Site-specific Laser Annealing of low temperature ALD-grown MoS_2 for enhanced electron device performance

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Owing to the advancement in field of 2D transition metal dichalcogenides (TMDs) [1][2], it has become essential to optimise their performance for integration in electronics. In this study, we report an ultrashort pulsed laser annealing (PLA) process for specific, localised modification of ALD-grown crystalline MoS_2 thin films. PLA was performed with a 515 nm wavelength, operated at a pulse repetition frequency of 100 KHz. The thin films were grown at 350^{0}C, followed by device fabrication. Multiple two-point resistor structures with varying MoS_2 channel widths were fabricated on a 15 mmx15 mm chip using optical lithography to ensure the application of various laser conditions on the same chip, as shown in Fig.1(a), thus avoiding chip to chip variability. These devices were electrically measured prior to site-specific femto-second (fs) PLA. Thereafter, a wide range of laser fluences were used varying from 5.8-8.1 mJ/cm^2 with a different number of scans, with the laser processing focused only on the exposed MoS2 regions of the devices. The devices were re-measured electrically post-PLA to see the difference in the resistance. It was observed that the resistance of MoS_2 decreased by almost 50% post PLA, as shown in Fig. 1(b). The device chip was also characterised using metrology techniques such as AFM, SEM and XPS to determine the change in morphology and stoichiometry because of PLA, to correlate the electrical modification with changes in physical properties. Overall, the localised PLA proved to be an efficient way to locally modify MoS2 for enhanced electron device performance.

References

[1] B. Radisavljevic et al., Nature Nanotechnology 6, no.3 (2011):147–150
[2] Q.H. Wang et al., Nature Nanotechnology 7, no.11(2012):699–712

Figures

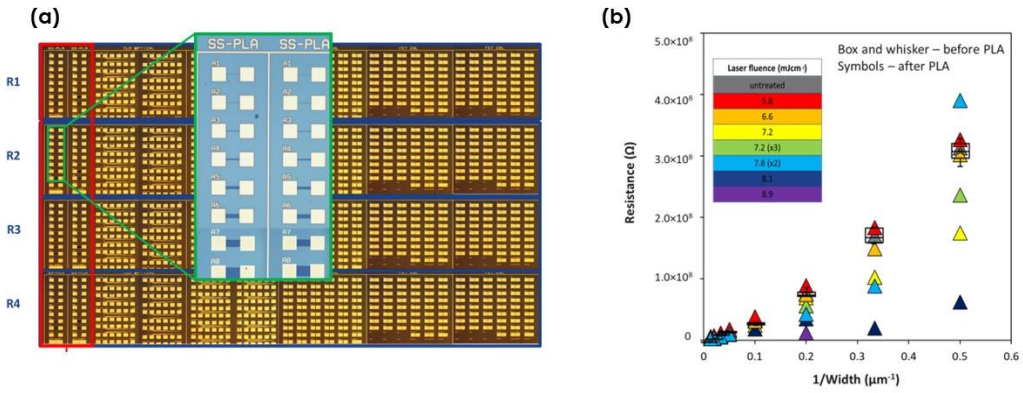

Figure 1: (a) Representative optical microscopy image of the as-fabricated device chip. Zoom in: 2-point resistor structures with varying MoS_2 channel widths; (b) Resistance variation with the reciprocal of width of MoS_2 channels before and after laser annealing.