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# Nonfolding Origami lattice for energy dissipation and strength

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## Abstract

Origami, an ancient art primarily used in festivities in East Asian cultures, has found new applications in engineering over the past three decades. Among these, triangulated Origami (also known as Kresling springs) stands out due to its unique uniaxial and rotational coupling. In fact, there has been a surge of studies delineating the fundamental aspects of making this Origami, analyzing its underlying mechanics, and applying it in real-world engineering contexts. However, many of the proposed, particularly niche, solutions remain in the conceptual or proof-of-concept stages at best, often utilizing primitive paper-based designs. Recently, a two-phase material version of the Kresling spring has proven effective, making it functional, robust, and reliable while maintaining the behavior of its paper-based counterpart. In this study, we focus on a unique region within the design space of the Kresling spring, where the edges of the Origami are not easily foldable, and the entire structure is instead made from a single-phase flexible material. This design induces a spring-like behavior that can exhibit either a linear or nonlinear response. The exact response can be fully customized via the geometric parameters. We propose using this stiffer and less foldable version of the Kresling spring to create a cubic anisotropic unit cell, which forms a three-dimensional (3D) lattice material. The strength and energy absorption and dissipation are determined by the twisting action of the spring under uniaxial compression, which results in stiff contact friction between the panels. The intersection of these springs forms an intentional jagged core. When the extended panels reach the end of their rotational range, the jagged core of adjacent unit cells interlocks, providing an additional strengthening and toughening mechanism.

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