Strained Nanosheets via Piezoelectric Bimorph Bender

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Abstract

Strain in graphene has been studied extensively using polymers [1], piezoelectric actuators [2], microelectromechanical systems (MEMS) [3, 4], thermal mismatch [5], bubbles [6], and defects [7]. However, a simple and repeatable method to study strain in graphene and other 2D materials is needed. In this work, we achieve a simple and repeatable method to strain graphene using a piezoelectric bimorph bender, as shown in Figure 1a. The graphene is transferred over a 1 mm hole, drilled at a location on the bender exhibiting the highest strain, determined by finite element analysis, Figures 2b-c. A maximum displacement of 135 µm can be achieved at a drive voltage of 150 V, corresponding to a strain of 0.41% (Figure 2c). Higher strains are achievable with a longer bender (28 mm) that has a maximum displacement of 450 µm, creating high local strain (>1.5%) on the suspended graphene. The strain is probed using Raman Spectroscopy techniques previously developed [8] and compared to the finite element model. The bender serves as a simple platform for investigating strain in 2D materials by controlling displacement at specified voltage settings.

References

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Figures

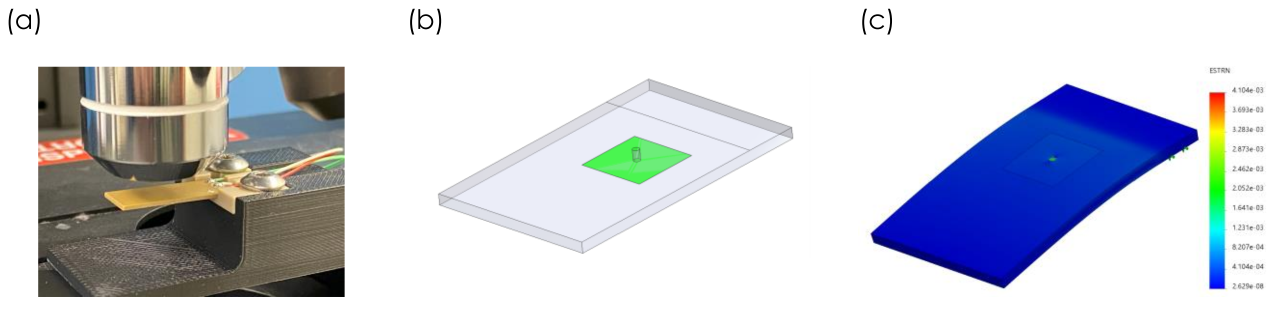

Figure 1: (a) The 16 mm long bimorph bender attached to a 3D printed fixture for studying strain. (b) Solid model of the graphene (green) attached to the bimorph bender (grey). (c) Finite element analysis of the bender and graphene suspended over a hole, with graphene strain highest at this location.