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Nonlinear Mechanics of Polycrystalline Two-Dimensional Materials such as Graphene RYAN COOPER, ADAM HURST, ALEXANDRA HAMMERBERG, GWAN-HYOUNG LEE, CHRISTOPHER MARIANETTI, Columbia University, XIAODING WEI, Northwestern University, CHANGGU LEE, Sungkyunkwan University, BRYAN CRAWFORD, Nanomechanics, Inc. , JAMES HONE, JEFFREY KYSAR, Columbia University, COLUMBIA UNIVERSITY TEAM — Two-dimensional films such as graphene can potentially exist as pristine crystals. These crystals present a unique opportunity to design unique experiments that uncover intrinsic material properties. Recent experimental studies have shown graphene is the strongest material ever measured. An Agilent G200 nanoindenter and Park Systems atomic force microscope are used in this study to make measurements of the mechanical response of graphene and other two-dimensional materials. Chemical vapor deposition is employed to manufacture graphene. The mechanical properties of the chemical vapor deposited graphene is compared to that of pristine graphene. Experiments investigate the elastic response up to the point of fracture. These suspended sheets are probed using atomic force microscopy and nanoindentation. The experimental work is modeled using first-principles density functional theory and finite element analysis. Previous work has shown that density functional theory and finite element analysis accurately predicts the breaking force of graphene and molybdenum disulfide. This work also explores the probability of fracture using a generalized form of the Weibull modulus in finite element analysis.

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