

Materials in the Flatland

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Abstract

When one writes by a pencil, thin flakes of graphite are left on a surface. Some of them are only one atom thick and can be viewed as individual atomic planes cleaved away from the bulk. Such one atom thick crystals of graphite (dubbed graphene) turned out to be the strongest crystals available to us, the most conductive, most thermally conductive, most elastic, flexible, transparent material, etc, etc, etc. Its electronic properties are particularly exciting: its quasiparticles are governed by the Dirac equation so that charge carriers in graphene mimic relativistic particles with zero rest mass.

Still, probably the most important “property” of graphene is that it has opened a floodgate of experiments on

many other 2D atomic crystals: BN, NbSe₂, TaS₂, MoS₂, etc. The resulting pool of 2D crystals is huge, and they cover a massive range of properties: from the most insulating to the most conductive, from the strongest to the softest.

If 2D materials provide a large range of different properties, sandwich structures made up of 2, 3, 4 ... different layers of such materials can offer even greater scope. Since these 2D-based heterostructures can be tailored with atomic precision and individual layers of very different character can be combined together, the properties of these structures can be tuned to study novel physical phenomena or to fit an enormous range of possible applications, with the functionality of heterostructure stacks is “embedded” in their design.