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Atomically Thin One-Dimensional Contacts to Two-Dimensional Semiconductors MARCOS GUIMARAES, Kavli Institute at Cornell, Cornell University, Ithaca, New York 14853, USA, HUI GAO, KIBUM KANG, Department of Chemistry and Chemical Biology, Cornell University, Ithaca, New York 14853, USA, DANIEL RALPH, Department of Physics, Cornell University, Ithaca, New York 14853, USA, JIWOONG PARK, Department of Chemistry and Chemical Biology, Cornell University, Ithaca, New York 14853, USA — Two dimensional van der Waals materials, including graphene and transition metal dichalcogenides (TMDs), are promising candidates for atomically thin circuitry. However, electrical contacts to semiconducting TMDs made using metal electrodes (e.g. Ti, Au) show high contact resistances ($\geq$ 50 k$\Omega.\mu$m). This makes it difficult to study and utilize the intrinsic properties of TMD materials, and the 3D metal contacts add significant thickness to the final devices. Here we report one-dimensional, atomically-thin, lateral contacts between graphene and monolayer TMDs with low contact resistance. The graphene/TMD lateral heterostructures are mechanically strong, and the structural and electronic properties of each individual material are well preserved after the growth processes. The interface between graphene and MoS_2 shows a much lower resistance (below 20 k$\Omega.\mu$m) than conventional metal contacts despite its atomic thickness and one dimensionality. Our devices exhibit linear I-V characteristics and very weak temperature dependence down to 77 K, confirming the ohmic properties of our contacts. By studying graphene/WS_2 devices fabricated in a similar way we show that our method is universal and can be expanded to other two-dimensional semiconducting TMDs.

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