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Novel Shape Morphing Strategy of Plastic Films via Peeling

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ABSTRACT

Three-dimensional (3D) architectures and related devices have been widely concerned in recent years due to their unique geometrical advantages and superior performance. Existing approaches to transforming planar thin films into 3D architectures require the use of active materials [1,2] or need substrates to maintain 3D shapes [3,4]. Here, we propose a peeling-induced shape morphing strategy to construct freestanding 3D architectures from 2D plastic films including inert polymers, such as polyethylene terephthalate (PET) and polyimide (PI), which are significant substrate materials for flexible electronics. The plastic strains generated by peeling the film from an adhered plane can be programmed by controlling relevant parameters with the help of developed theoretical models which are verified by finite element calculations and experiments. The peeling angle and deviation angle are two key parameters to form different types of architectural morphologies. Complex 3D structures with permanent shapes and free from substrate can be obtained by using appropriate combined peeling operations. The proposed shape morphing strategy creates 3D structures of dimensions down to micrometers and can be applied to a wide range of plastic materials such as polymers and metals. The 4D transformation is achieved by introducing responsive materials into the peeling-induced shape morphing. In addition to the applications in flexible electronics devices, a piezoelectric energy harvest system with high efficiency is designed by utilizing 3D architectures enabled by peeling.

KEYWORDS

Shape morphing; peeling; plastic thin film; flexible electronics

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