SAMPLE PREPARATION MODULE

By Roos de Boer and Jesse Buckmann

Visit our Git !

Problem

Users of the modular experiment box might have to prepare samples for their experiment off-grid. Without fume hood, this can cause contamination of the sample and release of toxic fumes. Because of the corona virus, limited labs are available and installing a fume hood in your house is very expensive and the size is not practical. Also, a fume hood is not portable which limits the places where you can work.

Solution

We created a sample preparation module that provides a ventilated, clean, and chemical resistant workspace for samples to be prepared in. The sample preparation module is lightweight, which make it easy to carry around. It can be integrated in and powered by the modular experiment box.

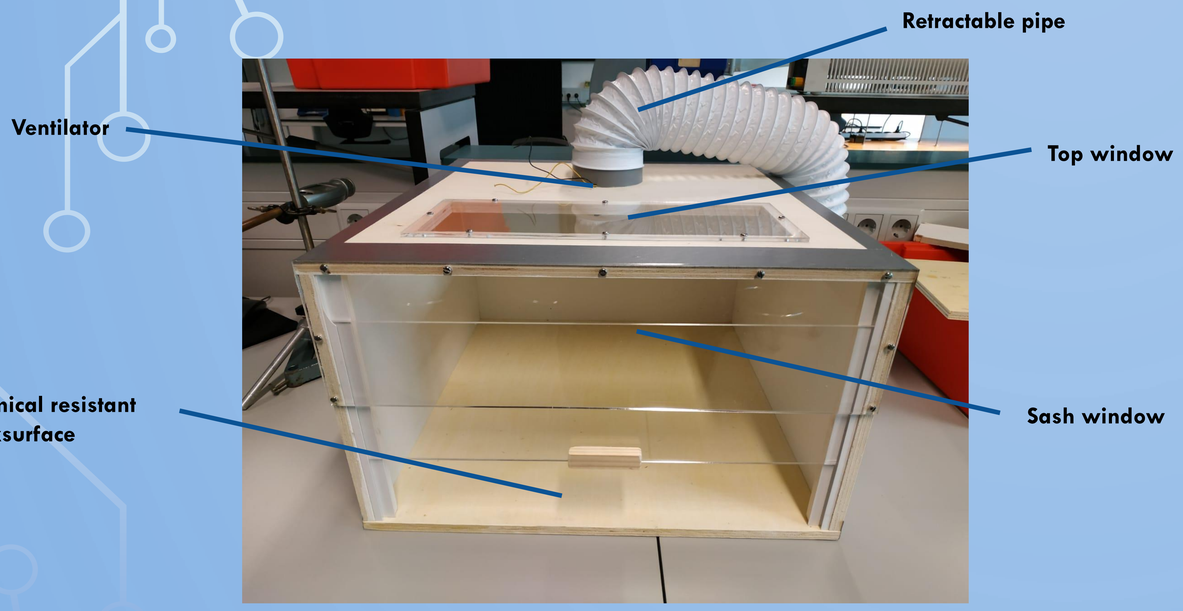

Figure 1: Photo of the sample preparation module with labels indicating the components. Later the Peltier elements were added to the sides.

Specifications

The sample preparation module has a computer ventilator to carry away fumes that are produced while doing an experiment. The box is constructed out of wood. The inside has been painted white in order to easily see any contaminations. The worksurface has been coated with 2 layers of polyurethane coating, which makes it resistant to many chemicals. The sides of the box are taped so they are airtight to ensure safe working conditions. The sample preparation module comes with a retractable pipe that can be easily assembled on the box. The sample preparation module can be stored in the modular experiment box, where it is kept level by springs.

Last minute we decided to work together with the temperature group to incorporate out projects. We added Peltier elements to the sides of the sample preparation module so that the temperature inside the box can be controlled.

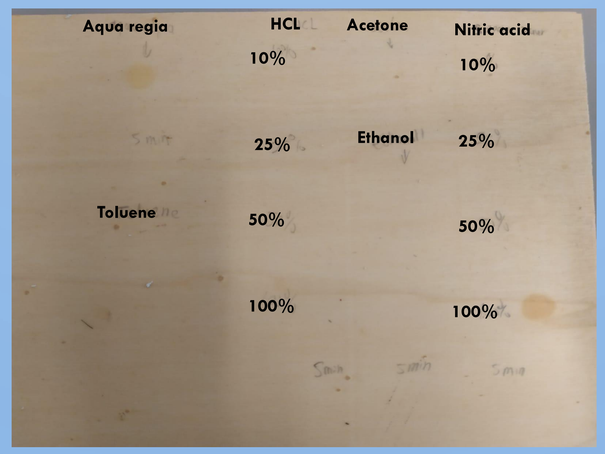

Figure 2: Photo of the scrap wood after testing the chemical resistance. It can be clearly seen that the 100% nitric acid and aqua regia affected the coated wood.

Building process

We built the sample preparation module in 2 weeks with a total cost of €61.75. Most of the materials were bought at a local hardware store and are accessible to most countries. The box was assembles in the workshop of the Bleeker building. First holes were drilled and countersunk, after which the panels were screwed together. The window rails and pvc pipe for the ventilation were glued in place with construction glue. A polyurethane coating has been used to make the worksurface chemically resistant and all panels were painted white on the inside. The fans were recycled from an old computer, but are also widely available online. The windows are made out of plexiglass, which were cut to size using a laser cutter. The power of the box comes from the solar panels connected to a 12V battery that is connected by the power group. In case one wants to build the sample preparation as a stand alone project, a 12V battery has to be bought. After testing the ventilation of the box, we added duct tape to the sides to improve the airtightness.

Last minute we decided to work together with the temperature control group to incorporate our projects. We added their Peltier elements with heat sinks to the sides of the box so that the temperature inside can be regulated. The temperature control group mounted their circuit with Arduino on top. This has not been added to the cost.

Testing

Ventilation:
We tested the airflow in the box by measuring the air velocity using an anemometer. We measured a face velocity, which is the air velocity through the face of the hood while being fully opened, of 0.2 m/s. The guideline for a professional, full-sized fume hood is that the face velocity should be between 0.3 and 0.5 m/s [1]. For the purpose of preparing samples that are kept in usual solvents, a face velocity of 0.2 m/s is enough to provide safe working conditions. No flow was measured through the sides of the box. However, we did add duct tape to the sides after the measurements for extra safety.

Chemical resistance:
The chemical resistance of the box was tested by applying approximately 0.5-1 ml of several different solvents and concentrations of acids on a scrap piece of wood with the same coating as the actual worksurface.
The solvents that have been tested are: acetone, ethanol, water and toluene. For hydrochloric and nitric acid four different concentrations have been measured: 10%, 25%, 50% and 100%.
After letting the drops sit for 5 minutes they were removed. Only the aqua regia and the 100% nitric acid appeared to have damaged the coating of the wood. The wood itself remains unharmed after these five minutes.
A feel test was also performed after 24 hours, which indicated that acetone might have, since a feel test is not an exact measure, affected the coating.

References:
[1] A guide to Laboratory Fume Hoods, ESCO, http://www.escoglobal.com/products/download/1334055898.pdf