MSCA contingency plan: the lifeguard during the pandemic

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How the contingency plan of the action is serving as an international hub to advance in the semiconductor scaling.

- **The MSCA framework**

Marie Skłodowska-Curie Action (MSCA) supports innovative and ground-breaking ideas whose development would potentially benefit the Society and the applicants' career. These ideas are included in a meticulous proposal that defines the execution of the action. Work packages, objectives, milestones, and potential results are carefully described. And, at the end, the project should include a contingency plan, a part which is usually not so extensive and whose content could even pass unnoticed. Probably, no one could have anticipated the global pandemic while writing the contingency plan of an MSCA two years ago (or at least, I couldn't have). However, reality exceeds fiction, and here we are. Now, for some of us the contingency plan has become the project's lifeguard. Additionally, in my case, it has also contributed to perform a wider collaboration than initially planned.

- **The project and the Covid-19 pandemic**

The MSCA project, *Understanding The Role of the defects to Accomplish high Performance and Stable Two Dimensional Devices (TRAPS-2D),* aims to fabricate semiconductor devices employing novel two-dimensional (2D) materials. These 2D materials are single-atom-thick layers whose electrical properties allow us to perform more scalable, reliable and powerful circuits and chips. MSCA Global fellowships require an outgoing phase and we have chosen Taiwan, the unmatched leader of the global semiconductor industry. However, the pandemic and the subsequent lockdown threatened the outgoing phase from the very beginning.

After the initial chaos of the pandemic and the end of the initial lockdown, things seemed to be improving with the incidence low enough to plan how to launch the action. Moreover, by these dates, the pandemic in Taiwan was under control thanks to the prompt response of the local

government. With all the parameters looking in our favor, we started the action. The initial delay to get the visa was compensated for by starting the project remotely, fabricating devices in the host institution laboratory, and holding online supervision meetings.

- **Delta variant and the Contingency Plan**

Once the visa was obtained and the flights and the quarantine hotel stays were booked, and as I was almost getting ready to proceed with our outgoing phase part of the project, the Delta variant of COVID-19 suddenly surged and struck India and close Asian areas. As a result, on the advice of the Taiwan Centers for Disease Control, Taiwan's Government suspended the entrance for foreign nationals who do not hold a valid resident certificate. These successful measures have demonstrated to block the spread of the virus, but they definitely blocked me too.

At that time, there were just two possibilities: one option was to ask for a break in the project until the situation would improve and, the second one was to activate the contingency plan. The first solution would have dismantled the previous work. The remote supervision was working perfectly with promising initial results in both, the sample fabrication and characterization. Breaking the project and putting the action apart for an uncertain period of time would have weakened the novelty of the project and damaged the originality of the results. The second option was risky because the contingency plan did not initially cover the consequences of a global pandemic but, at least, it allowed us to keep the project goals in mind. It consists of fabrication of the samples in the host institution and then sending devices to be processed in Taiwan and in other state-of-the-art semiconductor centers in Europe to increase the chances of success. Our recent collaboration with Prof. Paul Hurley's group at Tyndall National Institute, Ireland, perfectly fitted with the contingency plan requirements. In order to fulfill the action objectives, I would initially receive the planned training in Ireland while some samples could be remotely processed in Taiwan. Despite the possible risks of this latter alternative, we decided to adapt the contingency plan to the pandemic with the support of our collaborators and the approval of the project officer.

- **Wider international collaboration and results**

Fortunately, what seemed a dead-end has become a three-party international collaboration in the race for semiconductor scaling. While I am waiting to visit Taiwan after the covid incidence reduces, this incipient collaboration has brought impressive advances in our project. At the host institution, we have successfully synthesized the target samples using the chemical vapor deposition technique (Figure 1.a). Then, we have carried out the structural characterization (Figure 1.b). At Tyndall National Institute these samples have been metallized to fabricate devices. The electrical characterization of these devices has demonstrated interesting capabilities for sensing applications (Figure 1.d). For example, the operation of the devices has demonstrated a strong dependence on the ambient conditions. This dependence can be used to implement light or temperature sensors. Simultaneously, some samples are being processed employing alternative technologies in Taiwan.

With the continuous collaboration of the three groups, we recently published several manuscripts (Figure 1.e depicts the one showing the light-sensing of MoS_2 devices (Marquez et al., 2021)) and

others are being written. In this framework, we have recently received an invitation to contribute to one of the most important conferences on this topic (IEEE, IRDS and International Nanodevices Conference).

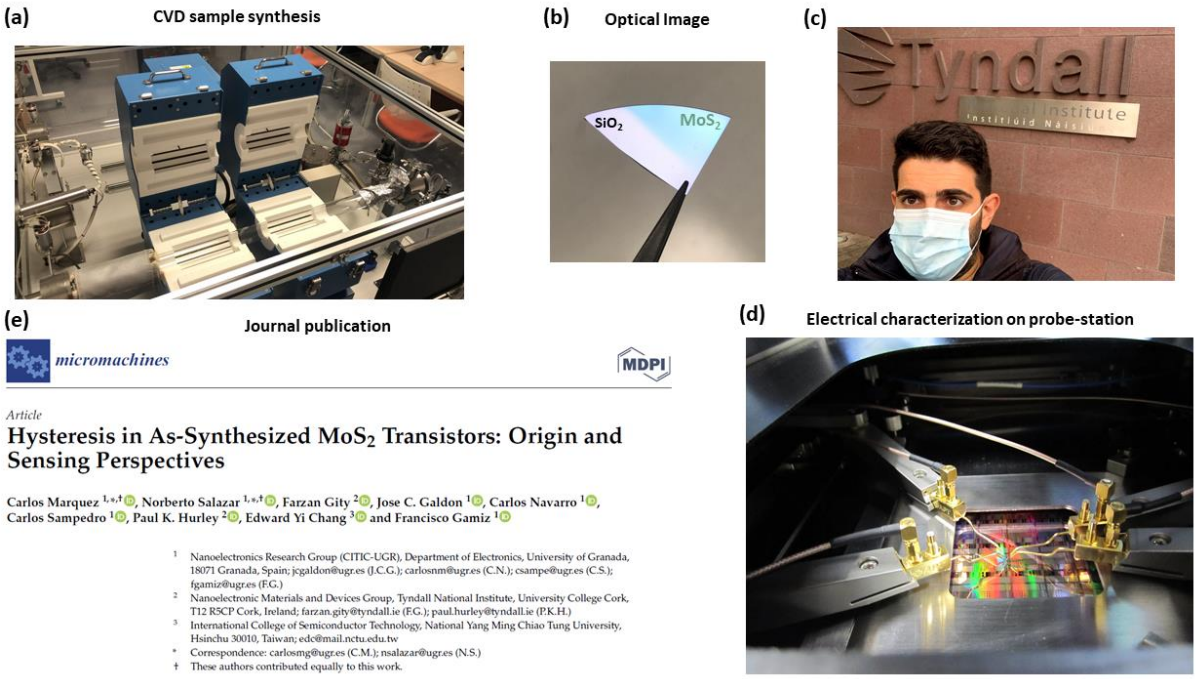

Figure 1. **a) Chemical vapor deposition furnace located at University of Granada and used for the synthesis of two-dimensional materials. b) Optical image of a MoS_2 layer deposited on a SiO_2/Si structure used to perform electronic devices. c) Me at the Tyndall National Institute in Ireland where some of the sample processing has been carried out. d) Image showing the electrical characterization of devices using a probe station. e) One of our recent publications in which the sensing perspective of the synthesized MoS_2 devices has been evaluated.**

- **Conclusion**

Covid-19 pandemic has brought difficulties in all aspects of daily life, and research is not an exception. Many researchers are worried about the challenges that the mobility restrictions have brought in these international actions. However, the contingency plan that was put together with the support of our collaborators and the European Commission MSCA board, has helped us in dealing with the actual limitations and creating new opportunities from the adversity.

I hope that this personal experience will help other researchers that face similar challenges.

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- **Bibliography**

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