

Automating Molecular Layer Deposition

Two custom-built robots, RoboTerje and RoboKnut, have been developed to automate the precise yet time-consuming MLD process at **SINTEF**

What is MLD, and why automate it?

Molecular Layer Deposition (MLD) is a technique used to build materials one molecular layer at a time. The process involves exposing a sample to two different reagent solutions in sequence. Each reagent reacts only until all available surface sites are occupied—a property called **self-limiting growth**.

In the **PurPest** project, MLD is critical for creating **Surface Metal-Organic Frameworks (SURMOFs)**, which are sensitive layers designed to capture specific **volatile organic compounds (VOCs)**.

However, doing MLD manually is:

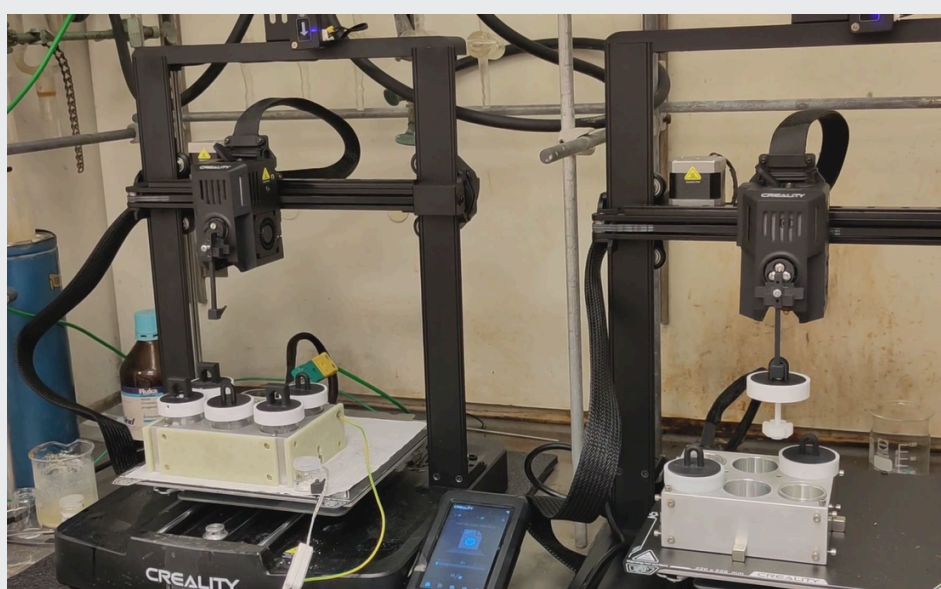
- Slow: Each cycle takes time, with multiple steps to repeat.
- Repetitive: Tedious work for researchers.
- Inconsistent: Small human errors can lead to irregular results.

The solution?

Make robots to do this work for us!

Meet the Robots: RoboTerje & RoboKnut

Adapted from Ender 3 3D printers, these two robots have been custom-built to master the MLD process.

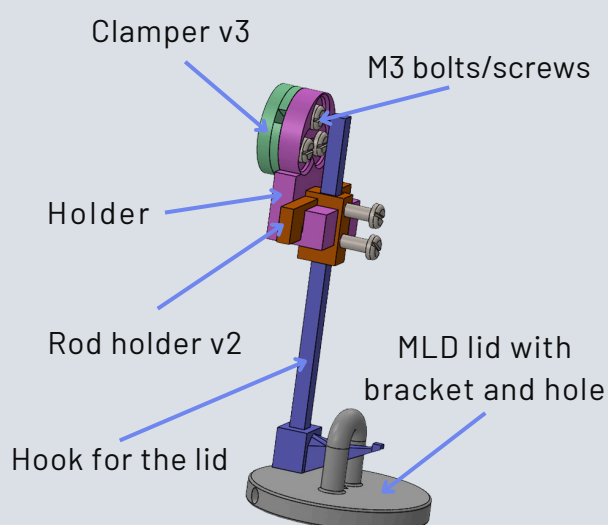


See RoboTerje and RoboKnut in action on the **PurPest channel!**

Here's what makes them special:

Physical Adaptations

- Teflon Sample Holders and Lids: Chemical-resistant, unlike standard plastic parts.
- Custom Components: Designed in SolidWorks and printed with durable black resin.
- Lid-Lifting Mechanism: The robots use a hook to lift the lid from each reagent and rinsing beaker, place it in a pit stop, move the sample, and return the lid.
- Multi-Sample Efficiency: The system cycles through positions, enabling the simultaneous use of two or more sample holders.



Temperature Regulation

- Aluminum Heating Block: Ensures constant, precise temperatures.
- Electric Heating Cartridge & Thermocouple: Regulates heat for optimal MLD conditions.

User Control & Automation

- A Python-based **graphical user interface (GUI)** allows the user to set beaker coordinates, dipping sequences, times, and the number of cycles.
- The GUI exports the requested sequence into **gcode** to control 3D printer movement.

A Note of Caution

Efficient but lacks fault-detection sensors, requiring error monitoring.



Streamlining MLD and advancing plant pest VOC detection

- Enhances MLD efficiency and sample consistency while reducing variability.
- Accelerates the development of advanced pest detection technologies.
- Optimizes SURMOF properties for improved VOC interactions.
- Automates repetitive tasks, giving researchers more time for innovation.