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Improvement Performance of Graphene-MoS_2 Barristor treated by 3-aminopropyltriethoxysilane (APTES)

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Graphene by one of the two-dimensional (2D) materials has been focused on electronic applications due to its ultrahigh carrier mobility, outstanding thermal conductivity and superior optical properties. Although graphene has many remarkable properties, graphene devices have low on/off current ratio due to its zero bandgap. Despite considerable efforts to open its bandgap, it's hard to obtain appropriate improvements. To solve this problem, heterojunction barristor was proposed based on graphene. Mostly, this heterojunction barristor is made by transition metal dichalcogenides (TMDs), such as molybdenum disulfide (MoS_2) and tungsten diselenide (WSe_2), which have extremely thickness scalability of TMDs. The heterojunction barristor has the advantage of controlling graphene's Fermi level by applying gate bias, resulting in barrier height modulation between graphene interface and semiconductor. However, charged impurities between graphene and SiO_2 cause unexpected p-type doping of graphene. The graphene's Fermi level modulation is expected to be reduced due to this p-doping effect. Charged impurities make carrier mobility in graphene reduced and modulation of graphene's Fermi level limited.

In this paper, we investigated theoretically and experimentally a relevance between graphene's Fermi level and p-type doping. Theoretically, when Fermi level is placed at the Dirac point, larger graphene's Fermi level modulation was calculated between -20 V and +20 V of V_{GS}. On the contrary, graphene's Fermi level modulation was 0.11 eV when Fermi level is far away from the Dirac point in the same range. Then, we produced two types heterojunction barristors which made by p-type doped graphene and graphene treated 2.4% APTES, respectively. On/off current ratio (32-fold) of graphene treated 2.4% APTES was improved in comparison with p-type doped graphene.

Keywords: graphene, barristor, APTES, 3-aminopropyltriethoxysilane, MoS_2

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2D transition-metal dichalcogenide (WSe2) doping methods for hydrochloric acid

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3D semiconductor material of silicon that is used throughout the semiconductor industry currently faces a physical limitation of the development of semiconductor process technology. The research into the next generation of nano-semiconductor materials such as semiconductor properties superior to replace silicon in order to overcome the physical limitations, such as the 2-dimensional graphene material in 2D transition-metal dichalcogenide (TMD) has been researched. In particular, 2D TMD doping without severely damage of crystal structure is required different conventional methods such as ion implantation in 3D semiconductor device. Here, we study a p-type doping technique on tungsten diselenide (WSe2) for p-channel 2D transistors by adjusting the concentration of hydrochloric acid through Raman spectroscopy and electrical/optical measurements. Where the performance parameters of WSe2 – based electronic device can be properly designed or optimized. (on currents increasing and threshold voltage positive shift .) We expect that our p-doping method will make it possible to successfully integrate future layered semiconductor devices.

Keywords: WSe2, HCl, doping