Oral Request

Buckling instabilities of graphene flakes within polymer matrices

Costas Galiotis, Charalampos Androulidakis, Emmanuel N. Koukaras, Georgia Tsoukleri, Dimitris Sfyris, John Parthenios, Konstantinos Papagelis

FORTH/ICEHT, Stadiou Str., Platani, Patras, Greece
c.galiotis@iceht.forth.gr

Abstract

Using the scotch tape method graphene sheets were produced by cleaving of graphite and deposited directly on plastic bars. Suitably selected graphene flakes were tested under compressive loadings. The number of layers of so the examined flakes varied from one to three. By bending the poly(methyl methacrylate) bars using a four-point-bending apparatus compressive strain was induced to the graphene flakes. The strain was applied in step-wise increments, and Raman measurements were taken at each step for the 2D and G Raman bands. The mechanical behaviour can be captured by monitoring the shift of the Raman bands in function with the applied strain.
Previous studies on single layer graphene show that monolayer flakes can sustain compressive strains up to –0.6%[1], which corresponds to a compressive strength of ~ 4 GPa[2]. At this strain level buckling failure occurs. Using analytical models the buckling amplitude and wavelength were calculated, with values in the range 1–2 nm for the wavelength and 6.0 nm for the amplitude. Experiments on bi-layer and tri-layer show that these flakes fail at lower strains than the monolayer despite the higher flexural rigidity. The corresponding critical strains are ~–0.2 % and ~–0.15 % for the bi-layer and the tri-layer respectively. More so, it was found that the critical strain to buckling (including 2LG and 3LG flakes) does not depend on the dimensions of the graphene sheet.
In order to gain insight about the buckling characteristics of the graphene, molecular dynamic simulations were performed using the AIREBO potential. The simulations confirmed the hypothesis that the form of instability is multiple wrinkling with very small wavelength and amplitude. Also, good agreement was found between analysis and simulations for the buckling characteristics.

References

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