Enhanced 2D $MoTe_2$ Analogue Switching Through Laser Processing and ALD-Passivation for Dual-Function Neuromorphic Devices

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Neuro-based computing, enabled by memristors and memtransistors, has drawn significant attention, with Two-dimensional (2D) molybdenum ditelluride ($MoTe_2$) emerging as a promising candidate for its low phase-change energy barrier and tunable electrical behavior. However, realizing the full potential of $MoTe_2$ for neuromorphic applications has been hindered by the lack of a sufficiently large memory window in pristine devices. In this work, we present an effective method to significantly enhance the analogue switching of lateral $MoTe_2$ devices. This method involves two sequential processes: laser treatment followed by atomic layer deposition of Al_2O_3. The synergistic effects of both processes yielded significant performance improvements, with a 70-fold improvement in dynamic range when operating as a memristor and a 20-fold enhancement when functioning as a memtransistor. Consequently, artificial neural network simulations demonstrated 10-fold enhancement in pattern recognition accuracy, while the dual memristor/memtransistor capability enabled the emulation of both homosynaptic and heterosynaptic plasticity.

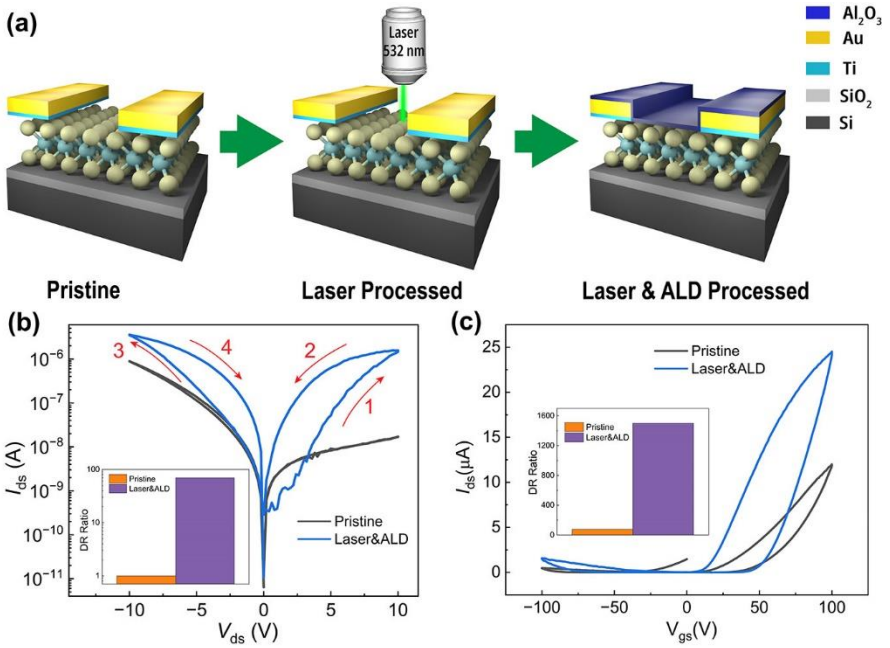

Figure 1. a) Schematic of pristine, laser processed, and laser & ALD processed $MoTe_2$ devices. b) I_{ds}-V_{ds} characteristics of the pristine and processed (laser & ALD) $MoTe_2$ memristors. The inset shows dynamic range (DR) ratio for both memristors (DR calculated at V_{ds} = 2V). c) I_{ds}-V_{gs} characteristics of the pristine and processed (laser & ALD) $MoTe_2$ memtransistors at V_{ds}=1 V. The inset shows DR ratio for both memtransistors (DR calculated at V_{gs} = 25V). The laser & ALD processed device was optically treated for 10 min with 532 nm laser beam, followed by the ALD deposition of 20 nm Al_2O_3 at 130 °C [1].

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