Large scale compatible stabilization of a 2D semiconductor platform toward RF applications

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Atomically-thin 2D materials have drawn considerable attention in the past years with potential applications ranging from transistors to optoelectronics [1]-[3]. As such, they are now foreseen as strong candidates for epitaxy-free technologies and the tetrad of size-weight-power-and-cost (SWAP-C) reduction. Targeting radiofrequency (RF) applications, the 2D semiconducting Transition Metal DiChalcogenides (TMDC) family as well as black phosphorus could offer the opportunity of wide tunability of their electronic properties, providing a large variety of band gaps. However, evaluation and integration of those materials into discrete components requires a stabilization of their properties. We evaluated a large-scale compatible process [4] on large area (> 1000 μm^2) monolayers of the prototypical MoS_2 and phosphorene. The process was developed including pre and post patterning protection/passivation layers. For MoS_2, it was shown to reduce the initial natural p-doping of the sample, lead to lower transistor threshold voltages, a 10^6 I_{ON}/I_{OFF} ratio and a field-effect mobility under ambient conditions up to 19.5 cm^2/V.s (~40 fold increase compared to a conventional process) (see Figure 1). Our work represents an important step towards the integration of 2D TMDCs in RF circuits and components.

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Figures

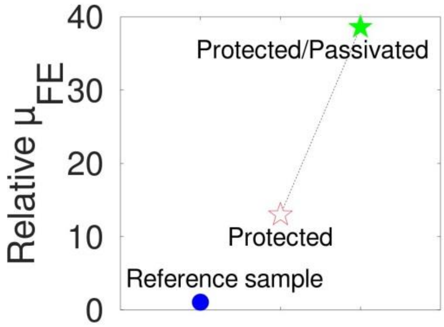

Figure 1: Relative field-effect mobility of MoS_2 at the different step of the protection/passivation process