structures and devices for high-performance engineering applications, such as solar panels and antennae for space, civil architectures, robotics, and healthcare.
3D printing facilitates advanced design exploration, which we have used for printing Origami fold patterns. Conventionally, such structures are manufactured by the Synchronous folding process, the Gradual folding process, the Pre-gathering process, or Cold gas-pressure folding. Usually, origami-based structures are designed on the premise of 'rigid foldability', i.e., Sthe facets and fold lines of origami can be replaced with rigid panels and ideal hinges, respectively.

We are introducing a novel manufacturing technique by 3D printing- a particular Origami structure- A Miura fold. We have used Thermoplastic Polyurethane [TPU] as the material for printing. TPU is a category of plastic that is created when a polyaddition reaction occurs between di-isocyanate and one or more diols. It is super easy to print with; virtually all 3D printers can print this material. It has rubber-like elasticity, high tear and abrasion resistance, high elongation at break, and thermal stability.

The 3D-printed Miura fold as illustrated in **Figure 10** can be twisted into a saddle-shaped configuration with a negative global Gaussian curvature. Also, it assumes a saddle-shaped configuration under out-of-plane bending which is typical behavior for materials with a positive Poisson's ratio. It exhibits Positive Poisson's ratio under out-plane deformations and a Negative Poisson's ratio under in-plane deformations.

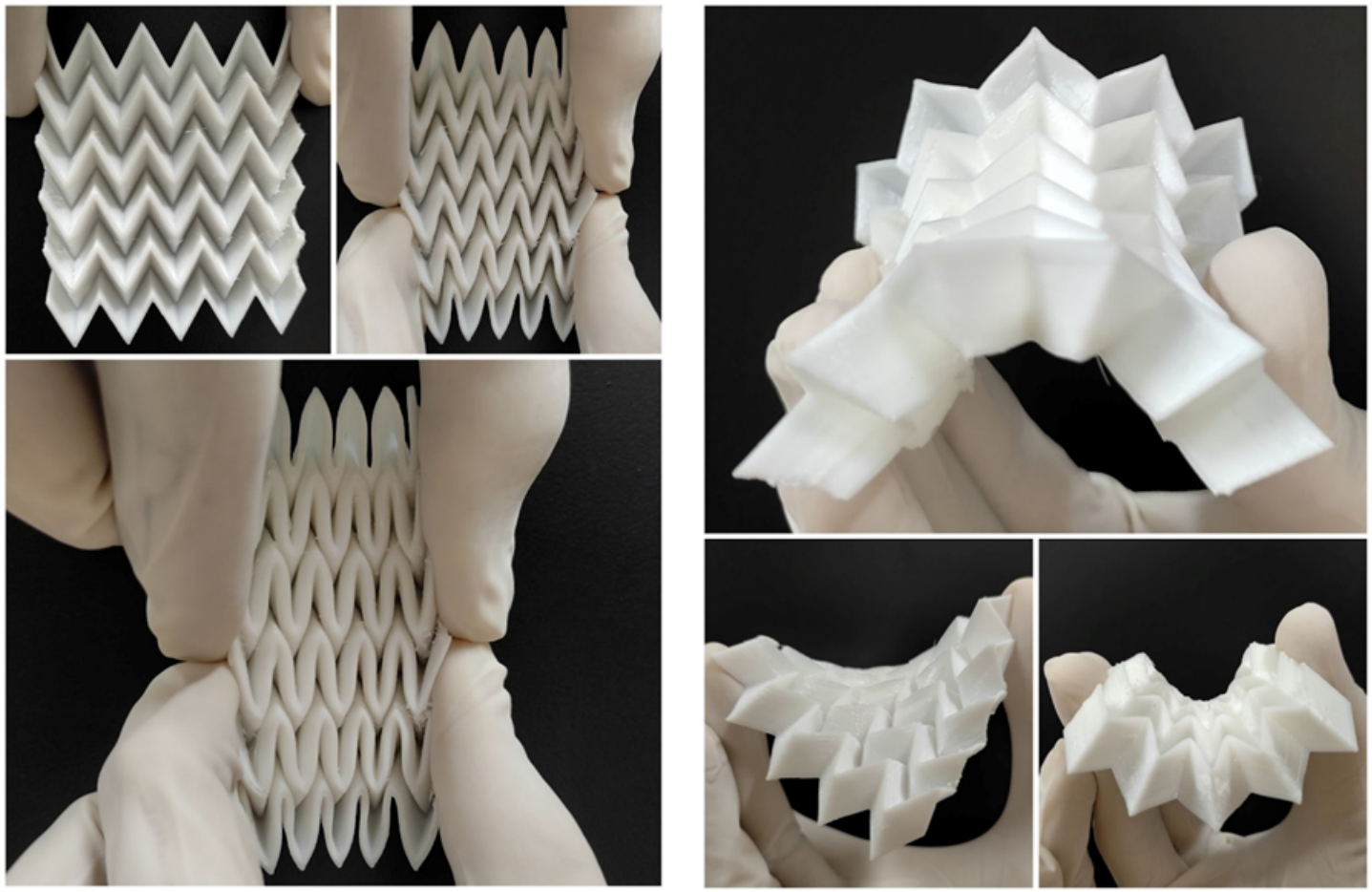

Figure 10: Additive Manufacturing of Miura Fold - An Origami Structure illustration Images