Gate-tunable bandgap in bilayer graphene devices

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Graphene systems, consisting of one or a few crystalline monolayers of carbon, stand out because of their unusual electronic properties and of their potential for applications in nanoelectronics. Carrier mobility values as high as 10,000 cm2/Vs at room temperature -ten times higher than in silicon- are routinely obtained in these materials, without the need for sophisticated preparation techniques. Both the high mobility and the envisioned possibility of low-cost mass-production provide a strong drive to explore the use of graphene for future high-speed integrated electronic circuits. In order to develop such âgraphene-based electronicsâ, however, several problems need to be overcome. Perhaps the most important obstacle is the absence of an energy gap separating the valence and conduction band of graphene. Since graphene is a zero-gap semiconductor, electrical conduction cannot be switched off by using control voltages, which is essential for the operation of conventional transistors. In this presentation I will show that in a graphene bilayer a band-gap can be opened and controlled by applying an electric field perpendicular to the bilayer. The gap manifests itself in the appearance of an insulating temperature dependence of the conductivity, which becomes more pronounced for larger applied electric fields. This result demonstrates the capability to controllably switch off transport through a graphene bilayer in nano-electronic devices equipped with gate electrodes, and it represents the first step towards the realization of electrostatically controlled graphene-based devices.