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Two-dimensional Semiconducting Alternative to Graphene: Single-Layer MoS_2

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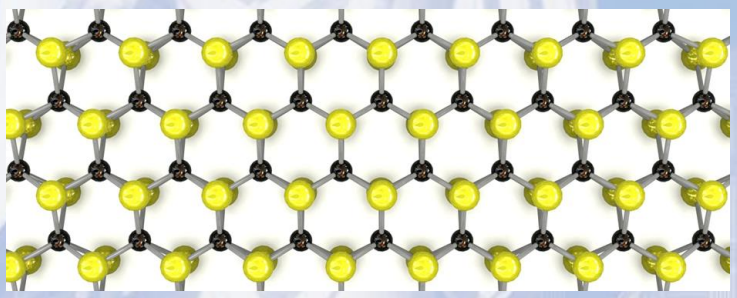

After quantum dots, nanotubes and nanowires, two-dimensional materials in the shape of sheets with atomic-scale thickness represent the newest addition to the diverse family of nanoscale materials. The most widely studied two-dimensional material to date is graphene because of its rich physics, high-mobility and wide variety of potential applications. Pristine graphene is however not a semiconductor and the lack of band gap is a serious problem in many applications, for example in electronics.

I will present here our work on a material similar to graphene – single layer MoS_2, a direct-gap semiconductor. We have exfoliated single layers 6.5 Å thick from bulk crystals of semiconducting MoS_2, using the micromechanical cleavage technique commonly used for the production of graphene. Our nanolayers are mechanically and chemically stable under ambient conditions. We have fabricated transistors based on single-layer MoS_2 which demonstrate that this material has several advantages over silicon or graphene for potential applications in electronics. Free-standing MoS_2 membranes have also been prepared, allowing us to observe ripples arising from thermodynamic fluctuations, previously seen only in graphene. Mechanical measurements on MoS_2 membranes show that this new material also has interesting mechanical properties with stiffness higher than stainless steel, mechanical strength at the theoretical limit and 30x higher than steel.

References:

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