Boosting the carrier mobility of graphene

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The carrier mobility is an important figure of merit for electrical conductors, characterizing how quickly a charge can move in response to an electric field. High carrier mobilities play a fundamental role for high frequency electronics, integrated optoelectronics as well as for sensor and spintronic applications, where device performance is directly linked to the magnitude of the carrier mobility. Thanks to the suppression of backscattering guaranteed by pseudo-spin conservation and weak electron-phonon interaction, graphene outperforms all known materials in terms of room temperature mobility. I will show that the best performance of state-of-the-art graphene devices -- which is close to the theoretical limit set by electron-phonon scattering -- can be surpassed by more than a factor four employing van-der-Waals heterostructures consisting of tungsten diselenide (WSe_2), graphene and hexagonal boron nitride. This enhancement, which leads to extraordinary high room temperature mobilities of up to 350,000 $cm^2/(Vs)$, can be understood in terms of a suppression of electron scattering with acoustic phonons. This is most likely due to the mechanical coupling between graphene and tungsten diselenide, which converts graphene's acoustic phonon branches into finite-energy interlayer shear modes.

Figure 1: Illustration of a quasi-two dimensional heterostructure consisting of 2 layers of hexagonal boron nitride (bottom), graphene and 2 layers of WSe_2