Scalable MoS_2 phototransistors with ultra low power consumption and high light/dark current ratios

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Abstract

Over the last 12 years, there were a lot of investigations on the basic properties of two dimensional (2D) materials. An amount of interesting properties have been observed by using techniques which are adapted only for research purpose. All of these methods are not scalable, which delays the process of mass production of electronics. Recently, how to build up scalable devices with commercial realistic properties has attracted attention of global researchers. In this work, we fabricated scalable MoS_2 phototransistors using scalable processes, such as chemical vapor deposition (CVD), photolithography, e-beam evaporation and plasma ion etching (see figure 1). Results indicate successful fabrication of MoS_2 phototransistors, as the typical output and transfer characteristics have been observed. The phototransistors show ultra low power consumption and high light/dark current ratios. The hysteresis of the devices has been minimized by introducing an annealing step with controlled time (after fabrication process). By studying the MoS_2 channels after a longer annealing process, we observe that these performances are related to the small domain size of the polycrystalline monolayer MoS_2 sheet (164 ± 54 nm in diameter, see figure 2).

Figure

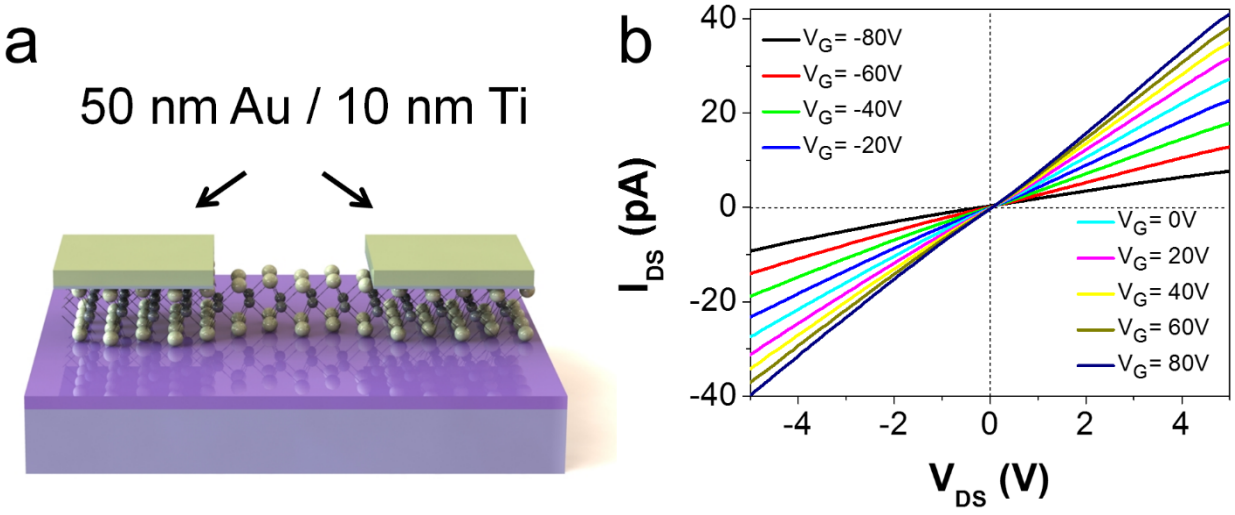

Figure 1. (a) Schematic of the monolayer MoS_2 phototransistor; (b) Output characteristic at different back-gate voltages for the MoS_2 phototransistors with channel width of 20 μm.