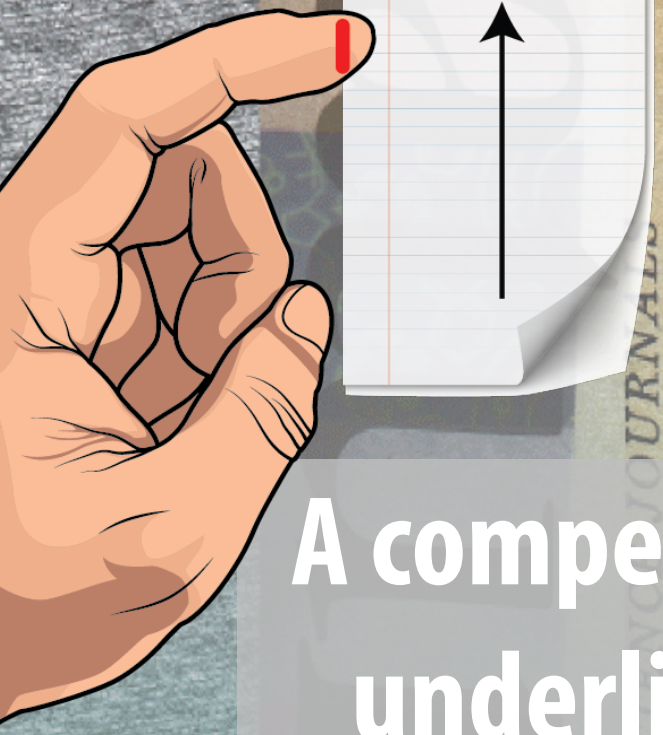

A competition between slicing and buckling underlies the erratic nature of paper cuts

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THE PAPER CUT PARADOX: Explaining why thin paper does not cut

Paper cuts are a common injury that can cause significant pain and discomfort [1]. Surprisingly, the physics underpinning a thin flexible sheet of paper slicing into soft tissues remains unresolved. (Other cases, such as chess-wire cutters, have been described; e.g., [2].) In particular, the unpredictable occurrence of paper cuts, often restricted to a limited thickness range, has not been explained.

Here, we visualized and quantified the motion, deformation, and stresses during paper cuts, uncovering a remarkably complex relationship between cutting, geometry, and material properties [3]. A model based on the hypothesis that competition between slicing and buckling controls the probability of initiating a paper cut was developed and successfully validated.

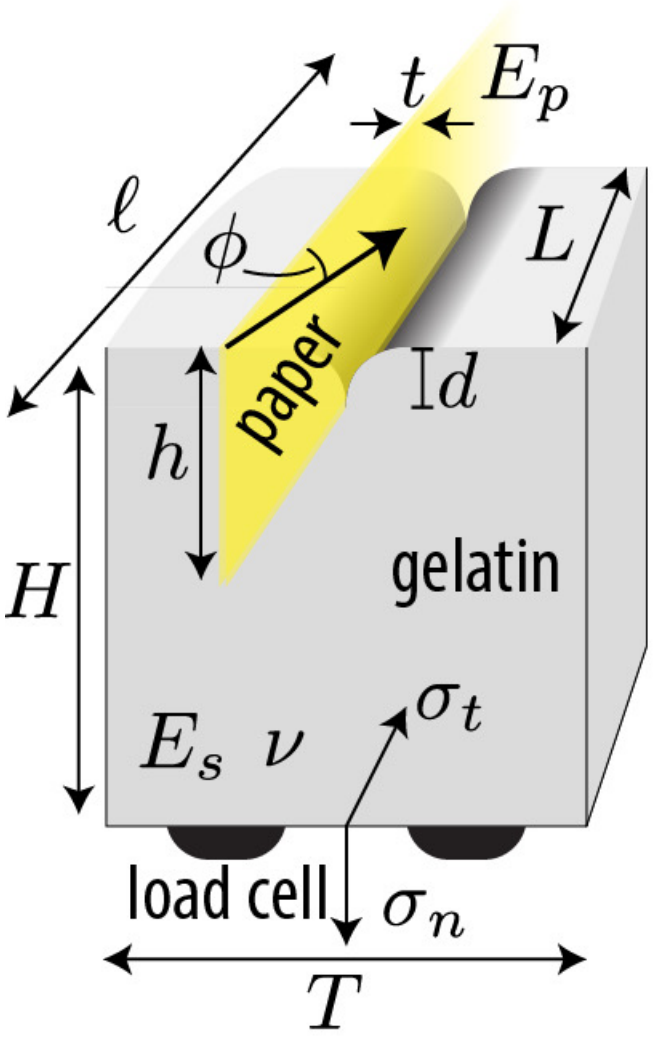
Our study reveals why paper with a specific thickness is most hazardous (≈65 µm, corresponding, e.g., to dot matrix paper or printed scientific journals). Based on our results, we developed the *Papermachete*, a cost-effective paper-based scalpel. It uses scrap paper blades and can easily cut vegetables and meat. To 3D print your own, use the files accessible here.

Website: www.papermachete.org
Email for correspondence: khjensen@fysik.dtu.dk

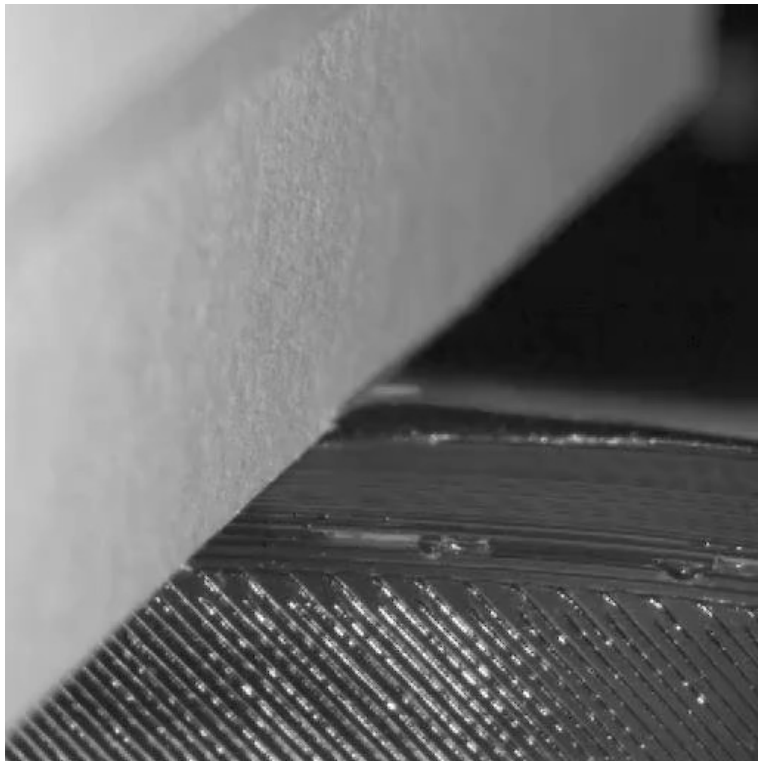
References

[1] Mirsky, S., The unkindest cut, Scientific American 306, 80, 2012
[2] Reyssat, E., Tallinen, T., Le Merrer, M., & Mahadevan, L. Slicing softly with shear. Physical review letters, 109(24), 244301, 2012
[3] Arnbjerg-Nielsen S. F., Biviano M. D., & Jensen, K. H., Competition between slicing and buckling underlies the erratic nature of paper cuts, Physical Review E (2024) www

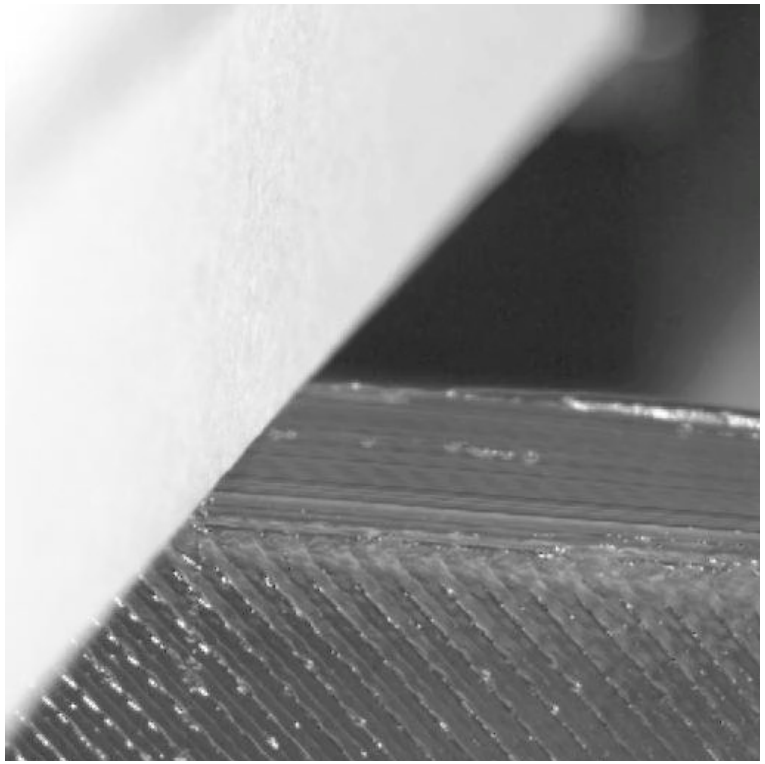
We built a paper cutting machine



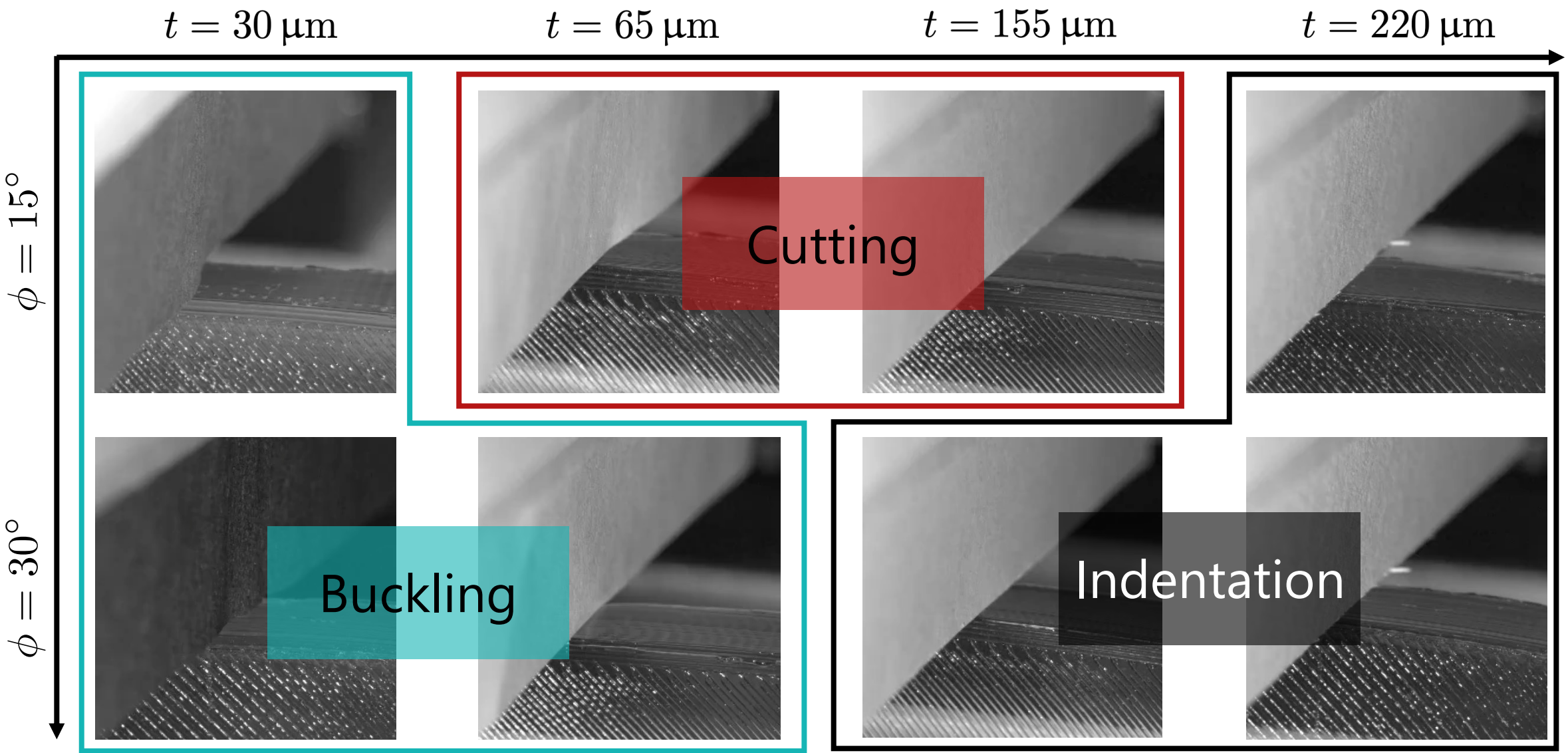
$\phi = 5°$



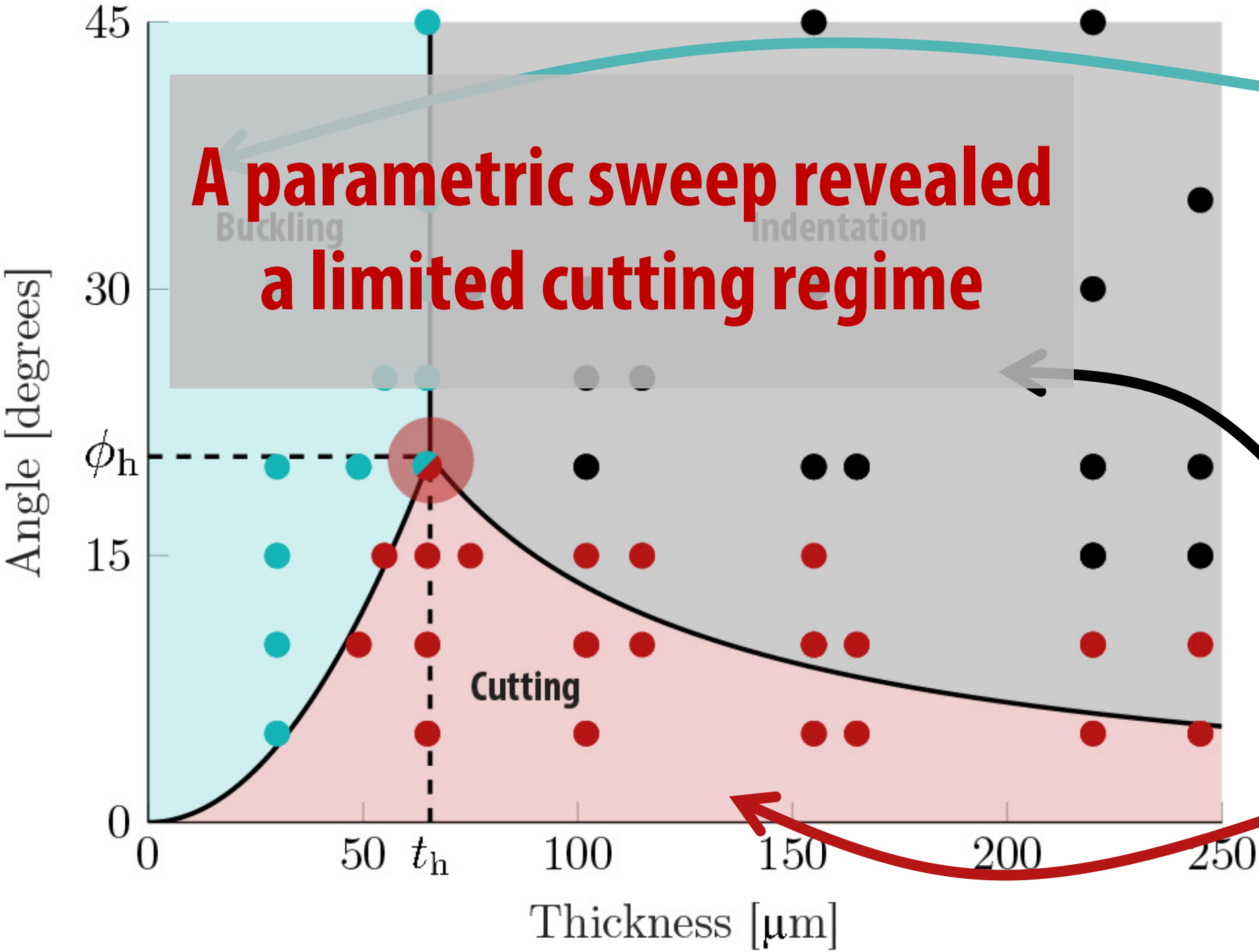
$\phi = 90°$

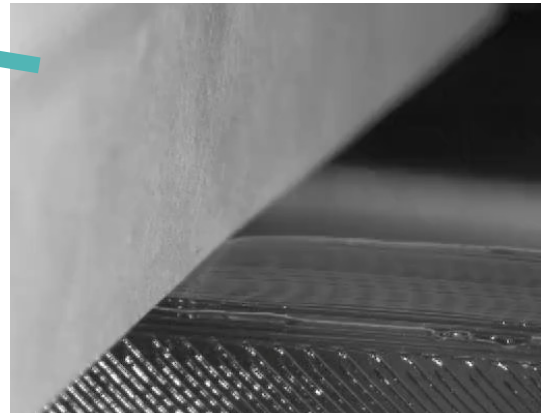


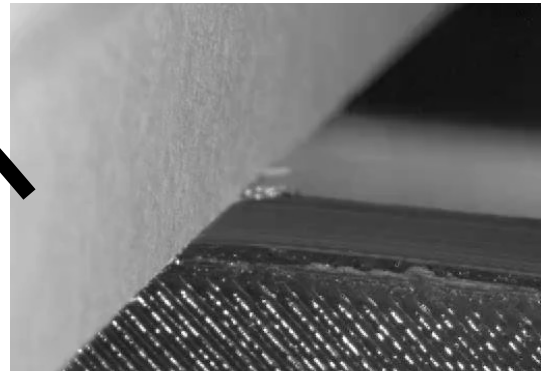
… revealing when buckling, indentation and cutting occurs

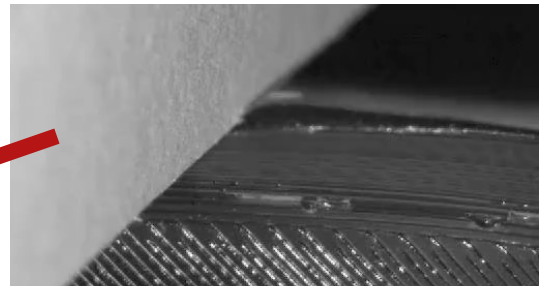


A parametric sweep revealed a limited cutting regime



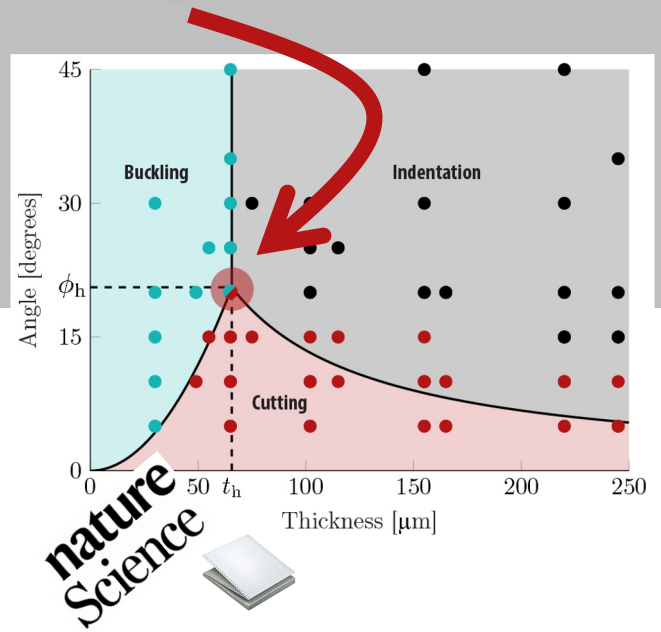


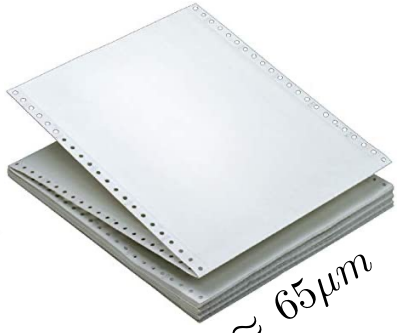




And the most hazardous thickness: 65 µm

This is close to dot-matrix printer paper,
but the journals *Nature* and *Science* are also dangerous…





Science
$t \approx 55\,\mu m$

$t \approx 65\mu m$

nature
$t \approx 50\,\mu m$

2 1 3

THE PAPERMACHETE

Based on our results, we developed the *Papermachete,* a cost-effective paper-based scalpel. It uses scrap paper blades and can easily cut vegetables and meat.

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