Enabling MoS2 memtransistors via localised helium ion beam irradiation

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Memristors are two-terminal switches which can retain a state of internal electrical resistance based on the history of applied voltage and current. They are the key to neuromorphic hardware and in-memory processing. Recently, resistive switching has been observed over a naturally-occurring grain boundary in MoS_2 monolayers. However, their performance needs to be significantly improved, and viable approaches to incorporate them into the existing silicon technologies are yet to be developed. In this work, we demonstrate a MoS_2-based memristor via helium ion beam irradiation. The localized ion irradiation introduces site-specific sulphur vacancies in the MoS_2 flake (see Figure 1(a)). The migration of the vacancies under the external electric field induces the resistance switching. We will discuss the viability of further device optimization and large-scale integration.

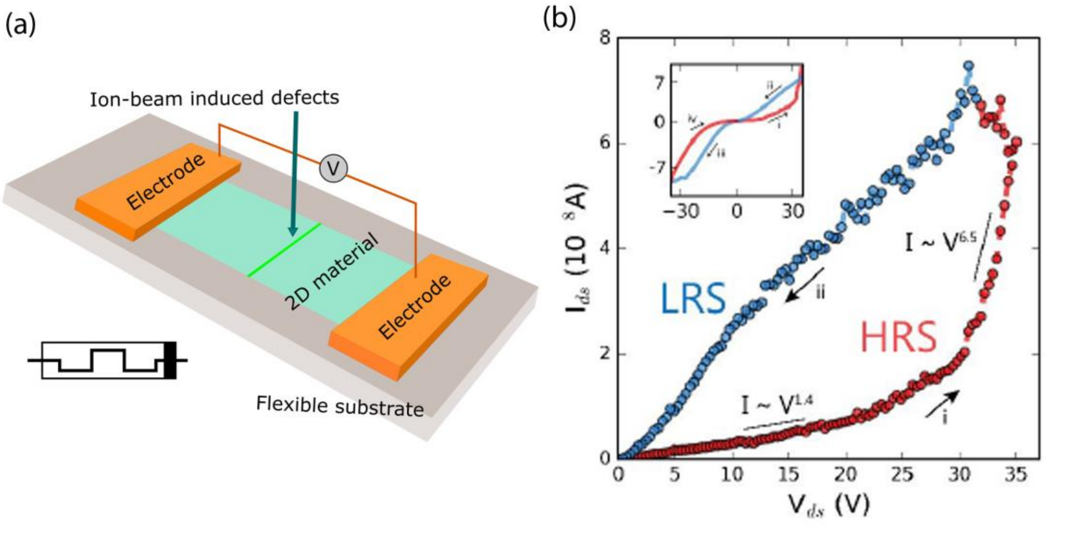

Figure 1 (a) Illustration of the irradiation strategy and the device structure. (b) Positive-bias sweep region of an irradiated monolayer memtransistor device (L = 1 μm, W = 6 μm) recorded at Vg = 0 V. Inset: full range of the sweep with labelled trace directions. A sharp emergence of non-linearity in the I-V sweep marks the set point from the high resistance state (HRS) to the low resistance state (LRS). The device stays in LRS until a reset bias of negative polarity is reached on the reverse sweep.