

MoS₂ integration in microelectronic devices

C. Ligaud¹

B. Reig¹, M. Jamet², J. David-Viffantzeff¹, S. Cadot¹, L. Le Van-Jodin¹

¹CEA, Letil, Univ. Grenoble-Alpes, 38000 Grenoble, France

²RIG SPINTEC, Univ. Grenoble-Alpes, CEA, 38000 Grenoble, France

clotilde.ligaud@cea.fr

The outstanding and unique 2D materials properties will allow the fabrication of smaller and more efficient new generation electronic devices. However, up to now, their integration remains a challenge. Indeed, most of the best demonstrations reported in the literature were fabricated using mechanical exfoliation of micrometric flakes^[1].

To make possible the industrialization of 2D materials based devices on large-scale wafer, the following three main steps need to be addressed. First, the growth of 2D materials on wafer-scale substrates^[1]. Then, the development of a wafer-scale transfer process, compatible with clean room and microelectronic standard equipments. Finally, the adaptation of devices fabrication technologies to fragile 2D materials^[2].

We report in this work the successful total transfer of large area CVD grown MoS₂ multilayers on electronic devices. Then, several transfer methods are compared in terms of clean room compatibility, transferred surface area and induced contamination. Finally, MoS₂ is patterned by photolithography and contacted with gold electrodes (cf. Figure 1). Raman spectroscopy performed at each process step shows that the 2D material retains its crystalline quality throughout the fabrication (cf. Figure 2). Finally, we investigated the performance of our device through the measurement of contact resistance and electrical mobility.

References

- [1] Cadot, Stephane, Olivier Renault, Mathieu Fregnaux, Denis Rouchon, Emmanuel Nolot, Kai Szeto, Chloe Thieuleux, et al. « A Novel 2-Step ALD Route to Ultra-Thin MoS₂ Films on SiO₂ through a Surface Organometallic Intermediate ». *Nanoscale* 9, n° 2 (14 janvier 2017): 538-46.
- [2] Neumaier, Daniel, Stephan Pindl, et Max C. Lemme. « Integrating Graphene into Semiconductor Fabrication Lines ». *Nature Materials* 18, n° 6 (june 2019): 525-29.

Figures

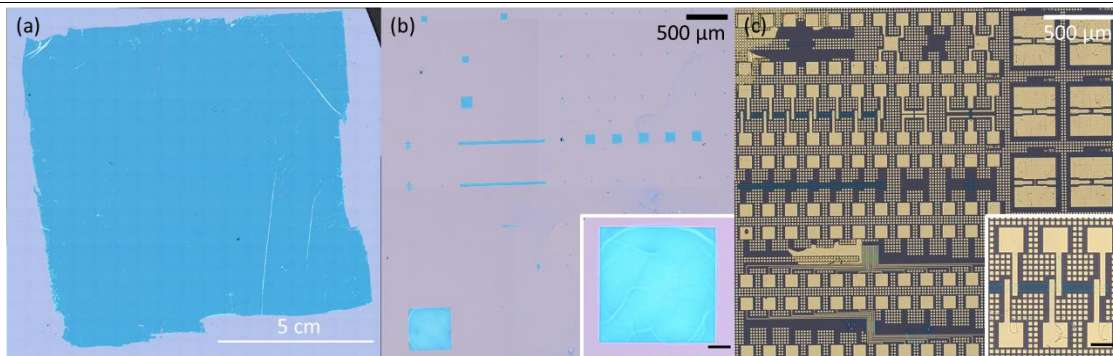


Figure 1: Integration of MoS₂ in devices (a): after wet PMMA transfer on SiO₂ substrate, (b): after patterning and (c): after the deposition of Au electrodes. Insets in (b) and (c) pictures show enlarged 2D areas: scale bars length: 100 μm.

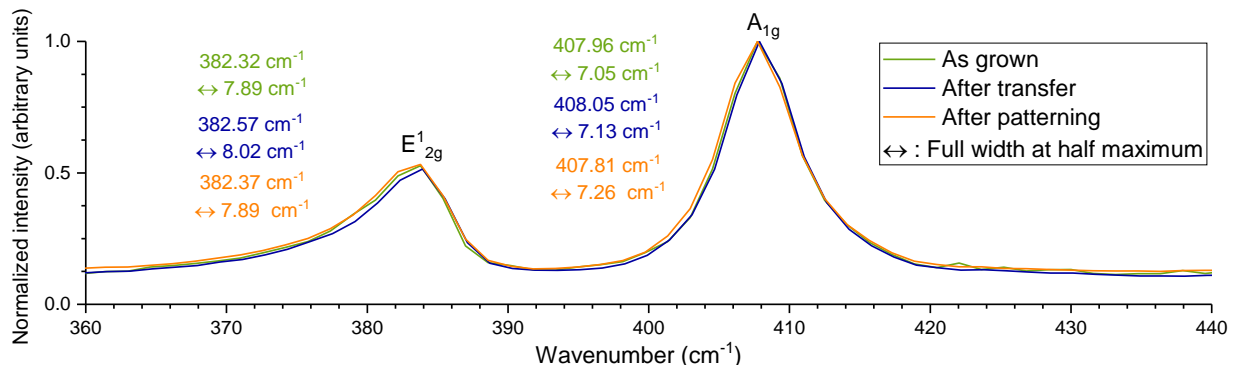


Figure 2: Raman spectra (average of 25 scans on the sample) at different steps during MoS₂ integration. Peak positions and full width at half maximum are given for each spectrum.