# Single-layer $MOS_2$ - 2D devices and circuits beyond graphene

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After quantum dots, nanotubes and nanowires, two-dimensional materials in the shape of sheets with atomic-scale thickness represent the newest addition to the diverse family of nanoscale materials. Single-layer molybdenum disulphide ($MoS_2$), a direct-gap semiconductor is a typical example of new graphene-like materials that can be produced using the adhesive-tape based cleavage technique originally developed for graphene. The presence of a band gap in $MoS_2$ allowed us to fabricate transistors that can be turned off and operate with negligible leakage currents [1]. Furthermore, our transistors can be used to build simple integrated circuits capable of performing logic operations and amplifying small signals [2] [3].

I will report here on high-performance 2D $MoS_2$ transistors with increased currents and transconductance due to enhanced electrostatic control [4]. Our devices also show current saturation for the first time in a 2D semiconductor. Electrical breakdown measurements of our devices show that $MoS_2$ can support very high current densities, exceeding the current carrying capacity of copper by a factor of fifty. We have also successfully integrated graphene with $MoS_2$ into heterostructures to form flash memory cells [5]. Next, I will show optoelectronic devices based on $MoS_2$ that have a sensitivity surpassing that of similar graphene devices by several orders of magnitude [6]. Finally, I will present temperature-dependent electrical transport and mobility measurements that show clear mobility enhancement due to the suppression of the influence of charge impurities with the deposition of an $HfO_2$ capping layer [7].

## References

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