Quantum conductance probing of oxygen vacancies in $SrTiO_3$ epitaxial thin film using graphene

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Combination of functional complex oxides and 2D layered materials let us explore novel physical phenomena and possible device applications in the unprecedented heterostructures. In particular, observation of quantum transport behavior in graphene in the vicinity of the transition metal oxides opens up a new possibility of understanding the constituent materials. In this presentation, we present examples of synergetic behavior in monolayer graphene on $SrTiO_3$ (STO) epitaxial thin film, using electrical transport measurements.

First, we show that a large gate-voltage scaling in graphene transport is plausible using STO thin film with the high dielectric constant. The graphene on epitaxial STO thin film shows quantum Hall state which survives up to 200 K at a magnetic field of 14 T. In addition, the substantial shift of charge neutrality point in graphene seems to correlate with the temperature-dependent dielectric constant of the STO thin film, and its effective dielectric properties could be deduced from the universality of quantum phenomena in graphene. [1]

Second, using the quantum conductance, we probe the creation and annihiliation of oxygen vacancies at graphene/STO surface. Since monolayer graphene is highly sensitive to the surrounding electronic environment without modifying it, we can exclusively understand the electronic reconstruction occuring in the STO layer due to oxygen vacancy formation. By analyzing the hysteretic current-voltage loops, we can quantitatively estimate the relation between the thickness, dielectric constant, and oxygen vacancy concentration in oxygen deficient STO layer. [2]

[1] J. Park *et al.*, *Nano Lett.* **16**, 1754-1759 (2016).

[2] K. T. Kang *et al.*, *Adv. Mater.* Early View, DOI: 10.1002/adma.201700071 (2017)