Graphene underneath Metals

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Both graphene/metal and graphene/insulator are key elements not only for realizing graphene FETs but also for interconnections. To make the best of surprisingly outperforming graphene properties for any applications, it is critically important to understand its interfacing properties. This paper discusses how electrical transport and physical properties in graphene are affected by interfacing with metals.

We reported that the contact resistivity at Ni/graphene was dependent on gate-voltage [1]. This suggests that the carrier density in graphene underneath Ni should be modulated by the back gate even though graphene is electrically in contact with the metal. **Fig. 1** shows (a) an optical micrograph of graphene FET with multiple Ni electrodes. ρ-V_G characteristics underneath Ni were investigated, as schematically shown in Fig. 1(b). The sheet resistivity of graphene without metal (ρ_G) and graphene underneath Ni ($\rho_G{}^M$) with different Ni length (L_M) was studied. ρ_G shows a sharp carrier density modulation, while $\rho_G{}^M$ decreases with increasing L_M. It was strongly suggested that the graphene conductivity was not significantly affected by the metal contact.

In the conventional patterning process of metals on graphene, the resist process should be inevitably employed. Thus, we studied metal/graphene interface without any resist process but with direct metal deposition, because there was a concern that the resist residue might affect the interface properties at metal/graphene. The quantum capacitance which is directly related to density of states in graphene was investigated in terms of effects of the resist process [3]. The results show that there is a difference of the quantum capacitance observation between with and without the resist process [4].

These results are crucial not only for controlling FET properties, but also interconnecting application of graphene, and point to the engineering direction of graphene technology.

References
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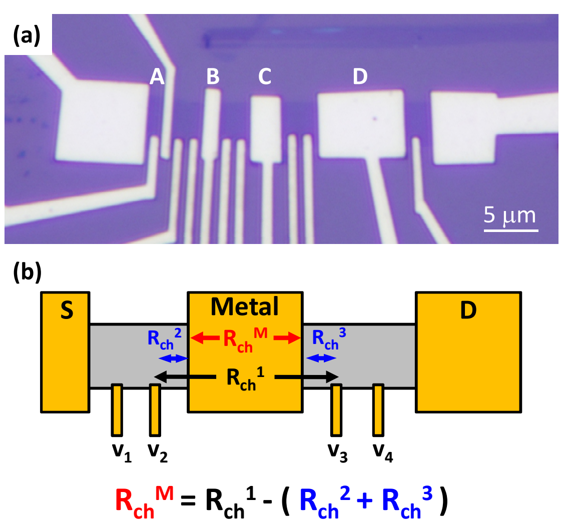

Fig. 1. (a) Optical micrograph of the fabricated graphene FET.. The contact metal was Ni and ohmic contacts were confirmed for all electrodes. Typical mobility extracted by four-probe measurements was ~4,500 cm^2/Vs at 1×10^{12} cm^{-2}. (b) A schematic top view of the device for extracting the resistivity of graphene underneath the metal.