Study of the Role of the Interface between Organic Semiconductors and Graphene on the Charge Transport

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Graphene or related 2D materials compared to organic semiconductors (OS), exhibit significantly different nature of electro-optical properties. In a wish to combine their properties, a comprehensive study of the interface between OS and graphene has been carried on. The electrical characteristics were investigated by means of measurements of time-of-flight photoconductivity and transconductance in field-effect transistors. These were complemented by atomic force and electron microscopy.
At first, the graphene flakes (GF) were introduced into OS matrix[1,2]. The highly conducting GFs offered an efficient charge transport path between the individual GFs within the film, overall yielding enhanced charge transport properties of the resulting bi-component system. Later studies on GF/OS blends brought into attention that the conductivity enhancement results from the interplay between charge carrier mobility and charge density[3]. In order to analyze both phenomena separately, charge density and charge mobility contributions to the conductivity were singled out. With the increasing GF concentration, the charge mobility was found to increase, thereby reducing the time spent by the carriers on the polymer chains. A phenomenon supported by variable-range hopping model of a mixed two- and three-dimensional transport. In contrast, charge density exhibits more entangled dependence on the molecular orientation in the nanoscale vicinity of the interface between graphene and OS. Recent results of perylene derivatives (PDI8) epitaxially grown on a single layer graphene demonstrate the complex dependence of charge transfer and molecular alignment. The first PDI8 layer comprises flat-lying molecules, whereas the molecules in the second layer orient themselves in an upright orientation. Also there is difference in the charge transfer and charge doping of the underlying graphene. Transconductance measurements show that the flat-lying molecules have little effect on the position of the Fermi level in graphene. Surprisingly, 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[4].

References:

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