Highlights

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Electrical transport and persistent photoconductivity in monolayer MoS_2 phototransistors

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We study electrical transport properties in exfoliated molybdenum disulfide (MoS_2) back-gated field effect transistors at low drain bias and under different illumination intensities. It is found that photoconductive and photogating effect as well as space charge limited conduction can simultaneously occur. We point out that the photoconductivity increases logarithmically with the light intensity and can persist with a decay time longer than 10^4 s, due to photo-charge trapping at the MoS_2/SiO_2 interface and in MoS_2 defects. The transfer characteristics present hysteresis that is enhanced by illumination. At low drain bias, the devices feature low contact resistance of 1.4 kΩ mm^{-1}, ON current as high as 1.25 nA μm^{-1}, 10^5 ON–OFF ratio, mobility of ⍰1 cm^2 V^{-1} s^{-1} and photoresponsivity of about 1 A W^{-1}. Electrical measurements were performed in a Janis ST-500 cryogenic probe station connected to a Keithley 4200-SCS semiconductor parameter analyzer at room temperature and at an air pressure of 30 mbar to possibly remove moisture and limit oxygen adsorption on the MoS_2 surface. Optoelectronic properties were investigated by irradiation under visible light from an array of white LEDs (spectrum in the range 400–750 nm and peaks at 450 and 540 nm), with tunable intensity up to 5.5mWcm^{-2}.

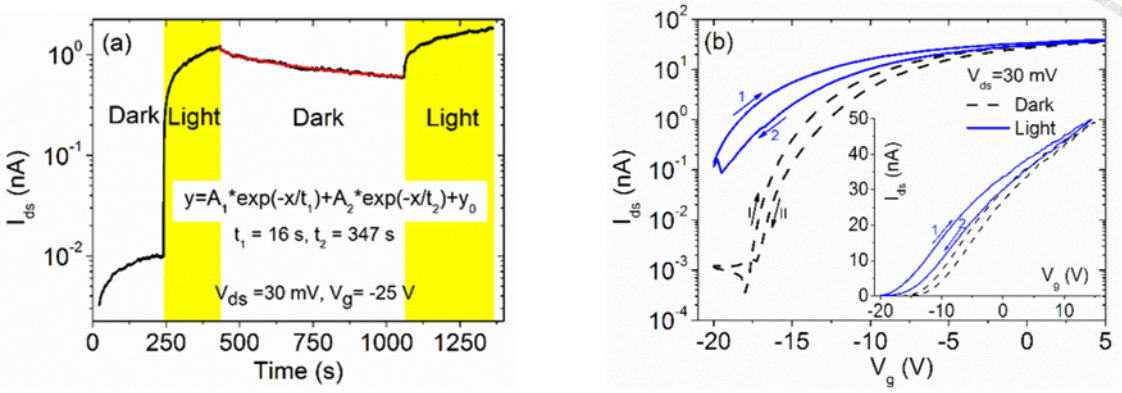

Fig.1: (a) Channel current versus time with and without light. (b) Comparison of transfer characteristics in dark and under illumination (the inset shows the current in linear scale).