INTERACTIONS OF IONS WITH GRAPHENE

IVAN RADOVIĆ[1], NATAŠA BIBIĆ[1] and ZORAN L. MIŠKOVIĆ[2]
[1]*VINČA Institute of Nuclear Sciences, P.O. Box 522, 11001, Belgrade, Serbia*
E-mail: iradovic,natasabi@vin.bg.ac.rs
[2]*Department of Applied Mathematics, University of Waterloo, Waterloo, Ontario, Canada N2L 3G1*
E-mail: zmiskovi@math.uwaterloo.ca

Abstract. We use a two-dimensional, two-fluid hydrodynamic model to describe the high-frequency plasmon excitations of the carbon valence electrons responding to fast ions which move parallel to a single sheet of graphene supported by an insulating substrate (Radović et al. 2007). We calculate the stopping and the image forces on ions, resulting from the dynamic polarization of graphene. The results are similar to those obtained earlier for ion channeling through carbon nanotubes in dielectric media. Besides, we describe the dynamic polarization of graphene's π electrons by means of the Vlasov equations in the relaxation-time approximation and evaluate the stopping and the image forces on slow ions moving parallel to a supported graphene under the gating conditions (Radović et al. 2008). The effects of variation in size of the gap between graphene and the SiO_2 substrate are found to be quite large, pointing to the need for including this gap explicitly in modeling of polarization of graphene. Finally, we evaluate the stopping and image forces on a charged particle moving parallel to a doped sheet of graphene by using the dielectric-response formalism for graphene's π-electron bands in the random phase approximation (RPA) (Allison et al. 2009). The forces are presented as functions of the particle speed and the particle distance for a broad range of charge-carrier densities in graphene. A detailed comparison with the results from a kinetic equation model reveal the importance of interband single-particle excitations in the RPA model for high particle speeds. We also consider the effects of a finite gap between graphene and a supporting substrate, as well as the effects of a finite damping rate that is included through the use of Mermin's procedure. The damping rate is estimated from a tentative comparison of the Mermin loss function with a high-resolution reflection electron energy loss spectroscopy experiment.

References

Allison, K. F., Borka, D., Radović, I., Hadžievski, Lj., Mišković, Z. L.: 2009, *Phys. Rev. B*, **80**, 195405.
Radović, I., Hadžievski, Lj., Bibić, N., Mišković, Z. L.: 2007, *Phys. Rev. A*, **76**, 042901.
Radović, I., Hadžievski, Lj., Mišković, Z. L.: 2008, *Phys. Rev. B*, **77**, 075428.