Highlights

Superconducting and correlated low dimensional materials and devices for quantum electronics and spintronic - 2018

Asymmetric Schottky Contacts in Bilayer MoS_2 Field Effect Transistors

Antonio Di Bartolomeo[1,2], Alessandro Grillo[1], Francesca Urban[1,2], Laura Iemmo[1,2], Filippo Giubileo[2], Giuseppe Luongo[1,2], Giampiero Amato[3], Luca Croin[3], Linfeng Sun[4], Shi-Jun Liang[5], and Lay Kee Ang[6]

[1]Physics Department, University of Salerno via Giovanni Paolo II n. 132, 84084 Fisciano, Salerno, Italy
[2] CNR-SPIN, c/o Università di Salerno- Via Giovanni Paolo II, 132 - 84084 - Fisciano (SA), Italy
[3]Istituto Nazionale di Ricerca Metrologica, INRIM—Strada delle Cacce, 10135, Torino, Italy
[4]Department of Energy Science, Sungkyunkwan University, Suwon 16419, Korea
[5]National Laboratory of Solid State Microstructures, School of Physics, Nanjing University, China
[6]Engineering Product Development (EPD), Singapore University of Technology and Design (SUTD), Singapore

ADVANCED FUNCTIONAL MATERIALS 28 (2018) 1800657

The high-bias electrical characteristics of back-gated field-effect transistors with chemical vapor deposition synthesized bilayer MoS_2 channel and Ti Schottky contacts are discussed. It is found that oxidized Ti contacts on MoS_2 form rectifying junctions with ≈0.3 to 0.5 eV Schottky barrier height. To explain the rectifying output characteristics of the transistors, a model is proposed based on two slightly asymmetric back-to-back Schottky barriers, where the highest current arises from image force barrier lowering at the electrically forced junction, while the reverse current is due to Schottky barrier-limited injection at the grounded junction. The device achieves a photoresponsivity greater than 2.5 A W^{-1} under 5 mW cm^{-2} white-LED light. By comparing two- and four-probe measurements, it is demonstrated that the hysteresis and persistent photoconductivity exhibited by the transistor are peculiarities of the MoS_2 channel rather than effects of the Ti/MoS_2 interface.

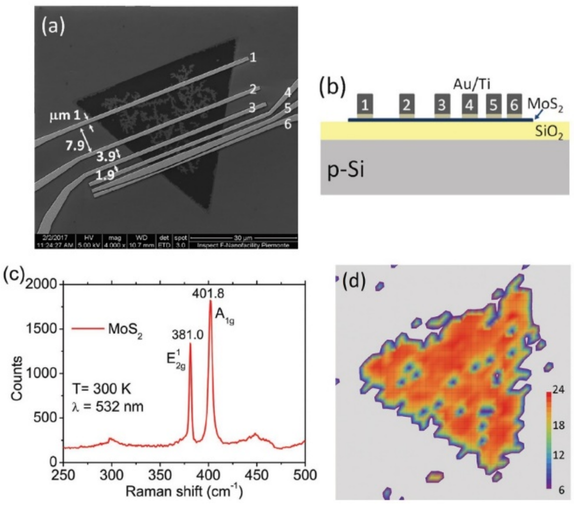

Fig.1: a) SEM top view of a CVD-synthesized bilayer MoS_2 with Ti/Au contacts. b) Schematic of the back-gate transistors. c) Raman spectrum of the bilayer MoS_2. d) Map of the difference between A_{1g} and E_{2g} peaks of micro-Raman spectra.

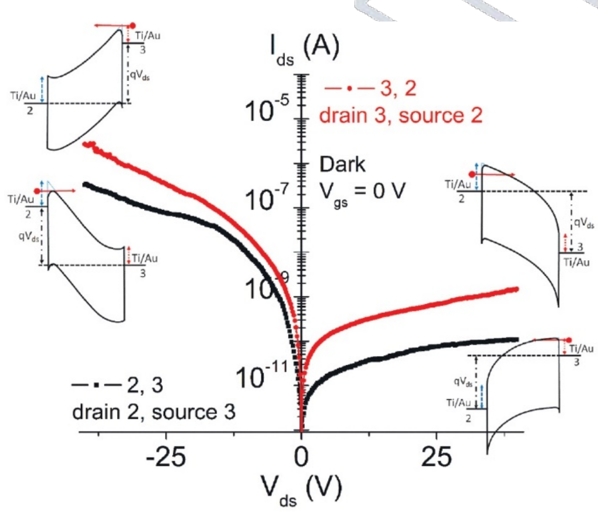

Fig.2: Band diagram based on two back-to-back Schottky barriers. The forward current for negative V_{ds} is due to the image force barrier lowering at the forced junction, while the lower (reverse) current at V_{ds} > 0 V is limited by the low electric field at the grounded junction.