High Performance 2D Transistors Enabled by a Novel Contact Strategy

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ABSTRACT

As silicon-based transistors approach their ultimate size and performance limits, two-dimensional (2D) semiconductors such as transition metal dichalcogenides (TMDs) have emerged as a possible alternative candidate. Field-effect transistors (FETs) fabricated with TMD materials have shown relatively high carrier mobility and high on/off ratios. This combined with their unique optical and mechanical properties has motivated further investigation of TMDs as promising electronic materials. A major limitation in the study of carrier transport and the eventual applications of TMDs is their tendency to form a substantial Schottky/tunneling barrier with most metals commonly used to make electrical contacts. Several strategies have been explored in the past to reduce the contact barrier, but with limited success. We report a novel strategy for fabricating high-performance and low-power FETs of TMDs. Furthermore, we have also fabricated TMD devices with asymmetric contacts to elucidate the contact mechanism. The low-resistance ohmic contacts achieved with this strategy represent a new device paradigm that overcomes significant challenges that limit the performance of TMDs as channel materials. This contact strategy is also applicable to a wide range of other 2D semiconductors. Particularly, we have achieved a record high on/off ratio in black phosphorus FETs using this contact strategy.