Strain engineering of Schottky barriers in single and few-layer MoS$_2$ vertical devices.

Jorge Quereda
Andres Castellanos-Gomez
Juan José Palacios
Nicolas Agrait
Gabino Rubio-Bollinger

Universidad Autónoma de Madrid, Madrid, Spain.
jorge.quereda@uam.es

Two-dimensional transition metal dichalcogenides have demonstrated a huge potential for the development of novel electronic devices. Among them, atomically thin MoS$_2$ raises special interest due to its relatively high carrier mobility and intrinsic 1.8 eV bandgap [1, 2]. Further, it has been recently demonstrated that the band structure of atomically thin MoS$_2$ crystals can be modified applying uniaxial or biaxial strain [3], enhancing even more their technological possibilities.

In this work we study experimentally the electron transport through vertical metal/atomically thin MoS$_2$/metal junctions, using a conductive AFM tip to contact single and few-layer MoS$_2$ crystals deposited onto a metallic substrate. Remarkably, even when the MoS$_2$ crystal is just one layer thick, two metal-semiconductor barriers are formed at the tip/MoS$_2$ and MoS$_2$/substrate interfaces. As a consequence, the structure shows a strong rectifying I-V characteristic. Furthermore, the rectification ratio of the I-V characteristic can be modified by applying mechanical pressure to the MoS$_2$ crystal with the AFM tip.

To further demonstrate the studied devices, we use them to rectify a periodic voltage, controlling the rectification ratio through the mechanical pressure applied with the AFM tip.

References


Figures

Figure 1: Schematic of the experimental setup: The semiconducting MoS$_2$ flake is sandwiched between a conductive ITO substrate and a metallic AFM tip. Two Schottky barriers are formed at the tip/MoS$_2$ and MoS$_2$/ITO interfaces.

Figure 2: Measured I-V characteristics of an atomically thin MoS$_2$ flake under four different tip-flake contact forces. Inset: Force-dependent rectification ratio measured at ±1V.