Electron transport in nanoporous graphene: Probing the Talbot effect

Electrons in graphene can show diffraction and interference phenomena fully analogous to light thanks to their Dirac-like energy dispersion. However it is not clear how this optical analogy persists in nanostructured graphene, e.g. with pores. Nanoporous graphene (NPG) consisting of linked graphene nanoribbons has recently been fabricated using molecular precursors and bottom-up assembly [Moreno et al, Science 360, 199 (2018)]. We predict that electrons propagating in NPG exhibit the interference Talbot effect, analogous to photons in coupled waveguides. Our results are obtained by parameter-free atomistic calculations of real-sized NPG samples, based on seamlessly integrated density functional theory and tight-binding regions. We link the origins of this interference phenomenon to the band structure of the NPG. Most importantly, we demonstrate how the Talbot effect may be detected experimentally using dual-probe scanning tunneling microscopy. Talbot interference of electron waves in NPG or other related materials may open up new opportunities for future quantum electronics, computing or sensing.

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