ID de Contribution: **507** Type: **Poster**

Molecular doping of graphene on SiC for the quantum Hall resistance standard at low magnetic field

The quantum Hall resistance standard is a key element for the dissemination of electrical units within the International System of Units (SI). Currently, the realization of this resistance standard at the best level of uncertainty $\left(10^{-9}\right.$ in relative value) mainly relies on the use of GaAs-based quantum Hall effect (QHE) devices , which requires demanding operating conditions, namely high magnetic induction ($B = 10$ T), low temperature ($T = 1.5$ K), and low measurement current ($I < 100\mu$A). With the goal to obtain easier-to-implement quantum Hall resistance standard, graphene on $\mathrm{SiC(G/SiC)}$ is promising as it has shown QHE in much more relaxed conditions (respectively at 3.5 T, 10 K and 0.5 mA) without degrading the level of accuracy[1]. However, the control of doping in G/SiC to achieve the emergence of the quantization of the QHE at low magnetic field is still a major challenge.

In this work, we have explored molecular doping in $\mathrm{G/SiC}$, following precursor works using F4-TCNQ molecule as a stable electron acceptor under ambient conditions [2, 3]. We study the thickness effect of the spacer layer - between the graphene and the dopant layer - on the graphene carrier concentration. Our preliminary results indicate different doping regimes depending on the spacer layer thickness (50 nm to 500 nm), which strongly influences the carrier density and mobility, as well as their temperature dependence. Importantly, we achieved hole density as low as $3.7.10^{10}\ \mathrm{cm}^{-2}$ at $T = 5$ K, while mobility is $21000\ \mathrm{cm}^2\ \mathrm{V}^{-1}\ \mathrm{s}^{-1}$. Our work aims to provide a simple, reliable and reproducible method to engineer graphene devices with the electronic desired properties.

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Classification de Session: Session Poster 2: MC1, MC4, MC8, MC10, MC12, MC14, MC20, MC21, MC23, MC24, MC25, REDP

Classification de thématique: MC8 Dernières avancées dans le domaine des technologies quantiques