Molecular alignment on graphene surface determines transport properties of graphene/organic semiconductor transistors

Vadym Tkachuk, Egon Pavlica, Gvido Bratina
Laboratory of Organic Matter Physics, University of Nova Gorica, Slovenia
vadym.tkachuk@ung.si

Graphene field-effect transistor structures were used to investigate the role of molecular alignment on charge transport properties of heterostructures comprising a single-layer graphene and variable thickness of N,N′-bis(n- octyl)-(1,7&1,6)-dicyanoperylene-3,4:9,10-bisdicarboximide (PDI8-CN2) - an n-type organic semiconductor[1].

Our atomic force microscopy data show that under selected growth conditions PDI8-CN2 grows in a layer-by-layer fashion up to a second monolayer. The first layer comprises flat-lying molecules, whereas the molecules in the second layer orient themselves in an upright orientation. Transconductance measurements show that the flat-lying molecules have little effect on the position of the Fermi level in graphene.

Upright oriented molecules in the second layer instead, have a strong effect as to neutralize native p-type doping of graphene and cause a shift of charge-neutrality level towards the Dirac point. We interpret such behavior in terms of different orientation of the surface dipole on layers with different molecular orientations. At the same time the overall mobility of the charge carriers reaches values exceeding 3000 cm^2/Vs.

References:

(1) Tkachuk, V.; Pavlica, E.; Bratina, G. Molecular Alignment on Graphene Surface Determines Transport Properties of Graphene/Organic Semiconductor Transistors. *Org. Electron.* **2020**, *87*, 105933. https://doi.org/10.1016/j.orgel.2020.105933.