Tensile tests on single graphene layers

Maria F. Pantano[1], Giorgio Speranza[2,3,4], Nicola M. Pugno[1,2,5]

[1]Laboratory of Bio-Inspired & Graphene Nanomechanics, Department of Civil, Environmental and Mechanical Engineering, University of Trento, Via Mesiano 77, 38123 Trento, Italy
[2]Center for Materials and Microsystems, Fondazione Bruno Kessler, Via Sommarive 18, 38123 Povo (TN), Italy
[3]Istituto Fotonica e Nanotecnologie – CNR, via alla cascata 56, 38123 Trento, Italy
[4]Department of Material Engineering, University of Trento, Via Mesiano 77, 38123 Trento, Italy
[5]School of Engineering and Materials Science, Queen Mary University of London, Mile End Road, London E1 4NS, U.K.

nicola.pugno@unitn.it

Abstract

Owing to its outstanding electrical, mechanical, optical and thermal properties, graphene is considered the key material for next generation electronics [1-2]. The design of high performance yet reliable devices requires a deep understanding of its mechanical behavior. Unfortunately, while a number of computational and theoretical studies have been proposed [3-5], up to date availability of experimental data is still limited, with no information about graphene strength measured through a tensile test. In fact, the unique 2D topology of such material while being the key to its unprecedented behavior poses many issues to successful testing. For example, it is challenging to manipulate completely free-standing samples and fix them for a standard tensile test.

In the present paper we address such main issue through the fabrication of a novel device able to perform direct tensile tests on samples, like single atomic layers, initially deposited onto a substrate. In order to demonstrate the validity of the present device, this is first applied for the mechanical characterization of micro and nanospecimens, such as aluminum microwires (18 µm diameter) and ultra thin films (800 nm thickness). The results derived from our device are then compared to those obtained through a commercial nanotensile testing machine, showing good agreement. Finally, the device is applied for tensile testing of a single graphene layer, providing results in good agreement with the predictions of atomistic simulations and nano indentation membrane experiments (see review [6]).

References

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