Light emission and detection in single layer MoS_2

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Abstract

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(figure 1a). The observed photoluminescence and electroluminescence arise from the same excited state at 1.8eV(figure 1b)

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Figure

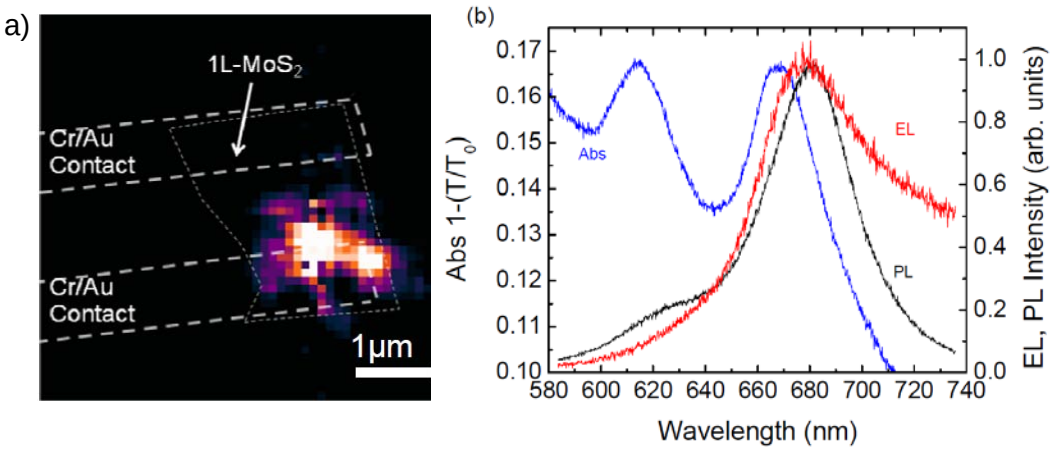

Figure 1. (a) False color image showing EL emission in the vicinity of a contact edge. The positions of Cr/Au contacts are highlighted by thick dashed lines (white) and the MoS2 layer is indicated by thin dashed lines (grey). Absorption (Abs), EL, and PL spectra on the same 1L-MoS_2.