
Mechanics of Metallic Kirigami-based Energy-Dissipating Devices

Martin Walker^{*1}, Sahand Khalilzadehtabrizi², Iman Mohagheghian², and Amanpreet Singh¹

¹Durham University – United Kingdom

²University of Surrey – United Kingdom

Abstract

Kirigami, the Japanese art of paper cutting, can be used to generate complex 3D shapes from 2D sheets. Kirigami structures can also be highly stretchable and accommodate extremely large strains when made from common materials, such as aluminium alloys, which allow relatively small strains at failure. The high stretchability of Kirigami makes it an ideal basis for energy dissipation applications. We will present an investigation into the mechanics of Kirigami sheets made from metallic materials. We derive a reduced-order model, using a simple yield-line mechanism analysis, which shows the behaviour is governed by a single dimensionless parameter related to the geometry of a unit cell. This is confirmed by a combination of finite element analysis and laboratory experiments. Furthermore, we present early results describing the strain-rate sensitivity of these metallic kirigami structures. The results of this study will enable the efficient design of novel energy-dissipating devices acting in tension.

^{*}Speaker