Emergence of Photoswitchable Quasi-Bound States in a Graphene−Azobenzene−Platform

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The origin of the intriguing physics of graphene can be traced to its unique electronic density of states that vanishes at the so-called Dirac points, where valence and conduction bands intersect and exhibit the linear dispersion characteristic of massless Dirac Fermions. In this context the Klein tunnelling, i.e. the possibility for relativistic particles to penetrate through high and wide potential barriers [1], is one example that proves the relativistic predictions of quantum electrodynamics. On the other hand, the possibility to confine electrons in tailored potential landscapes in graphene, induced for example by electrostatic gating, [2] would be highly desirable. Theoretically, the barrier transparency in graphene can be partially overcome if the electron reaches the confined structure with a path not normal to the potential, as described by Katsnelson et al. [1] explaining the angle dependence of the Klein tunnelling in graphene.

In this respect, over the past year we have been exploring the possibility to induce local, optically switchable potential perturbations in graphene using a self-assembled monolayer (SAM) of photochromic molecules. Fig.1a shows a scheme of the samples investigated, consisting of Au-electrode functionalized with mixed-SAM and with graphene exfoliated on it. The figure illustrates the molecular gating using azobenzene-derivatives (4-(1-mercapto-6-hexyloxy)-azobenzene). These molecules can exist in either the *cis* or *trans* conformation, one optically induced using UV-light and the other using visible light [3].

Conductive AFM measurements shown in Fig.1b reveal strong current resonances, the strength of which is optically gated on- and off- by isomerization of the azobenzene molecules. [3] Comparisons of the voltage separation between current resonances (∼70−120 mV) with solutions of the Dirac equation indicate that the radius of the gating potential is ∼7 ± 2 nm with a strength $\geq$0.5 eV.

References

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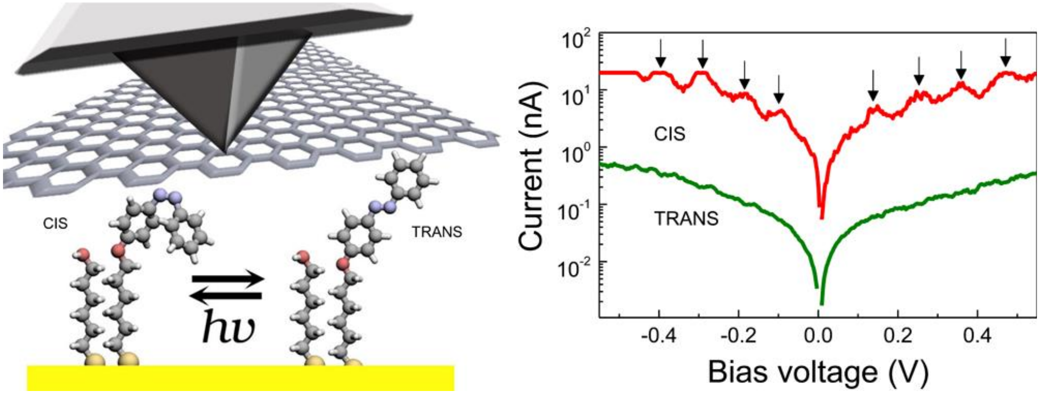

Figure 1: a) Scheme of the sample Au/SAM/graphene when the molecules are either in *trans* form or in *cis* form. b) I-V transport characteristics at a fixed position on the sample Au/SAM/graphene before and after switching the azobenzene molecules from *trans* (green curve) to *cis* (red) isomerization.