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Atomic and electronic structure of nanostructured few-layer graphene with self-aligned boundaries synthesized on SiC/Si(001) wafers

A.N. Chaika[1], H.-C. Wu[2,3], O.V. Molodtsova[4], M.-C. Hsu[5], T.-W. Huang[5], C.-R. Chang[5], B. Walls[3], I.V. Shvets[3], V.Yu. Aristov[1,4]

[1]*Institute of Solid State Physics RAS, 142432 Chernogolovka, Russia*
e-mail: chaika@issp.ac.ru

[2]*School of Physics, Beijing Institute of Technology, Beijing, 100081, People's Republic of China*

[3]*CRANN and School of Physics, Trinity College, Dublin 2, Dublin, Ireland*

[4]*Deutsches Elektronen-Synchrotron DESY, D-22607, Hamburg, Germany*

[5]*Department of Physics, National Taiwan University, Taipei 10617, Taiwan*

Few-layer graphene exhibits exceptional properties that are of interest both for fundamental research and technological applications. The abilities to open energy gap and to make graphene magnetic are principal challenges in the fields of graphene-based electronic and spintronic applications. Nanostructured graphene with uniformly aligned nanodomain boundaries and ripples is one of the promising materials because the domain edges can reflect electrons over a large range of energies [1] and host spin-polarized electronic states [2,3]. Additionally, transport gap opening and spin–orbit coupling can be induced by ripples at the graphene domain edges.

In this report we discuss the atomic structure and electronic properties of nanostructured few-layer graphene synthesized on SiC/Si(001) wafers [4-6]. Atomically resolved scanning tunneling microscopy studies revealed that few-layer graphene nanoribbons with self-aligned boundaries can be synthesized in ultra-high vacuum using these technologically relevant substrates [5,6]. The electron transport measurements demonstrated that fabrication of such nanodomain system can produce a charge transport gap about 1 eV at temperatures below 100 K [6]. Magnetic transport measurements of graphene/SiC/Si(001) revealed an unprecedented large positive magnetoresistance in parallel magnetic field with a strong temperature dependence [7]. According to the theoretical calculations performed for different domain edge structures, the transport and magnetic properties of graphene/SiC(001) are most probably related to the localized states at the nanodomain boundaries and linear ripples along them. Our recent scanning tunneling spectroscopy studies performed at low temperatures revealed substantially lower density of the occupied electron states and existence of the energy gap at the nanodomain boundaries and ripples in few-layer graphene/SiC(001). The results show the feasibility of creating new electronic nanostructures using graphene on SiC/Si(001) wafers.

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