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Contacts and transport characteristics of few-layer transition metal dichalcogenides JUNJIE WANG, JING LI, JACOB SHEVRIN, AN NGUYEN, TOM MALLOUK, J. ZHU, Penn State University, University Park, Pennsylvania 16802, USA, DANIEL RHODES, LUIS BALICAS, National High Magnetic Field Laboratory, Florida State University, Tallahassee, Florida 32310, USA, K. WATANABE, T. TANIGUCHI, Advanced Materials Laboratory, National Institute for Materials Science, Japan — Two-dimensional layered transition metal dichalcogenides (TMDs) are potentially useful for electronic and optoelectronic applications. However, the lack of reliable methods to make ohmic contacts has been a major challenge. This work addresses two aspects of this challenge, i.e. interface cleanness and conductivity of the material in the contact area. Using gentle Ar ion milling immediately before the deposition of metal electrodes, we can completely remove polymer residue from prior lithography without significantly damaging the few-layer TMD sheet. Gate stacks made of Au and HfO_2 films can inject carriers up to 3×10^{13} cm^{-2}. We make van der Pauw devices of few-layer ($<$ 5 L) TMD (MoS_2, WS_2, WSe_2) sheets using Ti/Au contacts with area $<$ 2 $(um)^2$ and observe contact resistance less than 10 kΩ at high carrier densities, where the sheet conductance is well above $2e^2/h$. We eliminate hysteresis in the transfer curve of TMD devices by pulsing the gate voltage. Ambipolar conduction is observed in WSe_2 devices, with an on/off ratio exceeding 10^6 for both electrons and holes. WSe_2 devices supported on h-BN show field-effect (hole) mobility $>$ 100 $cm^2/(Vs)$ at 300K. We discuss the effects of the various approaches taken above.

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