Mechanical properties of freely suspended atomically thin dielectric layers of mica

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Abstract

We study the elastic deformation of freely suspended atomically thin sheets of muscovite mica [1][3] (see Figure 1), a widely used electrical insulator in its bulk form. Using an atomic force microscope, we carried out bending test experiments [1,2] (see Figure 2) to determine the Young's modulus and the initial pre-tension of mica nanosheets with thicknesses ranging from 14 layers down to just one bilayer. We find that their Young's modulus is high (190 GPa), in agreement with the bulk value which indicates that the exfoliation procedure employed to fabricate these nanolayers does not introduce a noticeable amount of defects. Additionally, ultrathin mica presents low pre-strain and it can stand reversible deformations up to tens of nanometers without breaking. The low pre-tension and high Young's modulus and breaking force found in these ultrathin mica layers demonstrates their prospective use as complement for graphene in applications requiring flexible insulating materials or as reinforcement in nanocomposites.

References

[1] A. Castellanos-Gomez et al., Nano Research (accepted) 2012.
[2] A. Castellanos-Gomez et al., Advanced Materials, **24** (2012) 772-775.
[3] A. Castellanos-Gomez et al., Small, **7** (2011) 2491-2497.

Figures

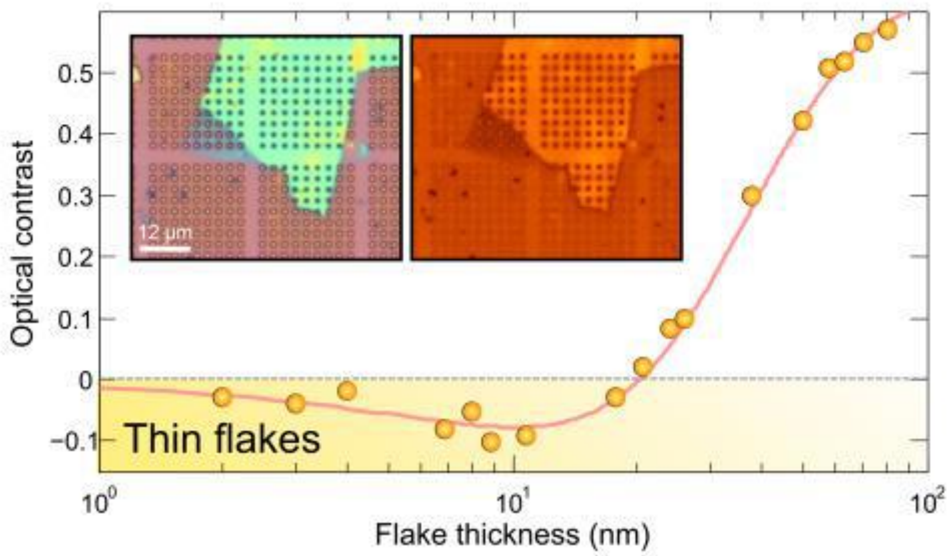

Figure 1. Optical micrograph of ultrathin two dimensional mica layers deposited on a silicon subtrate patterned with holes, where the mica sheet is suspended. Different colors correspond to different mica sheet thicknesses. The graph shows the optical contrast dependence on the mica sheet thickness.

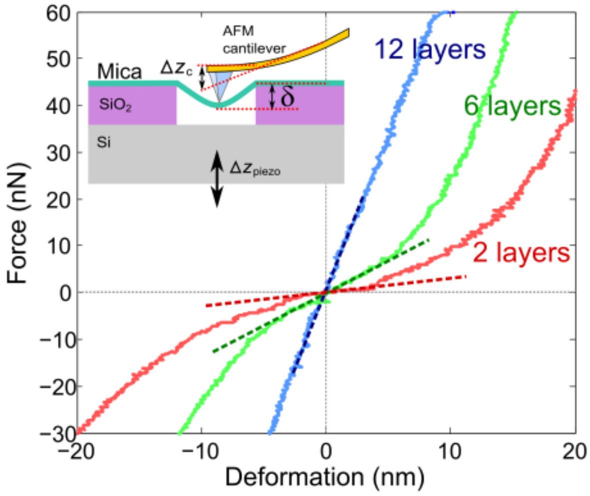

Figure 2. Force vs. deformation traces measured at the center of the suspended part of mica nanosheets with 2, 6 and 12 layers in thickness. The slope of the traces around zero deflection is marked by a dotted line. (Inset) schematic diagram of the bending test experiment carried out on a freely suspended mica nanosheet.