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Ohmic contact engineering in few-layer black phosphorus field effect transistors

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Achieving a good quality Ohmic contact on van der Waals materials is a challenge, since at the interface between metal and van der Waals material, different interface conditions could apply, ranging from the presence of a large energy barrier to the metallization of the layered material below the contacts. In black phosphorus (bP) a further challenge is its high reactivity to oxygen and moisture, which makes comparison among different experiments difficult, since the presence of uncontrolled oxidation can substantially change the behavior of the contacts. In this study, we tested the influence of the metal used for the contacts against flakes and sample variability, using three of the most used metals as contacts: chromium, titanium, and nickel. From an analysis of nine different devices, using the transfer length method at both room and at low temperature, Ni appears to be the best candidate for Ohmic contacts to bP, providing the lowest contact resistance and a very low scattering between different devices. Moreover, we investigated the gate dependence of the current-voltage characteristics of these devices. In the accumulation regime, we observed good linearity for all metals investigated. The authors thank the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation program (Grant Agreement No. 670173) for funding the project PHOSFUN by an ERC Advanced Grant to MP.

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