Real-Space Imaging of Localized Electronic States at Graphite Surfaces

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Graphene, a single layer of graphite, is an ideal two-dimensional electron system (2DES). Recently, graphene and bilayer-graphene devices have been fabricated, where the distinct quantum Hall (QH) plateaus are observed in transport measurements. These materials have the 2DESs at the surfaces, unlike the conventional 2DESs formed at semiconductor heterojunctions. This makes it possible to observe the QH states, especially the localized and extended states, in real space with local probes such as scanning tunneling microscope (STM). We have studied the local density of states (LDOS) of the quasi 2DES near defects at surfaces of highly oriented pyrolytic graphite (HOPG) in high magnetic fields with an ultra-low temperature STM [1]. Differential tunnel conductance images show alternating localized and extended spatial distributions of the LDOS at the valley and peak energies of the Landau level spectrum, respectively. Among the localized distributions with radii comparable to the magnetic length, we found two typical spatial patterns depending on the defects. These LDOS distributions are consistent with the recent calculations of the wave functions for the ground states of 2DES in magnetic fields in the 1/r and harmonic potentials [2].

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[2] D. Yoshioka, J. Phys. Soc. Jpn. 76, 024718 (2007).