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Electrical characterization of fully encapsulated ultra thin black phosphorous-based heterostructures with graphene contacts AHMET AVSAR, Graphene Research Center, National University of Singapore, IVAN JESUS VERA-MARUN, Graphene Research Center, National University of Singapore;Zernike Institute for Advanced Materials, University of Groningen, The Netherlands, JUN YOU TAN, Graphene Research Center, National University of Singapore, KENJI WATANABE, TAKASHI TANIGUCHI, National Institute for Materials Science, Japan, ANTONIO HELIO CASTRO NETO, BARBAROS ÖZYILMAZ, Graphene Research Center, National University of Singapore — The presence of finite bandgap and high mobility in semiconductor few-layer black phosphorous offers an attractive prospect for using this material in future two-dimensional electronic devices. Here we present for the first time fully encapsulated ultrathin (down to bilayer) black phosphorous field effect transistors in Van der Waals heterostructures to preclude their stability and degradation problems which have limited their potential for applications. Introducing monolayer graphene in our device architecture for one-atom-thick conformal source-drain electrodes enables a chemically inert boron nitride dielectric to tightly seal the black phosphorous surface. This architecture, generally applicable for other sensitive two-dimensional crystals, results in stable transport characteristics which are hysteresis free and identical both under high vacuum and ambient conditions. Remarkably, our graphene electrodes lead to contacts not dominated by thermionic emission, solving the issue of Schottky barrier limited transport in the technologically relevant two-terminal field effect transistor geometry.

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