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Photodetection and electroluminescence in single layer MoS2

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Molybdenum disulphide (MoS_2), a layered quasi-2 dimensional (2d) chalcogenide material[1-3], is subject of intense research because of its electronic[4] and optical properties[5], such as strong photoluminescence (PL)[5, 6], controllable valley and spin polarization[7, 8]and a large on-off ratio in field effect transistors (FETs)[4]. This combination of electrical and optical properties suggests that 1L-MoS_2 is a promising candidate for novel optoelectronic devices, such as 2d photodetectors[9, 10], and light-emitting devices. Here, we study photodetectors fabricated based on 1L-MoS_2[11]. Using spatially resolved photocurrent measurements we characterize the active areas of photodetection. Devices fabricated with Au source and drain electrodes show zero net photocurrent under zero bias conditions with charge separation occurring in the vicinity of the contacts. However, a strong built in potential within the channel is observed in devices fabricated with asymmetric drain-source contacts using thermally evaporated Au and Pt. This results in a net photocurrent at zero bias. Furthermore, we exploit the direct band gap of 1L-MoS_2 to demonstrate electrically excited luminescence in devices made of 1L-MoS_2 and study the underlying emission mechanism. We find that the electroluminescence occurs via hot carrier processes and is localized in the region of the contacts. The observed photoluminescence and electroluminescence arise from the same excited state at 1.8eV. Our results show that single layer MoS_2 is promising for novel optoelectronic devices, such as 2-dimensional light detectors and emitters.

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