Jong Hyun Jung †*

Jisoon Ihm †‡

† Department of Physics and Astronomy, Seoul National University, Seoul, Republic of Korea

‡ Department of Physics, Pohang University of Science and Technology, Pohang, Republic of Korea

* jjhjm17@snu.ac.kr

Period-Doubling Bifurcations of Graphene Wrinkles on a Soft Substrate: A Numerical Study

A compressed stiff film on a soft substrate may develop wrinkles and, under increased compressive strain, post-buckling instabilities as well. We numerically analyze wrinkling behaviors of graphene film attached on a polydimethylsiloxane (PDMS) substrate under lateral compression [1]. The finite element method (FEM) is used to simulate the equilibrium shape of the wrinkles as a function of compressive strain. The two-dimensional stretching and bending properties and the effective thickness of graphene used in the FEM are derived by the density functional theory (DFT). The PDMS is first described using an Ogden material model. Wrinkles first appear at tiny strain. As the lateral compression increases, due to the nonlinear elasticity of the PDMS, successive period-doubling bifurcations of the wrinkle mode are activated until the film folds and the bifurcation stops. We show that the bifurcations are consequences of a delicate balance between the deformations of the film and the substrate to minimize the total energy. We compared the Ogden model, which describes the stiffening of the substrate at large strain, to a Neo-Hookean model without the stiffening. The stiffening reduces the bifurcation onset strain and protects the folding from localization. Possible applications of these structures are the change of electronic structures, and the capture of small materials at the folding.

References

[1] J. H. Jung, J. Bae, M.-W. Moon, K.-S. Kim, J. Ihm, Solid State Commun. 222 (2015) 14

Figures

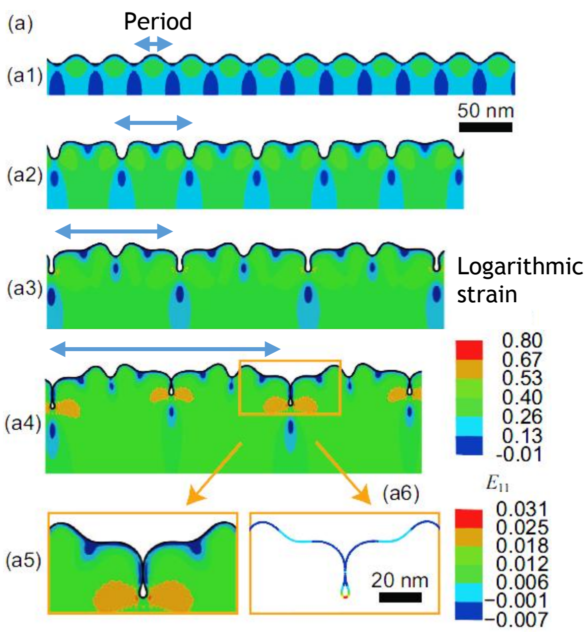

Figure 1: Period-doubling bifurcations of graphene wrinkles on a PDMS substrate under compression [1]