

Interface Properties of Multilayer MoS₂ Thin-Film Transistors

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There is a great interest in transition metal dichalcogenides (TMDs) such as MoS₂ because of their interesting electronic and optical properties.¹ Single or multilayer MoS₂ exhibits intriguing characteristics: relatively large bandgap (1.2 - 1.9 eV), high mobility at room temperature (up to ~100 cm²V⁻¹s⁻¹), low subthreshold swing (SS ~70 mV decade⁻¹), and an absence of dangling bonds.²⁻⁴ However, one of the challenges to realize high performance MoS₂ thin-film transistors (TFTs) is the detailed understanding and control of the interfaces of TMDs with contacts and dielectrics. Without the deposition of high-quality dielectrics on TMDs and the formation of low-resistivity metal-MoS₂ junctions, any attempts to improve transistor performance can be fundamentally hampered.^{5,6} This talk will present a review of our recent studies of multilayer MoS₂ TFTs in this context investigating the selective annealing of Ti/Au metal contacts using picosecond ultra-fast pulsed laser and the variability of electrical properties of Ti contacts. The reduced contact resistance after laser annealing provided significant improvement in transistor performance including higher peak field-effect mobility, increased output resistance, increased self-gain, and decreased subthreshold swing (Fig. 1). Furthermore, current-voltage characteristics from room temperature to 240°C demonstrate the formation of Schottky contacts as well as ohmic contacts at Ti-MoS₂ junctions of MoS₂ TFTs, suggesting that the variability of metal contacts on MoS₂ may originate from the intrinsic variability of defect distribution in naturally-occurring MoS₂ crystals (Fig. 1). These results demonstrate the importance of interface properties of MoS₂ TFTs, providing important implications for the application of high-performance two-dimensional semiconductor TFTs toward flexible electronics.

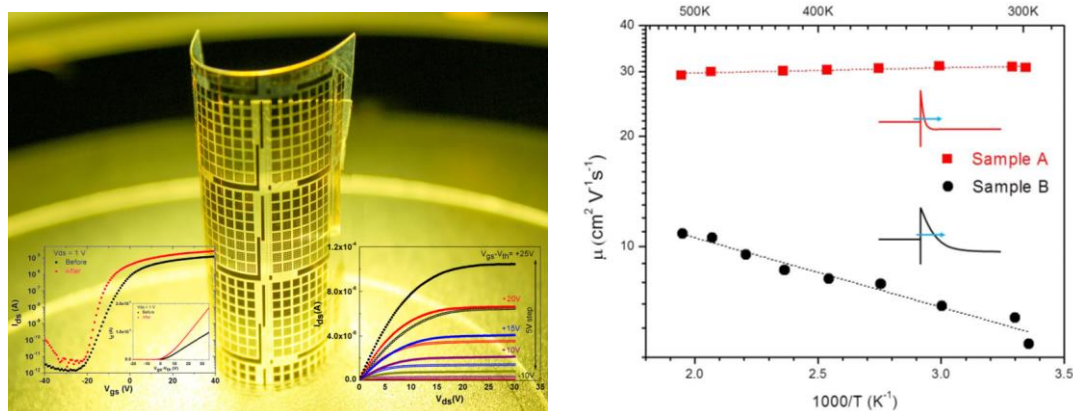


Fig. 1. Multilayer MoS₂ transistors fabricated on flexible substrates. Inset shows the transfer and output transistor characteristics before and after laser annealing of contacts (left). Field effect mobility of two distinct multilayer MoS₂ transistors, labeled as Samples A and B, as a function of inverse temperature. Inset shows schematic energy band diagrams of Samples A and B at the Ti-MoS₂ junction (right).

References

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