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Tailoring electronic properties of 2D crystals by strain engineering

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One of the enticing features common to most of the two-dimensional electronic systems that, in the wake of (and in parallel with) graphene, are currently at the forefront of materials science research is the ability to easily introduce a combination of planar deformations and bending in the system. Since the electronic properties are ultimately determined by the details of atomic orbital overlap, such mechanical manipulations translate into modified (or, at least, perturbed) electronic properties. Graphene, in particular, on account of its exceptional range of elastic deformation, complemented by an unusual electron-phonon coupling that can be captured by the concept of a fictitious or pseudo-magnetic field (PMF), has taught us that its intrinsic electronic properties can be molded by many more, and much richer, approaches that can be applied to 3D bulk solids. The ability to manipulate the local strain distribution in graphene opens the enticing prospect of strain-engineering its electronic and optical properties, as well as of enhancing interaction and correlation effects. I will describe some examples of how strain-engineered graphene can have richer spectral, transport, and optical properties, or how it allows potentially novel device functionalities and tunability. Some concepts will be discussed in parallel with a summary of selected experimental work. A general optimization framework for tailoring physical properties of 2D crystals by manipulating the state of local strain, and allowing a one-step route from their design to experimental implementation, will be presented, together with a discussion of examples of its application in the design of nanoscale transport devices.

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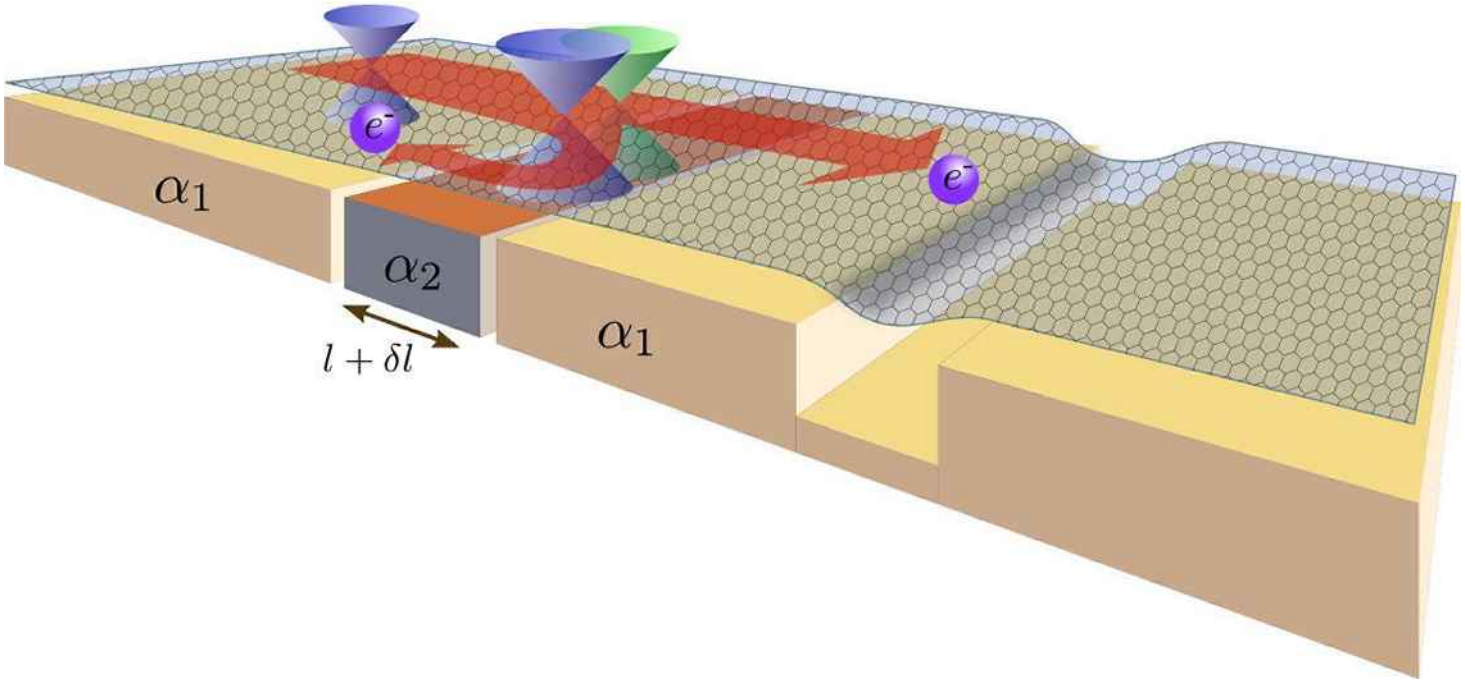

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