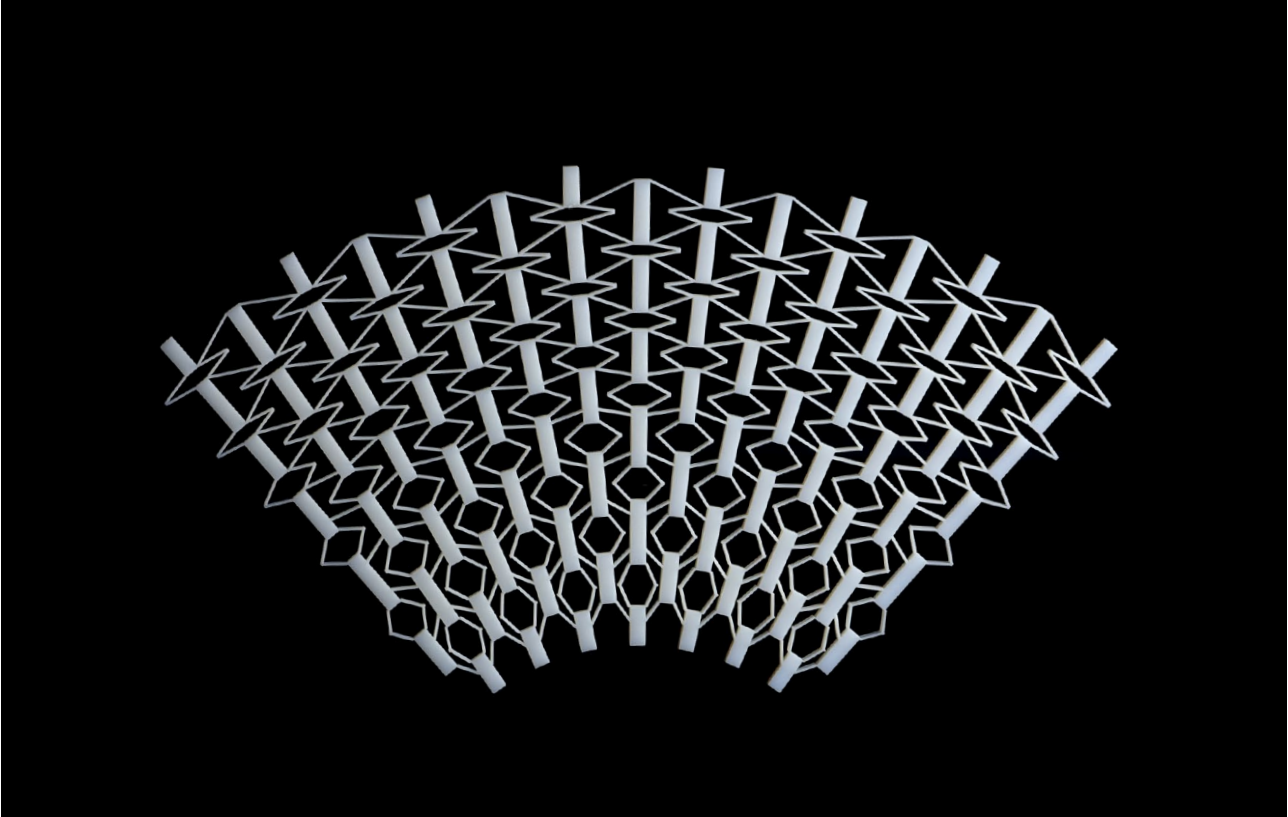




Pre-programmed deformable material

Taisuke Ohshima, Tomohiro Tachi, Yasushi Yamaguchi



Taisuke Ohshima, Tomohiro Tachi, Yasushi Yamaguchi “Pre-programmed deformable material” 2017, Material: VeroWhite, Size: 320.1W x 181.5D x 6.6H (mm)

“Pre-programmed deformable material” is a material which transforms into preprogrammed shape. It’s flexible in one preprogrammed deformation but stiff in the other deformation. The transformation into freeform curved surfaces from flat state is difficult because it should have three different Poisson’s ratio within one material. The Poisson’s ratio is related to Gaussian curvature in surfaces of deformation, ie. positive Poisson’s ratio realizes curved surfaces whose Gaussian curvature is negative and negative Poisson’s ratio realized curved surfaces whose Gaussian curvature is positive. Proposed material has explicitly distributed Poisson’s ratio and realizes double curved freeform surfaces.



Description

We propose structures to transform into preprogrammed surfaces (Figure 1). Submitted material is the structure that transforms into torus. The torus is a surface with three Gaussian curvatures (K), negative, zero and positive. If the deformation shape is $K \leq 0$ such as saddle shape or developable surfaces, materials must have positive poisson's ratio. However, if $K > 0$ such as dome shape, materials must have negative poisson's ratio (Figure 2).

Proposed material has combined three Gaussian curvatures and corresponding three poisson's ratio. In order to generate this structure, we developed original software. This software is the system to generate structure from target shape. Target shape is defined by principal curvature lines. Generated structure naturally transforms into target shape from simple external force.

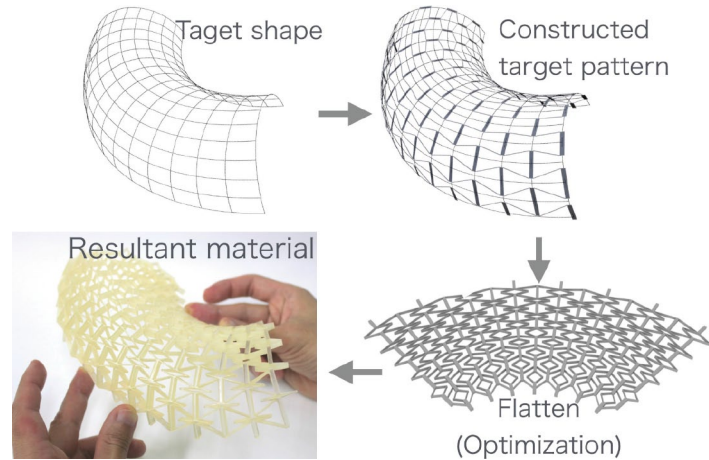


Figure 1: Proposed structure

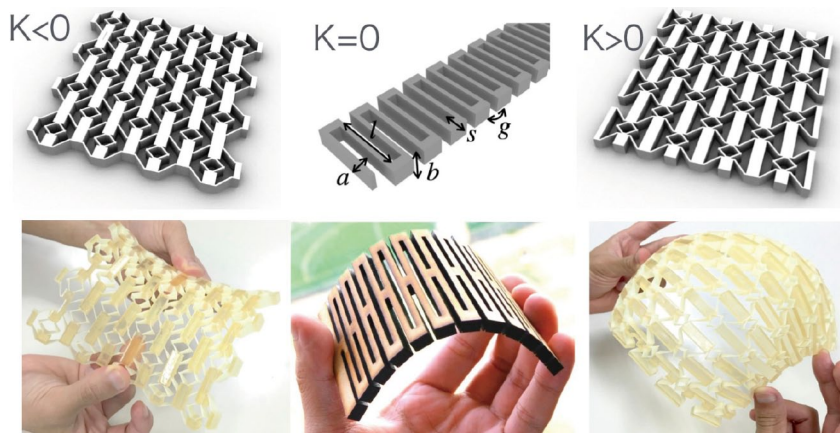


Figure 2: Three structures used in proposed materials. K is Gaussian curvature.