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Intrinsic disorder in graphene on transition metal dichalcogenide heterostructures MATTHEW YANKOWITZ, University of Arizona, STEFANO LARENTIS, KYOUNGHWAM KIM, JIAMIN XUE, The University of Texas at Austin, DEVIN MCKENZIE, SHENGQIANG HUANG, MARINA PAGGEN, University of Arizona, MAZHAR ALI, ROBERT CAVA, Princeton University, EMANUEL TUTUC, The University of Texas at Austin, BRIAN J. LEROY, University of Arizona — Recently, semiconducting materials in the transition metal dichalcogenide (TMD) family have gained great popularity for use in novel graphene-based heterostructure devices such as tunneling transistors, highly efficient flexible photovoltaic devices, and nonvolatile memory cells. TMDs have also been explored as alternatives to hexagonal boron nitride (hBN) as substrates for pristine graphene devices. However, their quality has thus far been significantly worse than comparable hBN devices. We examine graphene on numerous TMD substrates (MoS_2, WS_2, WSe_2, $MoTe_2$) with scanning tunneling microscopy and spectroscopy and find that point and line defects intrinsic to all TMD crystals (both of natural and synthetic origin) result in scattering of electrons in graphene. Our findings suggest that the quality of graphene on TMD heterostructures is limited by the intrinsic crystalline quality of the TMDs.

Matthew Yankowitz
University of Arizona

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