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Tearing graphene sheets from adhesive substrates PEDRO REIS, Department of Mathematics, MIT, DIPANJAN SEN, Civil and Environmental Eng. and Materials Science. and Eng., MIT, KOSTYA NOVOSELOV, School of Physics & Astronomy, University of Manchester, Manchester, UK, MARKUS BUEHLER, Civil and Environmental Eng., Massachusetts Institute of Technology, Cambridge, MA, USA — Graphene, the first example of a truly two-dimensional atomic crystal, is the ultimate "tinniest" of all thin films and it exhibits exceptional electronic and mechanical properties. We perform a combination of experiments and molecular dynamics simulations to study the tearing of graphene sheets from adhesive substrates. Under tearing loading, we observe the formation of tapered ribbons whose geometry is controlled by the adhesion energy between graphene and the substrate, and by the number of layers of the torn graphene sample. We find good agreement between the predictions of the molecular modeling and experimental results. In particular, for the case of a single graphene layer, the analysis of the tearing angle as a function of the adhesion strength shows a drastic departure from conventional thin film tearing theory; the release of elastic stretching energy stored in the sheet becomes the driving force for the tapering of the torn ribbon. This behavior is attributed to the two-dimensional nature of graphene, which results in a bending modulus that is much lower than that predicted by continuum theory.

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