
Bending properties of kirigami sheets

Lucie Domino^{*1,2} and Joel Marthelot³

¹Institut universitaire des systèmes thermiques industriels – CNRS – France

²laboratoire IUSTI – Aix Marseille Université (Aix-en-Provence) – France

³IUSTI – CNRS, Aix-Marseille Université - AMU – France

Abstract

‘Kirigami’ is a Japanese art form that comes from the words ‘kiri’ (to cut) and ‘kami’ (paper). While in the traditional art the goal is to obtain very intricate objects that can pop out beautifully, in the scientific literature it usually designates thin sheets that are pre-cut using a staggered pattern of slits. These kirigamis have been widely studied because of their very rich mechanical response when stretched as well as their numerous applications in adaptable solar panels (1) or shape morphing structures (2, 3) for instance.

Despite this extensive scrutiny, the bending properties of kirigami sheets have so far been overlooked. Here, we study thin sheets pre-cut with a staggered pattern of slits and measure their deflection due to gravity. We model their shape using a heavy elastica equation, and from this, extract the effective bending modulus of the kirigami sheets. We then study how the bending modulus depends on the geometric properties of the kirigami (size of the slits and spacing of the pattern).

Our work provides new insights into the mechanical behavior of kirigami structures, and opens up possibilities for their application in areas where controlling the bending properties is critical.

(1) A. Lamoureux et al. Dynamic kirigami structures for integrated solar tracking, Nat. Com., 2015

(2) Y. Zhang et al., Shape-morphing structures based on perforated kirigami, EML, 2022

(3) P. Celli et al., Shape-morphing architected sheets with non-periodic cut patterns, Soft Matter, 2018

*Speaker