Telecommunications beyond Silicon: One atom thick chalcogenide photodiodes

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One atom thick, two dimensional materials exhibit remarkable properties and are strong contenders to lead the way to the post silicon era. Graphene, the first two dimensional material has carrier mobility up to 200,000 $cm^2/V^{-1}s^{-1}$ [1]. This makes it a perfect candidate for high frequency electronic devices. However the lack of a bandgap limits it use for future optoelectronic fast devices. Two dimensional transition metal chalcogenides (TMDC's) are semiconductors of the type MX_2 where M is a transition metal and X a chalcogen atom, such as sulphur, selenium or tellurium[2][3]. In electronic applications, this group of 2D materials has the potential to outperform silicon and more importantly even graphene. When going from bulk to two dimensions, TMDC's also exhibit a direct band gap allowing for switching current ratios up to 10^8 [4]. Remarkably, this band gap can be fine-tuned simply by changing the number of the atomic layers giving unprecedented device versatility.[5]

We demonstrate promising results on atomically thin, one layer and multi-layer MoS_2 (molybdenum disulphide) based photo transistors with high responsivity and high on / off current ratio.

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