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Elastic coupling between the layers in 2D films YANG GAO, SI ZHOU, School of Physics, Georgia Institute of Technology, SUENNE KIM, Department of Applied Physics, Hanyang University, HSIAN-CHIH CHIU, National Taiwan Normal University, DANIEL NÉLIAS, Université de Lyon, CNRS, INSA-Lyon, LaMCoS, CLAIRE BERGER, WALT DE HEER, School of Physics, Georgia Institute of Technology, ROMAN SORDAN, LAURA POLLONI, L-NESS, Department of Physics, Politecnico di Milano, ANGELO BONGIORNO, ELISA RIEDO, School of Physics, Georgia Institute of Technology — Two-dimensional (2D) materials, such as graphene and graphene oxide, are a few-atomic-layer thick films with strong in-plane bonds and much weaker inter-layer interactions. While their in-plane elasticity has been widely studied in bending experiments where a suspended film is largely deformed, very little is known about their elastic modulus perpendicular to the planes. Investigations of the out-of-plane elasticity require indenting supported 2D films less than their interlayer distance. Here, we report on sub-Å-resolution indentation measurements of the perpendicular elasticity of 2D materials. Experiments, combined with semi-analytical models and density functional theory are used to study the perpendicular elasticity of a few-layers thick graphene and graphene oxide films. Interestingly, we find that the graphene oxide perpendicular Young's modulus reaches a maximum when one complete water layer is intercalated between the graphitic planes then the perpendicular Young's modulus decreases because a second water layer starts to form in between the layers further swelling and softening the GO structure.

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