FIELD-EFFECT TRANSISTOR WITH TWO-DIMENSIONAL CHANNEL REALIZED WITH LATERAL HETEROSTRUCTURES BASED ON HYBRIDIZED GRAPHENE

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PATENT STATUS: GRANTED/ FILED IN USA and EUROPE

PRIORITY NUMBER: PI20110135

PRIORITY DATE: 02/12/2011

PUBLISHED AS: EP2786416B1, US9620634B2

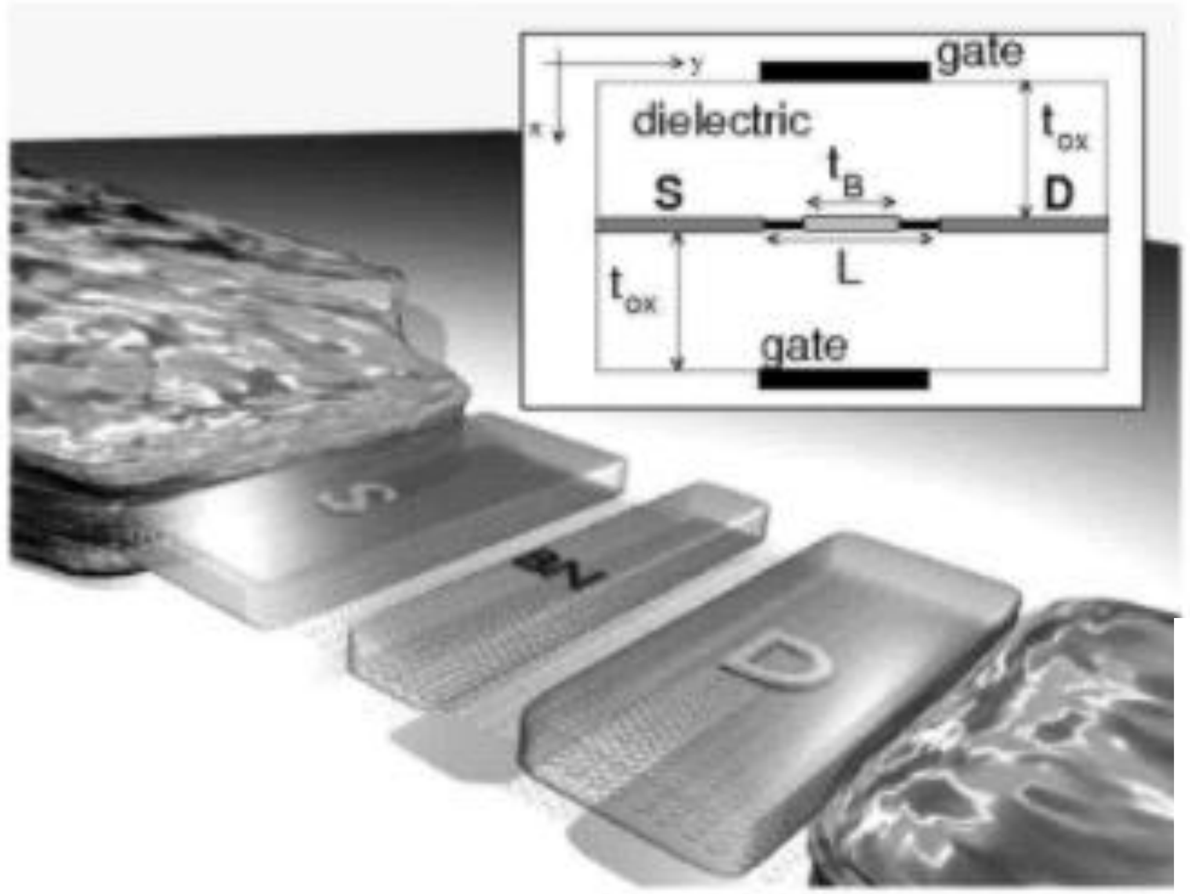
Invention

The present invention is a field-effect transistor with a two-dimensional channel consisting of a thin sheet of one or more atomic layers of lateral heterostructures based on hybridized graphene.

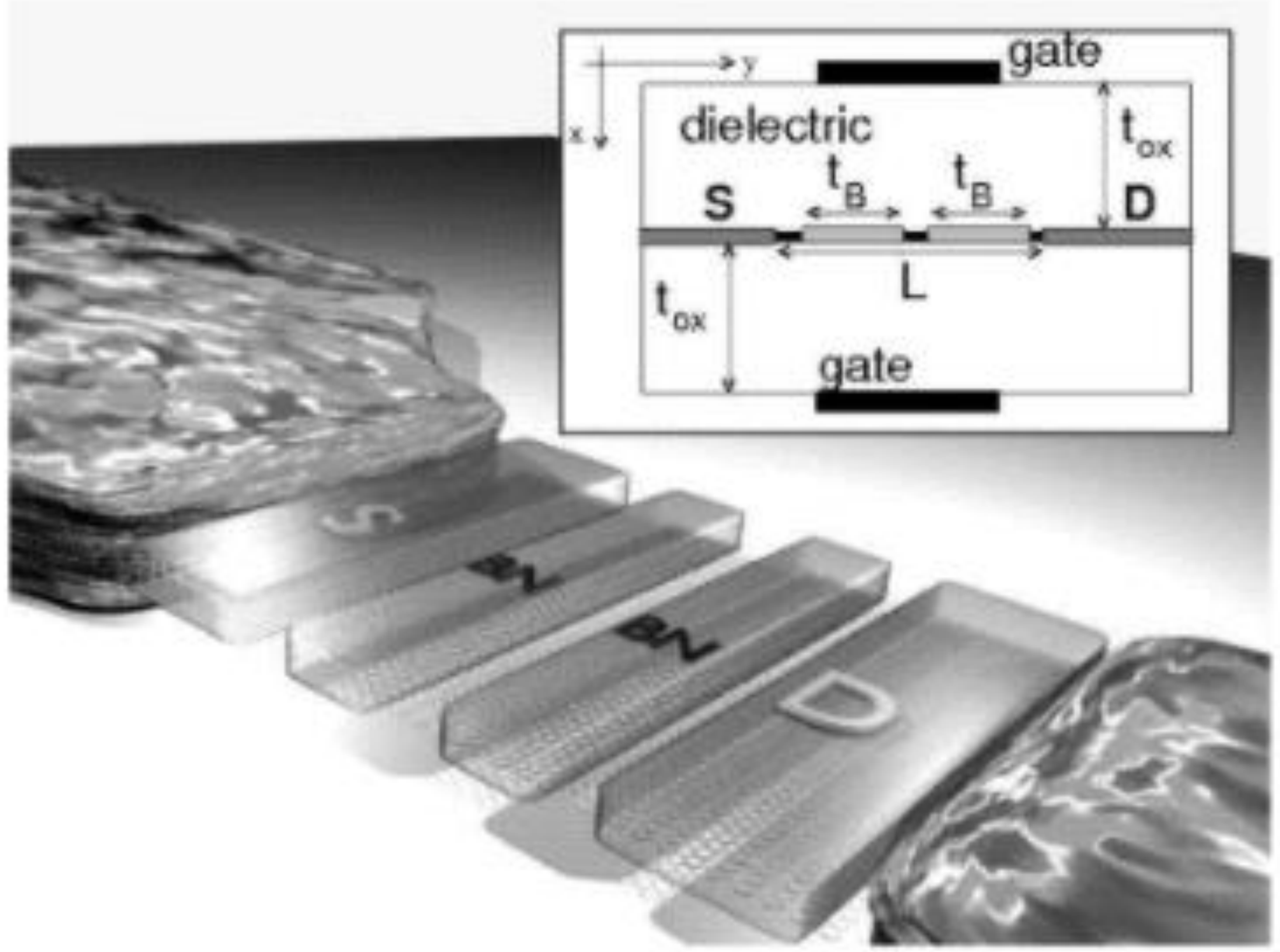
Graphene has interesting electronic properties, such as high mobility and a symmetrical dispersion relation for electrons and gaps. However, it has a zero energy gap, and is therefore not directly applicable as a channel for field-effect transistors. In fact, the zero energy gap does not constitute an effective barrier to electrons and hole transport, and it is therefore not possible to fully switch the transistor off.

The lateral heterostructures, composed by the interlayer of single- or multilayer atomic graphene domains and hexagonal boron-carbon-nitrogen (hBCN) domains with one or multiple gates, are intended to modify the energy gap in the channel so as to allow the transistor to operate effectively in all bias regions. This solution solves the problem of the missing bandgap in single-layer and multi-layer graphene, which does not allow the fabrication of transistors that can be efficiently switched off. The possibility of fabricating lateral heterostructures, with patterns of domains with different energy dispersion relations, enables the realization of field-effect transistors with additional functionalities with respect to common transistors.

Drawings
& pictures



Longitudinal section of a first realisation of the proposed field-effect transistor (FET). The channel is represented by the plane with hexagonal lattice, and extends from the source contact (S) to the drain contact (D). In the channel there is a hBCN type domain of length tB. Above and below the channel are two layers of dielectric material of thickness tox and two gates of length L.



Second realization of a resonant tunnel FET (RTFET), where two hBCN domains of length tB are present in the channel and below the gate, separated by a graphene region of length w.

Industrial applications

Electronics / Nanoelectronics

The invention concerns a new series of devices with a perfectly two-dimensional channel, based on the engineering of hybridised graphene.

This approach can open up new avenues for nanoelectronics in graphene, of a new family of transistors with fully two-dimensional channelbased on hybridized graphene engineering. This approach is of great advantage since hexagonal boron-carbon-nitrogen (hBCN) hybrid structures can allow to suppress ambipolar behaviour, blocking the flow of one type . of carriers, and to fully modulate current due to carriers of the other type.

Possible developments

Hybridized graphene with intercalated carbon and hBCN domains provides an exceptional platform for exploring truly two-dimensional electronic devices.
The ability to engineer the electronic properties of the channel with hBCNs enables excellent current modulation in graphene-based field-effect transistors.

Several modifications of the invention can be made to achieve further functionality by introducing two-dimensional structures of different domains.

Collaborations with industrial partners are expected to increase the technological readiness level of the invention; licensing or transfer for the patented invention use by interested entities or companies may be discussed.

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