Graphene/Organic Heterojunction Structure with Ion-Gel Gate Dielectrics

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High-quality channel layer is required for next-generation flexible electronic devices. Graphene, a two-dimensional atomic crystal made of carbon, has attracted significant interest for electronics applications due to its high intrinsic carrier mobility, excellent mechanical flexibility, optical transparency, and unique ambipolar transport characteristic. Especially, ambipolarity implies that carriers can be tuned continuously between holes and electrons by supplying the requisite gate biases and enables a wide array of applications including frequency multipliers, memory, fast switches, and high-frequency oscillators up to the THZ range. However, its gapless band structure gives rise to low on/off ratio in a graphene-based transistor whose implementation in real applications has yet to occur.

High on/off ratio has been achieved by introducing a heterojunction structure that is a gated graphene/semiconductor junction, because its high junction resistance can provide sufficiently low off-state current. However, such a heterojunction structure has usually lost the benefits of graphene, such as mechanical flexibility, optical transparency, and the ambipolar transport properties because rigid and opaque unipolar semiconductor and low-k dielectric have been used.

Here we propose a graphene/pentacene channel layer with high-k ion-gel gate dielectric. The graphene/pentacene device shows both high on/off ratio and carrier mobility as well as excellent mechanical flexibility. Most importantly, it reveals ambipolar behaviors and related negative differential resistance, which are controlled by external bias. Therefore, our graphene/pentacene barristor with ion-gel gate dielectric can offer various flexible device applications with high performances.

References

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Figures

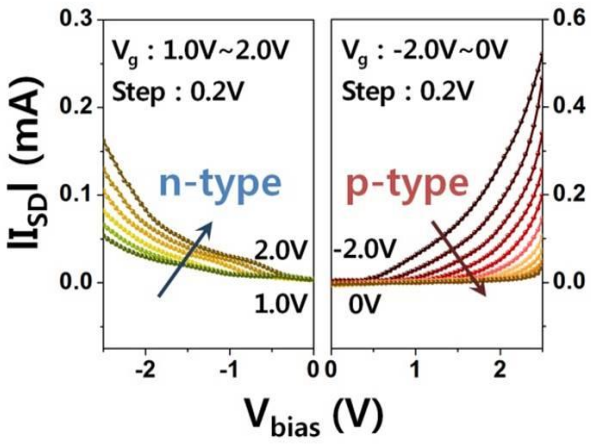

Figure 1: Ambipolarity of a graphene/pentacene heterojunction structure