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All-Metallic Vertical Transistors Based on Stacked Dirac Materials YANGYANG WANG[1], ZEYUAN NI, School of Physics, Peking University, QIHANG LIU, University of Colorado, RUGE QUHE, School of Physics, Peking University, JIAXIN ZHENG, School of Advanced Materials, Peking University, Shenzhen Graduate School, MENG YE, DAPENG YU, JUNJIE SHI, JINBO YANG, School of Physics, Peking University, JU LI, Massachusetts Institute of Technology, JING LU, School of Physics, Peking University, COLLABORATIVE INNOVATION CENTER OF QUANTUM MATTER, BEIJING COLLABORATION — All metallic transistor can be fabricated from pristine semimetallic Dirac materials (such as graphene, silicene, and germanene), but the on/off current ratio is very low. In a vertical heterostructure composed by two Dirac materials, the Dirac cones of the two materials survive the weak interlayer van der Waals interaction based on density functional theory method, and electron transport from the Dirac cone of one material to the one of the other material is therefore forbidden without assistance of phonon because of momentum mismatch. First-principles quantum transport simulations of the all-metallic vertical Dirac material heterostructure devices confirm the existence of a transport gap of over 0.4 eV, accompanied by a switching ratio of over 10^4. Such a striking behavior is robust against the relative rotation between the two Dirac materials and can be extended to twisted bilayer graphene. Therefore, all-metallic junction can be a semiconductor and novel avenue is opened up for Dirac material vertical structures in high-performance devices without opening their band gaps.

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