Designing a More Robust MOCVD System at PARADIM

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Abstract:

Two-dimensional transition metal dichalcogenides (TMDs) are widely used throughout the industries of modern technology. Metal-organic chemical vapor deposition (MOCVD) is a technique to produce these TMD thin films on a technologically relevant scale. To grow these films more readily, the MOCVD system used must be in the most robust state possible. Start with examining the mechanical parts of the MOCVD and the area of concern will be found. The purpose of this project is to prevent breakdown of certain mechanical parts found in areas of concern and allow for the facility to function in a more robust manner for all users. Specifically, the quartz tube (where the deposition occurs) needs to have support applied to each of its ends to ensure there will be no loosening of connections, cracking, and complete shattering.

Summary of Research

In an above the trees point of view, 2D-transition metal dichalcogenides have a multitude of fields of application, but at PARADIM the spotlight is more in the semiconductor industries of optoelectronics and electronics. Metal-organic chemical vapor deposition (MOCVD) is a technique used to produce layers of crystalline thin films over a large scale. At the MOCVD facility at PARADIM there is a focus 2D-TMD's, in which they are grown by MOCVD. For the users of the MOCVD facility there is a material need and it can be produced through this specific technique at PARADIM (Figure 1). What is important to understand is that for these crystalline layers to be grown properly, the MOCVD system must be

Figure 1: MOCVD System Overview

as robust as possible and that can be achieved by the prevention of the mechanical parts of the system from breaking down. To show the need for designing new mechanical parts, there have been reports of a handful of (around five) broken quartz tubes in the lab.

As seen in Figures 2a and 2b, the area of concern is the quartz tube that is freely resting on the furnace. Not all MOCVD systems use quartz tubes, but in this system, this is where we have revolved our project around. On the left and right ends of the tube there are stainless steel metal flanges that are used to seal the system during MOCVD processes. These flanges are connected (on the right) to a gas inlet and (on the left) a gas outlet, in which extra weight is being applied to the quartz tube. The building of adjustable supports will relieve this buildup of strain and will significantly decrease the likelihood of the quartz tube cracking, the openings shift and loosened vacuum seals. This is the one solution we have been researching as a step in the direction of prophylactically keeping/increasing the robustness of the MOCVD system.

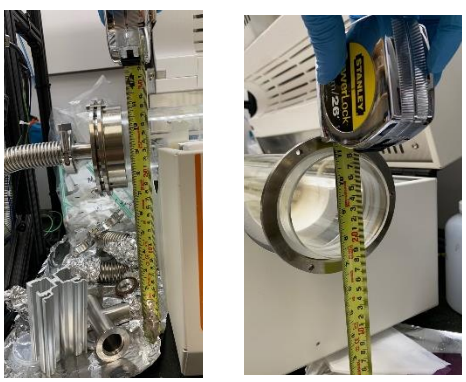

Figure 2: (a) Left-side and (b) right-side flanges

Results and Present Functionalities:

Figure 3 presents two different styles of adjustable metal supports. The first one is the Arced Head and it was chosen for its snugger fit around the metal flanges on either side of the tube. In this style, the amount of weight is distributed evenly on both sides of the arc. Secondly, we have the Y-shaped head style and it provides us with the ability to support not just rounded parts but other shapes and sizes of the system. Another important design specification is that the user can select any height they want and set it into place by a knob that twists into the side of a rod, that is attached to the head pieces, and friction holds the head in place.

After finalizing the design, the drawings that were created in the 3D CAD software Autodesk Inventor, and were sent out to local machine shops. The shop that we ended up collaborating with is CBM Fabrications located in Ballston Lake, NY.

Future Work/Conclusion:

The adjustable metal supports manufactured will aid in preventing the quartz tube of the MOCVD system from structure failure. The number of tubes broken should decrease and the excess strain on the quartz tube will no longer be an issue.

In the future if we need to build more parts or even more supports, we have the drawing files on hand.

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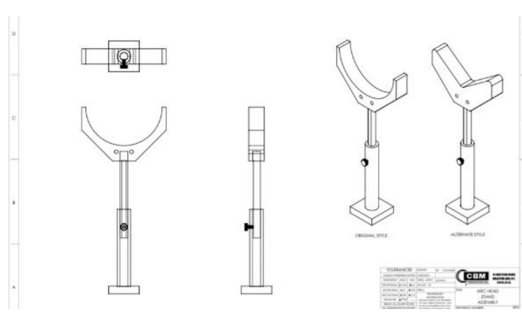

Figure 3: Finalized drawings from CBM Fab. (included are the two different head styles)