Multi-mode photodetection of van der Waals ReS_2/Si 2D/3D heterostructure

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2D/3D van der Waals heterostructures offer a new, promising platform for multifunctional photodetectors, combining the advantages of both 2D layered materials and 3D traditional bulk materials [1]. In this context, we fabricate and characterize a type II n-ReS_2/n-Si heterojunction, exploiting the direct bandgap and the weak coupling between ReS_2 layers, together with the mature fabrication knowledge of Si [2]. The device behaves as a diode with a low reverse current of nA and a high rectification ratio. Temperature dependent measurements, which were carried out both in the dark and under laser illumination, are used to extract the dominant Schottky barrier [3]. The photocurrent, recorded using a laser source, strongly increases as a function of the power intensity, yielding promising responsivity values. Additionally, a stable and repeatable switching behaviour is reported. The device can also operate in open circuit conditions, reaching high photocurrent values and a high-speed response in the order of 100 µs. These results encourage future applications of ReS_2/Si heterostructures as high speed and broadband photodetectors.

References

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[2] Intonti, K.; Faella, E.; Kumar, A.; Viscardi, L.; Giubileo, F.; Martucciello, N.; Lam, H. T.; Anastasiou, K.; Craciun, M.; Russo, S.; Di Bartolomeo, A. Temperature-Dependent Conduction and Photoresponse in Few-Layer ReS 2. ACS Appl. Mater. Interfaces 2023, 15 (43), 50302–50311.
[3] Pelella, A.; Grillo, A.; Faella, E.; Luongo, G.; Askari, M. B.; Di Bartolomeo, A. Graphene–Silicon Device for Visible and Infrared Photodetection. ACS Appl. Mater. Interfaces 2021, 13 (40)

Figures

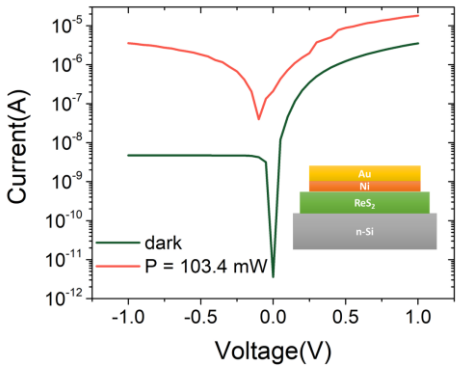

Figure 1: Current-Voltage curve in the dark and under laser illumination.

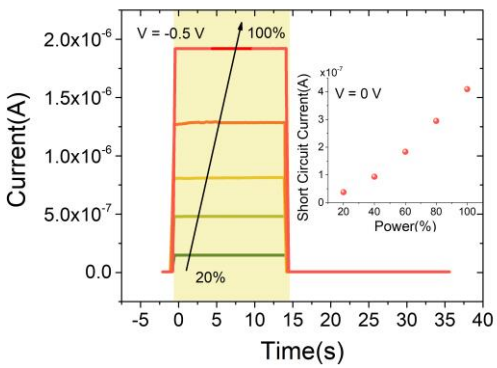

Figure 2: Laser pulses of increasing incident power at V = -0.5 V. In the inset, short circuit current recorded at V = 0 V as a function of increasing laser power.