MoS_2 Transistors with Electrografted Organic Ultrathin Film as Efficient Gate Dielectric

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Abstract

Two dimensional layered semiconductors, and in particular transition metal dichalcogenides such as molybdenum disulfide (MoS_2), have recently received increasing attention due to the combination of their unique electronic properties with their atomically thin geometry. Contrary to graphene, MoS_2 has a finite band gap of 1.2-1.9 eV (depending on the number of layers), thus complying with the requirements of digital electronic applications. To maximize the potential of MoS_2 as channel material in field effect transistors, it must be associated with an efficient gate dielectric.

Beside the mainstream CMOS technology, other fields such as large-area and/or printable electronics, sensors and display technologies could also benefit from the combination of 2D materials and new dielectrics, especially if these dielectrics present additional advantages in terms of mechanical flexibility, low temperature processes, conformability to structured substrates, cost and simplicity of equipment and processes, etc. In this respect, the development of *robust organic* nano-dielectrics and their combination with new semiconductors represent a high potential route.

In this context, we developed new dielectrics based on electrografted organic thin films on metallic electrodes. These dielectrics are produced at room temperature and under mild conditions. The process yields uniform films of nanometer thickness (4-8 nm range). In this work [1], we demonstrated the first transistors combining MoS_2 as channel material and an electrografted organic ultrathin film as gate dielectric. The transistors exhibit high I_{ON}/I_{OFF} ratio together with steep subthreshold slope as low as 110 mV/decade. Besides, the transfer characteristics of these transistors have no-hysteresis due to the hydrophobic and trap-free nature of our electrografted dielectric. The transistors reported in [1] were fabricated on rigid substrates and using mechanically exfoliated MoS_2. Their potential in large scale (based on CVD MoS_2) and flexible electronics will be discussed on the basis of our latest results.

References

[1] H. Casademont, L. Fillaud, X. Lefèvre, B. Jousselme, V. Derycke, submitted

Figures