SAWtrain network

SAWtrain Research Highlight 3: "Acousto-electric transport in epitaxial graphene coated with MgO/ZnO"

Graphene, a single layer of carbon atoms arranged in a honeycomb lattice, is a pure two-dimensional material with amazing electrical and mechanical properties. To use graphene in commercial electronic devices it is necessary (i) to develop methods for the reproducible fabrication of large-area graphene layers, and (ii) to have efficient mechanisms for the manipulation of the free electronic charges contained in it. Here, we demonstrate a promising approach to overcome these issues by means of acoustic transport of charge carriers in graphene formed epitaxially on silicon carbide (SiC).

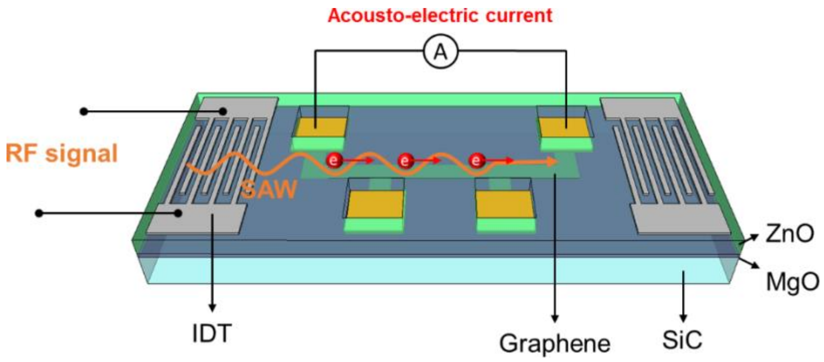

Figure 1 Schematic of a graphene device grown on SiC covered with MgO/ZnO layers

In our device, we patterned a 10x10 mm^2 graphene layer formed on a SiC substrate into stripes and deposited interdigital transducers (IDTs) for the generation of surface acoustic waves (SAWs), see Figure 1. As SiC is a low piezoelectric material, we coated the sample with a strong piezoelectric ZnO film before patterning the IDTs to enhance the efficiency of SAW generation and the coupling of the acoustic fields to the graphene charge carriers. To protect the graphene structures during the ZnO sputtering process, we first deposited a protective MgO layer. Both structural and electrical characterization of the device demonstrate that the properties of the epitaxial graphene are well preserved during the process.

In our experiment, we measured the electric current along the graphene stripes while scanning the frequency of the radio-frequency (RF) signal applied to one of the IDTs. For certain frequencies, the IDT launches a SAW leading to a deformation of the piezoelectric media, and therefore to the generation of a moving electrical potential. This moving potential drags electrons when it propagates through the graphene stripes, thus generating an electric current in the graphene. The process can be regarded as the acousto-electric analogue of an electronic transistor, where the presence of an electric current between the graphene source and drain is controlled by the switching on/off of the SAW, which plays the role of the gate. Due to the strong piezoelectric potential induced by the ZnO film, the acousto-electric currents measured in our device are 1000 times larger than in graphene that was not ZnO-coated. In addition, the linear dependence of the current amplitude with respect to the applied SAW power agrees well with the relaxation model that describes the acousto-electric interaction. Future work will include the combination of the acousto-electric current with top electric gates to control the electron carrier density in the graphene film.

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