Nonlinear analysis of the rectifying performance of zero-bias MoS_2-FETs for energy harvesting

A. Godoy[1,*], A. Medina-Rull[1], F. Pasadas[1], E. Reato[2], P. Palacios[3], M.C. Pardo[1], F. Ruiz[1], E.G. Marín[1], M. Saeed[3], Z. Wang[2], D. Neumaier[2], R. Negra[3] and M.C. Lemme[2]
[1]*Departamento de Electrónica y Tecnología de Computadores, PEARL Laboratory, Facultad de Ciencias, Universidad de Granada, 18071, Granada, Spain.*
[2]*AMO GmbH, Otto-Blumenthal-Strasse 25, 52074 Aachen, Germany.*
[3]*Chair of High Frequency Electronics, RWTH University, Kopernikusstraße 16, 52074 Aachen, Germany.*
*agodoy@ugr.es

The main purpose of wireless energy harvesting is converting the far-field radiofrequency (RF) energy into direct current (DC) energy, able to power electronic devices, by using a rectenna. The central element that enables this conversion is the rectifier and the choice of such nonlinear device is critical as it is the central component that limits the overall efficiency and operation frequency [1]. In this work, we analyse the rectifying performance of zero-bias MoS_2 field-effect transistors (FETs) as power detectors. In doing so, we have fabricated MoS_2-FETs on wafer-scale flexible substrates (Figure 1) [2] and calibrated our physics-based large-signal model of 2D-semiconductor FETs [3] with DC (Figure 1b) and RF (Figure 1c) measurements. We have incorporated our technology computer-aided design (TCAD) tool in a commercial circuit simulator to explore and optimize the rectifying performance in terms of maximum current responsivity and cut-off frequency. In order to assess the feasibility of our MoS_2-FETs as rectifiers for future flexible rectennas targeting energy harvesting purposes, different practical ambient/dedicated RF sources have been considered and the results have been put into context against the state of the art.

References

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Figures

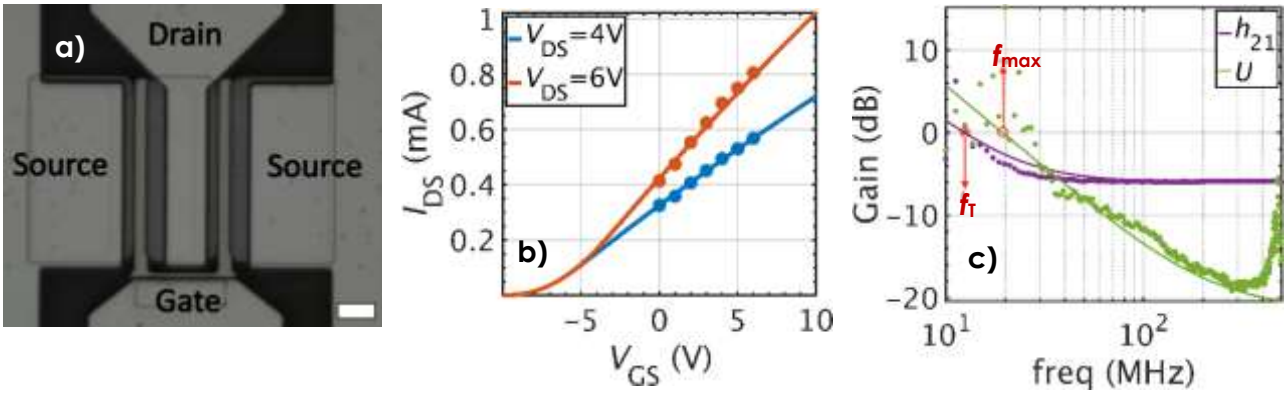

Figure 1: a) Optical micrograph of the fabricated MoS_2-FET. The MoS_2 channel is 6 µm long and 60 µm width and the scale bar is 16 µm long. Measurements (symbols) and simulations (solid lines) of **b)** the transfer characteristics and **c)** the RF performance at a bias point V_{GS} = 4V; V_{DS} = 6V. The cut-off (f_T) and the maximum oscillation (f_{max}) frequencies are highlighted in red.