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Coplanar Electrical Circuitry defined on an Atomically Thin Semiconductor Layer by Polymorphic Heteroepitaxy

We have fabricated coplanar field-effect transistors (FETs), where atomically thin semiconductors and metals are integrated within the single atomic-planes by polymorphic heteroepitaxy. To build this new device architecture, we utilized a concept of the crystal and electronic polymorphism in a certain class of two-dimensional (2D) transition-metal dichalcogenides (TMDCs); for the first time we have achieved coplanar heteroepitaxy of distinct metallic (1T') and semiconducting (2H) atomic layer crystals by a sequential chemical vapor deposition. It was verified that these coplanar metal-semiconductor contacts are atomically coherent, showing the lowest contact barrier height ever-reported, which immediately contributed to the substantial outperformance of the coplanar FETs over conventional top-contact 2D TMDC FETs. Synthetic integration of atomically-thin 2D electronic polymorphs in this work may establish a new design rule of the true 2D semiconductor circuitry, built with only one atomic layer.

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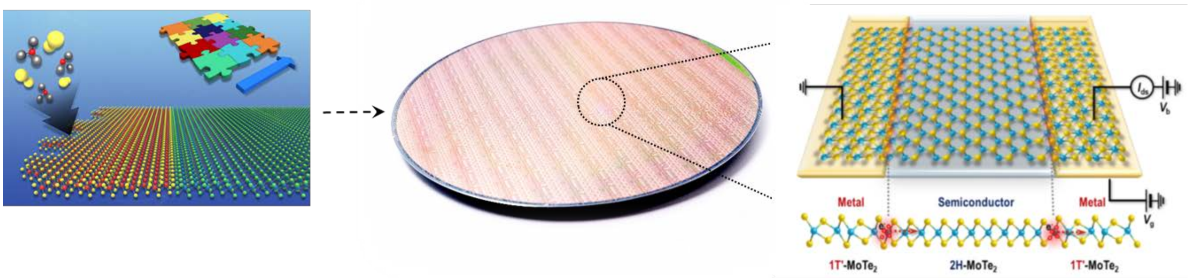

Figure 1: Atomically Thin Metal-Semiconductor Circuitry by Polymorphic $MoTe_2$ Heteroepitaxy