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Strain Engineered Graphene: Current Trends and Prospects

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The unavoidable intrinsic two-dimensionality of graphene brought the concept of on-demand materials and on-demand device functionality in electronic devices to a whole new level. Being a planar surface with no bulk, graphene is completely exposed to its environment, which affords an endless number of approaches whereby one can interact with its pristine structure, and tailor its properties. Gate engineering, direct patterning, chemical doping, adsorbate engineering, functional substrates, and strain, are some of the approaches being currently pursued, and examples of the great versatility of this electronic system.

Strain engineering, in particular, has gained considerable momentum and is now a well established avenue of research in graphene. There are fundamental and practical reasons for the surge of interest in strained graphene. On a fundamental level, lattice distortions couple to graphene's Dirac electrons in a unique way, such that deformations are felt by the electrons as an effective pseudo-magnetic field [1], and lead to unusual phenomenology: just recently, STM experiments revealed that pseudo-magnetic fields in excess of 300T can develop in CVD-grown graphene [2]. Combining this rich physics with the fact that graphene is the strongest material ever measured [3], supporting elastic deformations in excess of 15%, opens interesting prospects for using strain to tailor its electronic properties. One fast developing area where this interplay can be explored is the field of transparent flexible electronics, where graphene is poised to become a major player [4].

The designation strain engineering refers to using specific strain profiles and distributions, optimized to achieve a specific functionality. Local triangular blisters can lead to large spectral gaps, whereas local linear deformations can act as tunneling barriers, and so on. In this talk I will review some of the key aspects of this interplay between electrons and deformations, its implications, as well as the newest developments in transport and optics of strain-engineered graphene systems. As will be seen, the unsurpassed elasticity of the 2D carbon lattice, and the various possibilities to add strain to graphene devices adds an entirely new dimension to graphene phenomenology. Strain can potentially be used to engineer graphene's transport properties, optical absorption, chemical activity, electronic correlations, magnetism, etc, thereby adding new features to essentially every chapter of graphene physics.

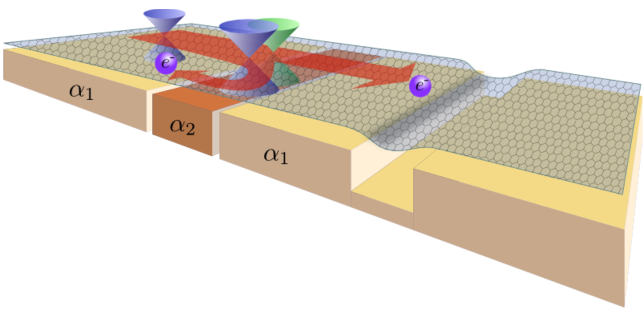

Fig. 1 A sketch of the effect of a local strain barrier for the electronic motion. Local strain can mimic the effect of tunneling barriers or confining regions, in such a way that charge transport can be suppressed by varying a gate voltage, even in the absence of a spectral gap in graphene's electronic structure.

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