



Portable Laminar Flow Hood

by [antoniraj](#) on September 26, 2013

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Author:antoniraj

I like to make things more simple with easily available resources. My favorite quote: A human being should be able to change a diaper, plan an invasion, butcher a hog, conn a ship, design a building, write a sonnet, balance accounts, build a wall, set a bone, comfort the dying, take orders, give orders, cooperate, act alone, solve equations, analyze a new problem, pitch manure, program a computer, cook a tasty meal, fight efficiently, and die gallantly. Specialization is for insects.! - Robert A. Heinlein

Intro: Portable Laminar Flow Hood

My interest in Mycology and Tissue culture started long back which led me to collect few laboratory equipment like Petri dishes, test tubes, weighing equipment, measuring glasses and also chemicals like Hydrogen Peroxide, Agar-agar and Potassium Permanganate. One equipment I wanted most but beyond my reach was a Laminar Flow Hood.

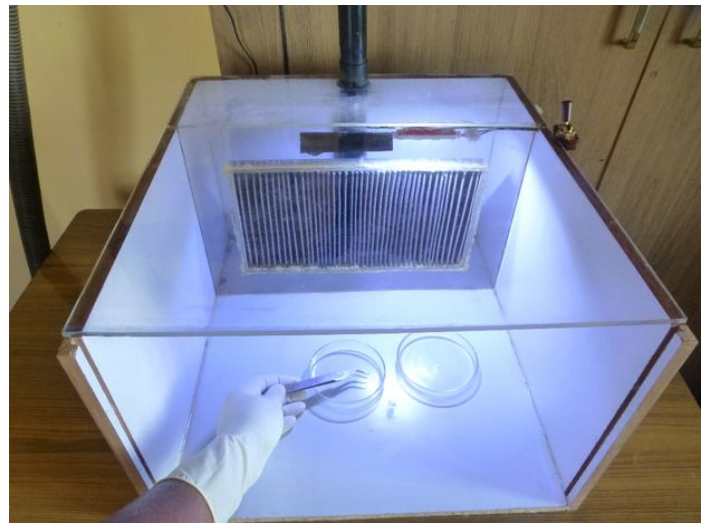
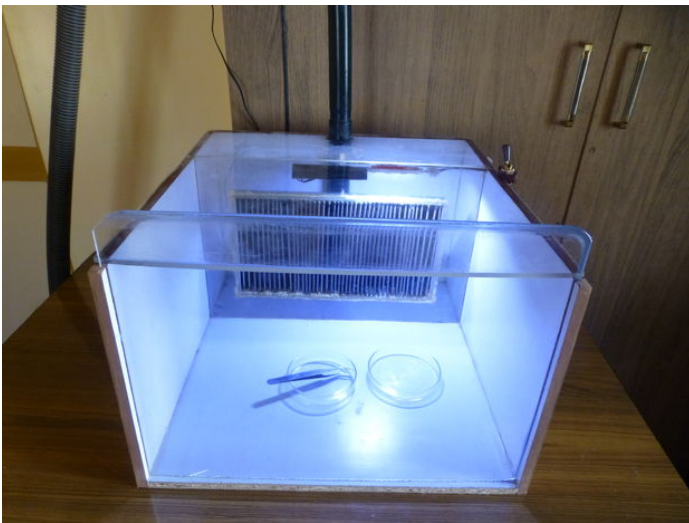
A Laminar Flow Hood provides a small sterile work area, where you can carry out all your culture works without the risk of contamination, simply by flowing completely purified air at a specified rate. However, the cost of the simplest form of the equipment is very prohibitive... the one with the very lowest specifications costs more than one thousand US Dollars... large corporations, universities, and research institutions can afford this but individual hobbyists like me can not.

The alternative...? Construct your own equipment...

There are two main types of Laminar Flow Hoods : Horizontal Airflow and Vertical Airflow. In a horizontal type, the purified air is blown from the back and moves towards the front of the working area. In a vertical type, the air is blown from the top over the working area and moves out through the base

I have carried out extensive study and came out with a design for constructing a Horizontal type Laminar Flow Hood, making use of a vacuum cleaner for the blower and press board / Plexiglas for the hood body thus reducing the cost considerably.

This Instructable will provide you step-by-step instructions on how to build your own portable Laminar Flow Hood without any compromise on standard specifications.



Step 1: Vacuum Cleaner as Blower for a Flow Hood...?

Are Vacuum Cleaners Suitable for Laminar Flow Hoods as blowers...?

I have used Euroclean Star model vacuum cleaner to be used as blower in the flow hood. Let us check out the facts for its suitability for quality and effectiveness for being used in a flow hood.

Filtration:

The model I used consists of unique five stage filtration process and the air coming out after filtration is pure and fresh...

The first stage involves the incoming air to pass through a special particle, anti-microbial, biocide treated paper filter which has been treated for protection against bacteria, fungus and yeast. This paper bag is replaceable and can be used for up to five times. However, for better results, we can use fresh bag whenever we use the laminar flow hood. This air then passes through a cloth bag, which filters out any particle which escapes through the paper bag. This bag can be removed, cleaned and then placed again in position. The next three stages involve the air to pass through specially designed built-in electric filters with carbon which blows out completely pure fresh air.

I have removed the outer-most filter and provided a cheaper version of High Efficiency Particulate Air (HEPA) filter between the air chamber and the work area. I have also added a pre-filter to remove any heavier particles before the air is sucked into the vacuum cleaner.

Work area provided by the blower

Laminar flow hoods are designed to provide an air-flow of about 0.5 meters per second in the working area. The blower efficiency of the model I have used is 20 liters per second, that is 0.020 cubic meters per second including all filters. I have removed the outer most filter from the outlet for connecting the outlet pipe, and used the HEPA filter instead.

With 0.020 cubic meter of air per second, let us see how much work area it can cover

Air flow provided by the blower = width of HEPA filter x height of HEPA filter x air speed required

therefore,

<http://www.instructables.com/id/Portable-Laminar-Flow-Hood/>

Work area (width x height) = air flow / air speed
 = 0.020 / 0.50
 = 0.04 square meter

Now, if we provide HEPA filter area of 0.27 meter width x 0.15 meter height, the available work area will be 0.04 square meters, which is sufficient for the effective functioning of the flow hood. I have provided the filter dimensions of 0.29 meters width by 0.15 meters height, considering the size of HEPA filter I could lay my hands on.

Advantages of using a Vacuum Cleaner as blower

There are some advantages in using vacuum cleaners, which may not be provided in a Laminar Flow Hood

- The air input level can be adjusted using a slider provided with the vacuum cleaner as per our requirement. Not all blowers in the laminar flow hoods are provided with adjustable air flow.
- There is also an option to heat the input air, which will be helpful in sterilizing the air chamber and back side of the HEPA filter which can not be normally accessed.
- What is more, you can vacuum clean the air-tight Air chamber by reversing the airflow by the vacuum cleaner unit.
- The vacuum cleaner unit can be separated from the Laminar Flow Hood, which is not at all possible with a normal unit.

The only disadvantage of using a vacuum cleaner is its limited airflow which limits the size of the sterile work area.

I think a suitable vacuum cleaner will serve the purpose of blower in a small Laminar Flow Hood for hobbyists, thus reducing the cost as well as the weight of the flow hood considerably.



Image Notes
 1. Vacuum cleaner

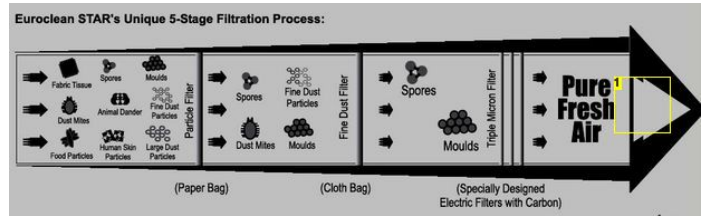


Image Notes
 1. The output air is pure and fresh after passing through the five stage filtration process

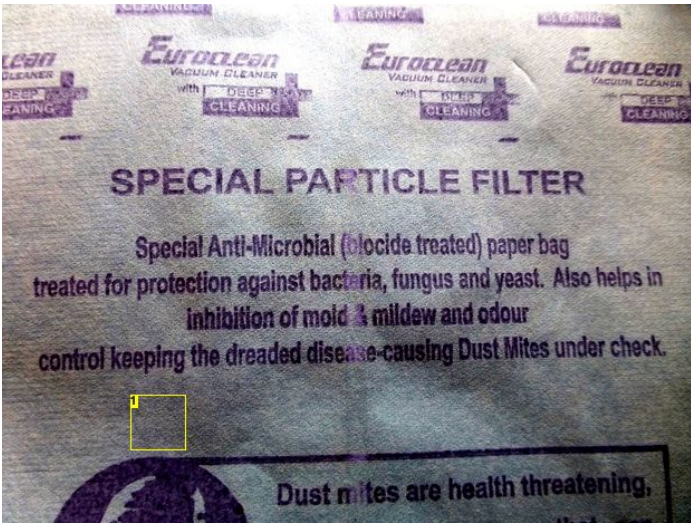


Image Notes
 1. Special Particle paper filter



Image Notes
 1. Second stage cloth filter

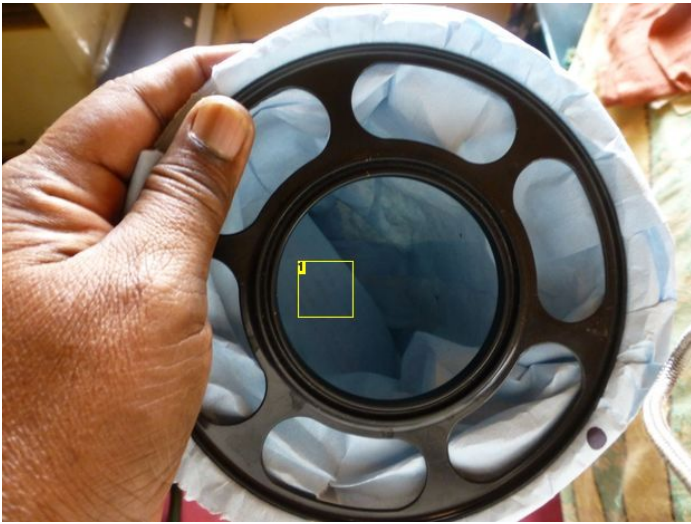


Image Notes

1. Combination of Particle filter and cloth filter

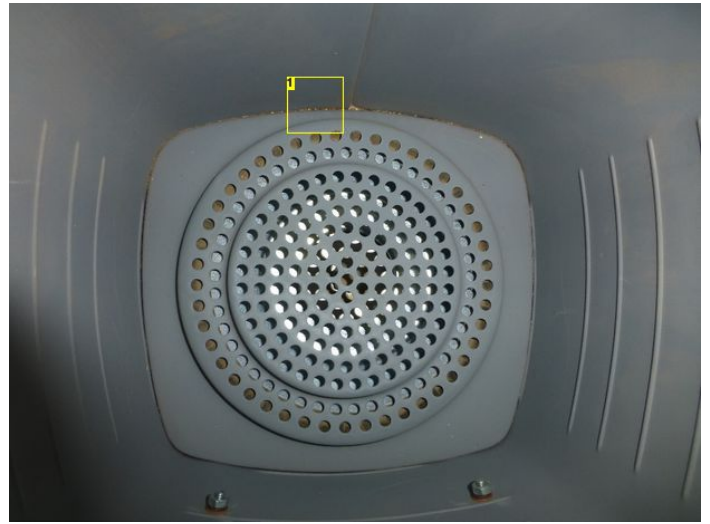


Image Notes

1. Built-in electric filters with carbon



Image Notes

1. Air heater switch

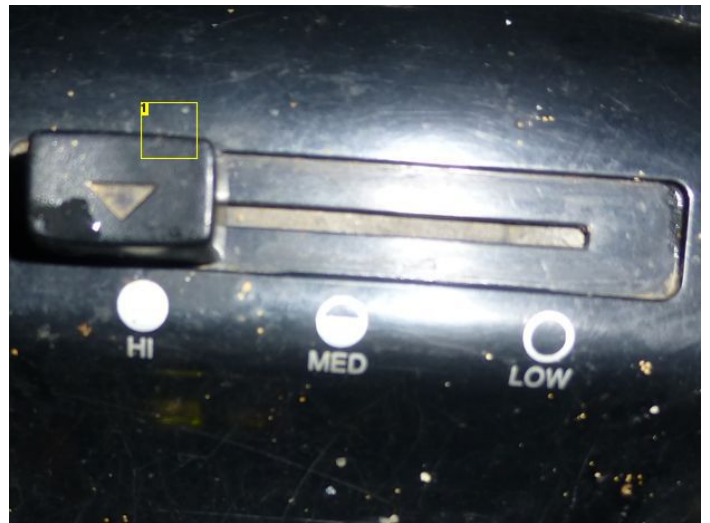


Image Notes

1. Air-control Slider



Image Notes

1. Pre-filter to remove air-born material

Step 2: High Efficiency Particulate Air (HEPA) Filter

I could lay my hands on a slightly larger sized HEPA filter used in window air conditioners. I have removed it from the original frame, reduced it to 29 centimeters by 15 centimeters size and mounted the filter to frame work made of Plexiglas.

This frame work is further fixed to the center of another frame of size 40 centimeters by 25 centimeters by cutting out the center portion to the required size. This frame is also made from Plexiglas. You can see the entire assembly of the HEPA filter in the first picture.

Plexiglas comes with protective covering on both sides to prevent any scratches. Do not remove these protecting covering while working with Plexiglas. I have used Gorilla Superglue for fixing and sealing the HEPA filter with the Plexiglas frame work.



Image Notes

1. HEPA filter fixed on a flexiglass frame

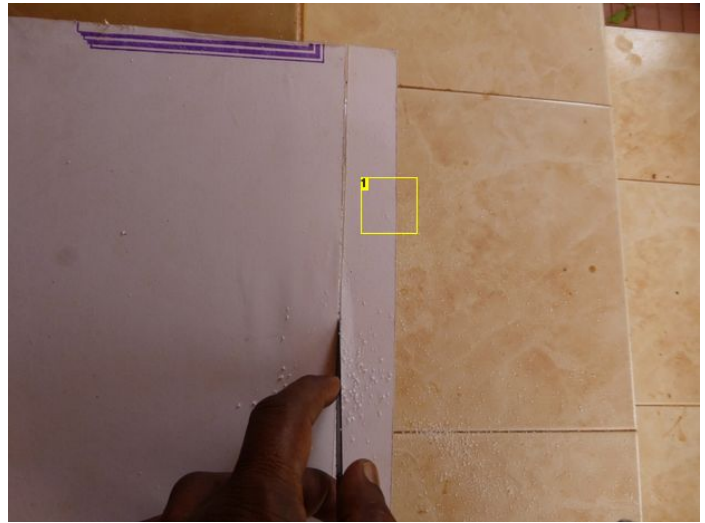


Image Notes

1. cutting flexiglass... do not remove paper while working on flexiglass



Image Notes

1. HEPA filter mounted on a frame work



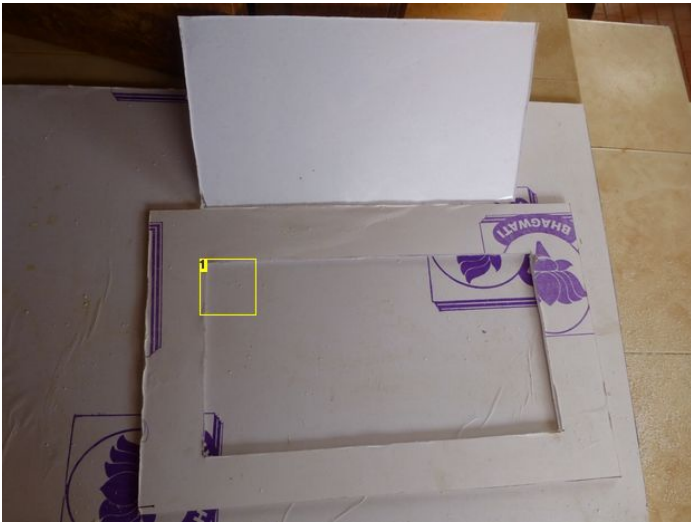


Image Notes

1. Flexiglass frame for fixing HEPA filter with the flow hood

Step 3: Materials Required

The following materials are required other than the HEPA filter I have mentioned above for the construction

- Plexiglas about 6 square feet
- Good quality half an inch thick press board 8 square feet
- Vacuum cleaner in good condition
- One spare air pipe, about 15 inches long, from a vacuum cleaner to be used as air inlet and for UV lamp shield
- Clamps 3 numbers and screws for fixing the air pipe
- Assortment of Gorilla glues, Araldite and Anabond instant glue
- 12 volt white led light with adapter
- 12 volt UVC germicidal bulb with holder
- Electrical connector
- Two way toggle switch
- About three feet of double core wire
- Medical spirit with cotton for sterilization



Image Notes

1. Flexiglass with protective layer

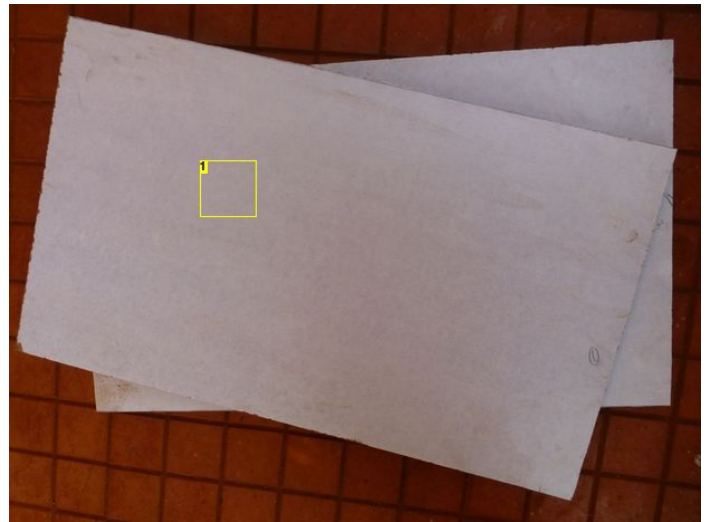


Image Notes

1. Half an inch thick press board



Image Notes
1. Vacuum cleaner



Image Notes
1. Clamp with screws



Image Notes
1. Various types of glue used in the project
2. Araldite
3. Anabond instant glue
4. Gorilla superglue
5. Gorilla Epoxy glue
6. Gorilla single use tube



Image Notes
1. Make holes on front and sides

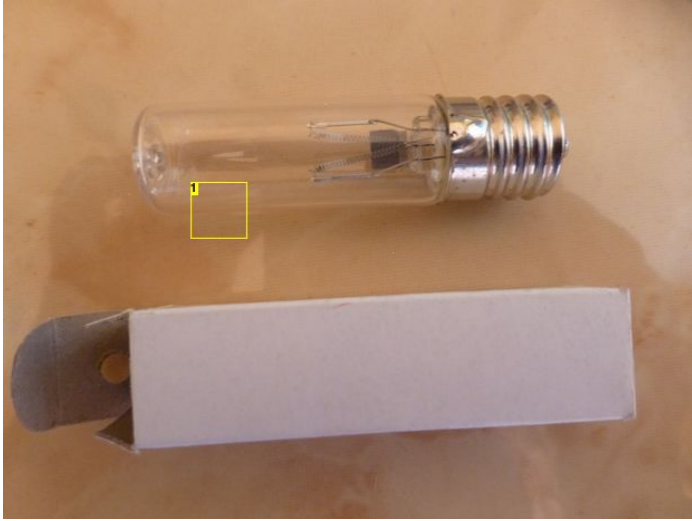


Image Notes
1. LEDs with adapter

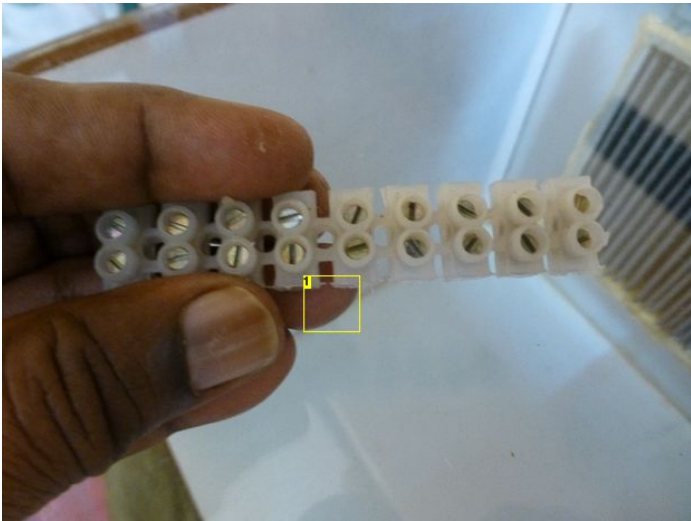


Image Notes
1. UVC Bulb

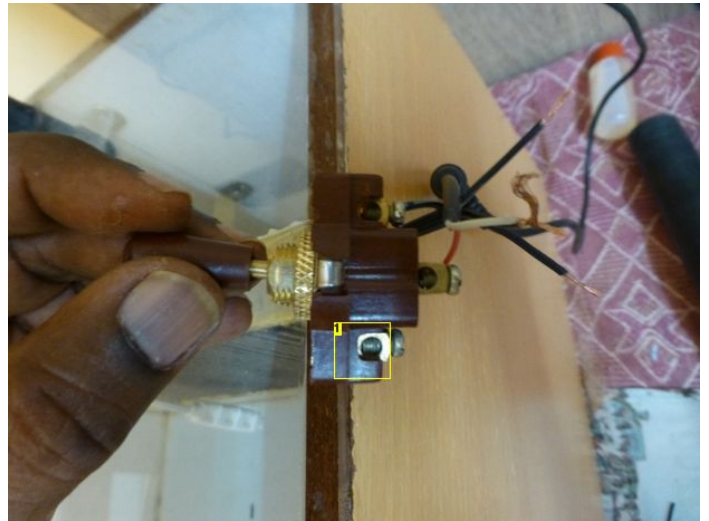


Image Notes
1. Use electrical connectors

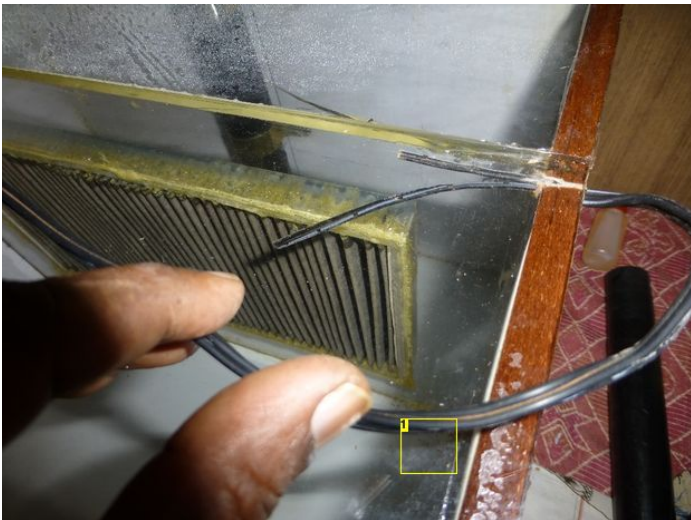


Image Notes
1. connect to the two way toggle switch



Image Notes
1. double core wire for lighting

Image Notes
1. Medical spirit

Step 4: Tools Required

Tools required

- Measuring tape
- Hand saw
- Hammers
- Chisels
- Carpenter Plane
- mason square
- Cutting pliers
- Screw driver set
- Wire stripper / cutter
- Hacksaw blade
- Marking pen /pencil
- Steel ruler



Image Notes

1. Hand saw
2. Hammers
3. Measuring tape
4. Chisel
5. Carpenter plane
6. Cutting plier



Image Notes

1. Mason square



Image Notes

1. Screw driver set

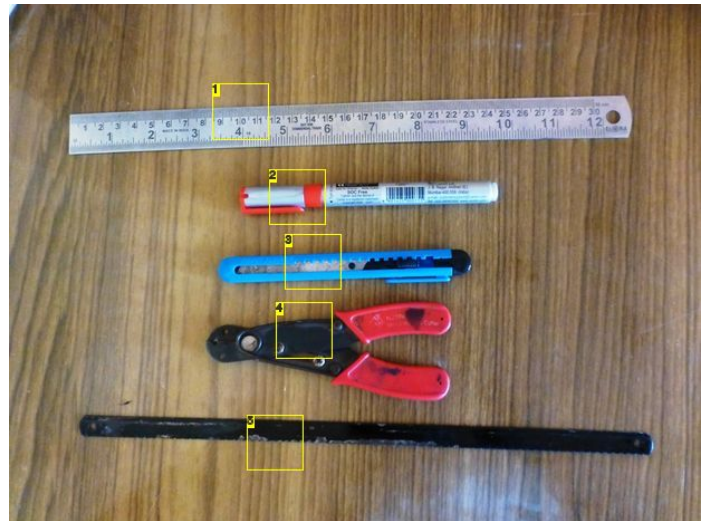


Image Notes

1. Steel rule
2. Marking pen
3. Crafting knife
4. Wire stripper / cutter
5. Hacksaw blade

Step 5: Constructing The Body With Press Board

Constructing the main chamber with press board

I like to work in the open portico at my home. This place gives me enough space to work. It is also very easy to clean up the mess you create working with wood and other material

- Cut 2 numbers of side boards to a size of 45 centimeter by 26.50 centimeter. The actual inside height will be 25 centimeters and the extra 1.5 centimeter is to cover the thickness of bottom board
- Make two vertical grooves at a distance of one centimeter from the front and 14 centimeters from the back on both the boards. The groove thickness should be equal to the thickness of the Plexiglas
- Place the HEPA filter assembly inside the two side boards in the grooves. Now you can take the exact measurement of the back side board, which is 39.50 centimeters by 26.50 centimeters size (height same for all three sides)
- Fix all the side boards with glue and nails.
- Measure the inside bottom of this assembly. This will be the size of the bottom board. The size measured to 44 centimeters by 39 centimeters
- Cut the press board to the required size and fix it to the bottom with glue and nails.

The assembling of the body with press board is complete. However, this is not airtight (will be done latter on). We will use Plexiglas for the top and front cover, which will <http://www.instructables.com/id/Portable-Laminar-Flow-Hood/>

give us a clear view while working in the flow hood.

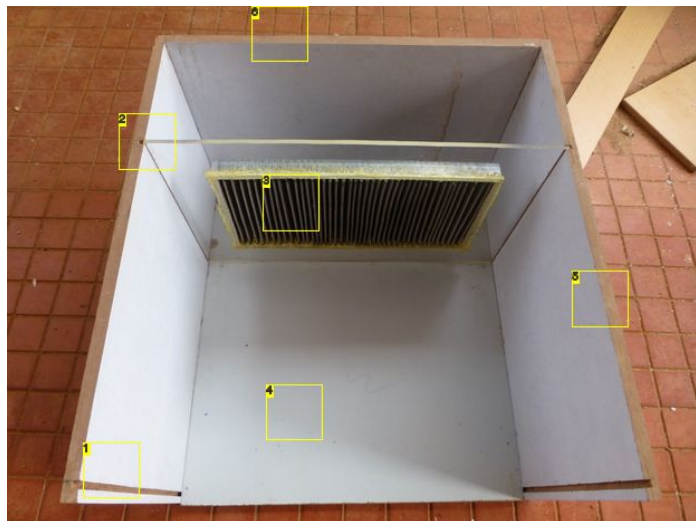


Image Notes

1. Groove at one centimeter from front for the cover
2. Groove at 14 centimeters from back for fixing the HEPA filter assembly
3. HEPA filter assembly
4. Bottom board
5. Side boards
6. Back board



Image Notes

1. half an inch thick press board

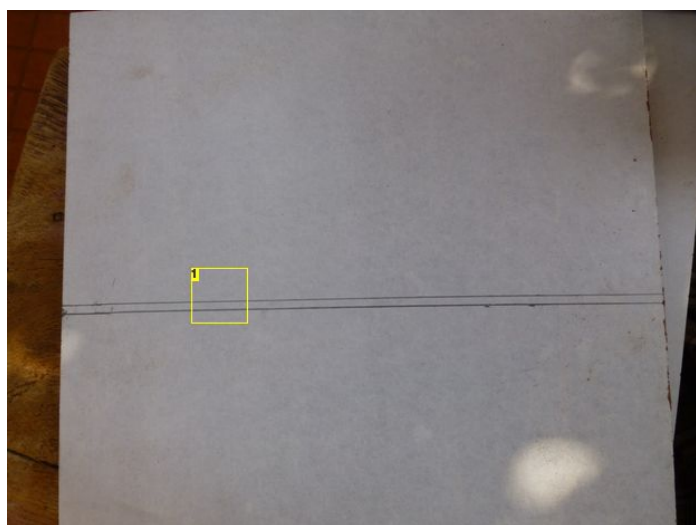


Image Notes

1. Mark the position of groove

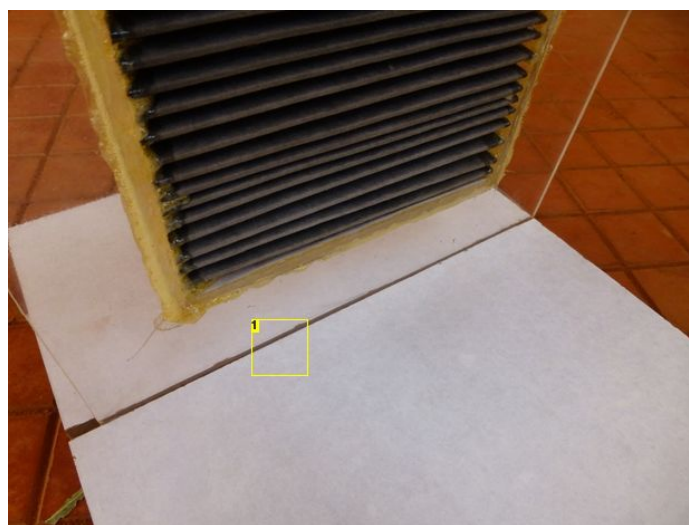


Image Notes

1. Groove to match the thickness of Flexiglass used in HEPA filter frame

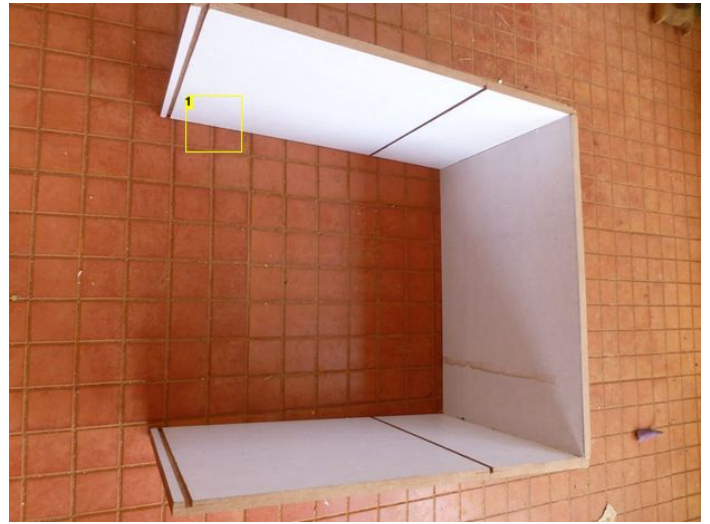
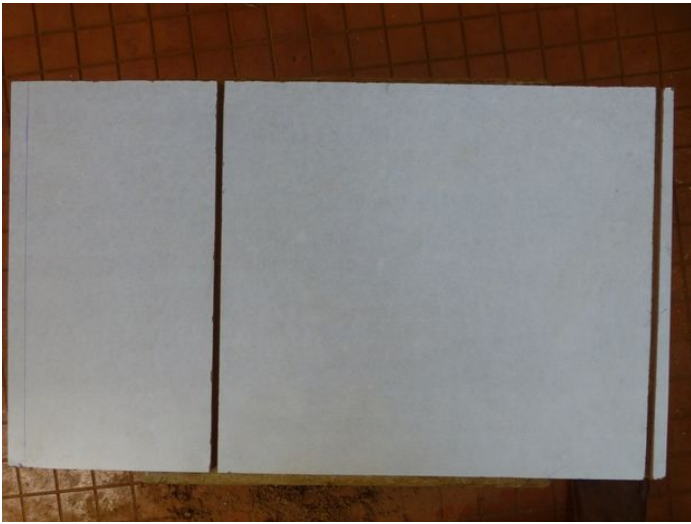


Image Notes

1. Assemble all three sides



Image Notes

1. Assemble the entire body

Step 6: Plexiglas Body

As the main body is completed with press board, we can easily measure the top and front cover portions of the flow chamber. Cut the Plexiglas to the required sizes. Here, I have cut the top cover in to two pieces, one covering the air chamber and another for the work area. Do not fix them to the body... we will do it latter

Plexiglas comes with protective paper covering on both sides to prevent scratching the surface. Remove this covering only when you are satisfied that your work will not cause any damage to the Plexiglas surface.



Image Notes

1. Top cover, which will be cut into two

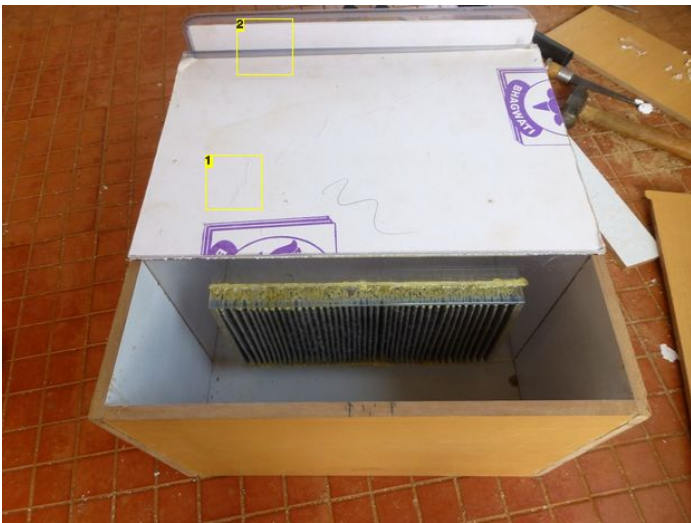


Image Notes

1. Top cover for the work area
2. Front cover

Step 7: Fix Air Pipe and Finish the Body

The air inlet pipe needs to be fixed to the body of the chamber at the back. Cut a piece of air pipe being used in the vacuum cleaner. The top of the extension air pipe is slightly larger than the rest of the pipe as this will help in inserting the hose from the vacuum cleaner into the air pipe securely without any leakage. Make sure you use this portion of the air pipe for the air inlet.

- Cut 30 centimeters length of pipe, so that about five centimeters of pipe will protrude above the top of the hood.
- Mark the center of the pipe on the back side and mark the position of clamps
- Make holes at the front and sides of the pipe for the air to escape at equal pressure on all sides on areas which will not be covered by the clamps
- Fix the air pipe with clamps and screws to the body
- Place the Plexiglas cover on this and mark the hole for the pipe to pass through
- Make the hole in the Plexiglas to the exact size

As all our cutting and drilling works are completed on Plexiglas, we can safely remove the protective covering. Now our chamber can be taken inside the house for final assembly

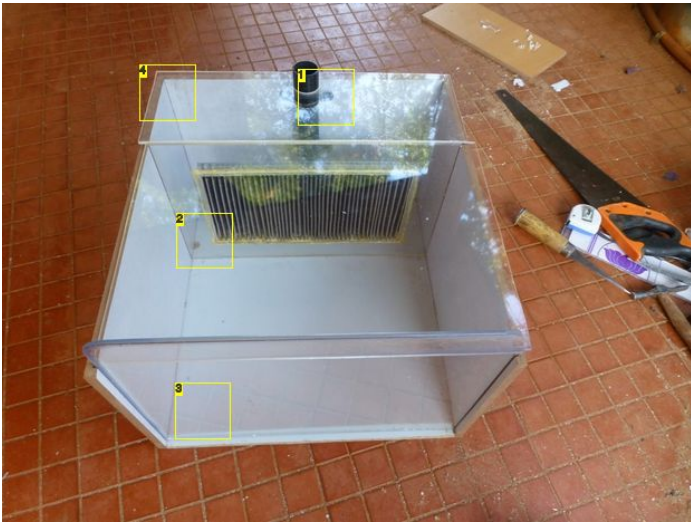


Image Notes

1. Air inlet pipe
2. Front top cover
3. Front vertical cover
4. Top back cover

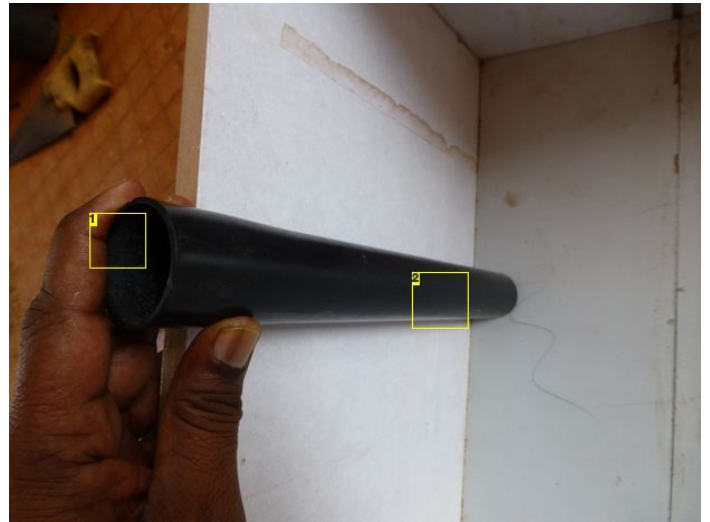


Image Notes

1. See the top portion of the air pipe is slightly larger than the rest
2. Mark clamp portion



Image Notes

1. Make holes on front and sides



Image Notes

1. Fix air pipe with clamps



Image Notes

1. Make a hole on the top back cover for the air pipe



Step 8: Fixing and Sealing HEPA Filter and Air Inlet Chamber

Our complete assembly is inside home. See that the hose pipe from the vacuum cleaner snugly fits in to the air inlet pipe. Firstly, we will fix the HEPA filter assembly and the top back cover over the air chamber and check for any leakage.

- Clean the inside of the chamber thoroughly with medical spirit. Make sure to clean out every dust and stain from the air chamber as it will be inaccessible once it is sealed.
- Apply epoxy based resin liberally on all joints. Wipe out excess.
- Apply epoxy resin inside the grooves for the filter assembly and fix the filter
- Tie tightly with a rope
- Apply epoxy resin on top and fix the top back cover
- Seal the joint between the air inlet pipe and the top cover
- Place weights on top of joints so that the load is distributed evenly. Do not place a single load as it may cause sagging of the top cover. I have used spice containers from the kitchen for this
- Allow the epoxy resin to cure for 24 hours



Image Notes

1. Complete assembly brought inside home. See the Air hose from the vacuum cleaner snugly fits in to the air inlet pipe

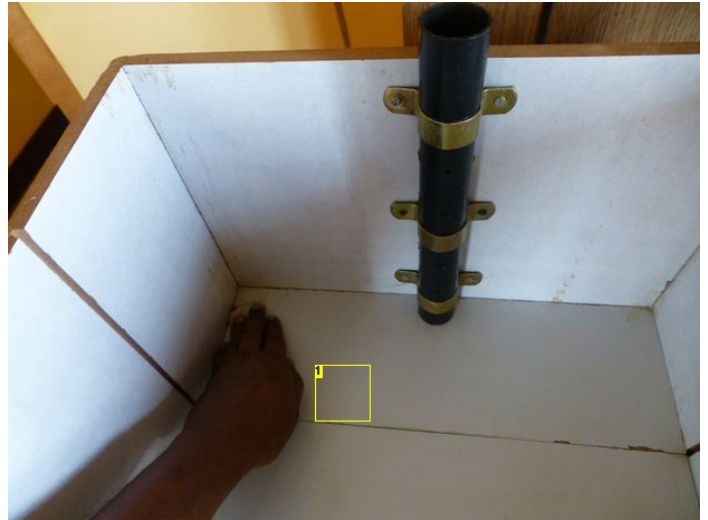


Image Notes

1. Clean inside with medical spirit



Image Notes

1. Epoxy based glue for sealing the chamber

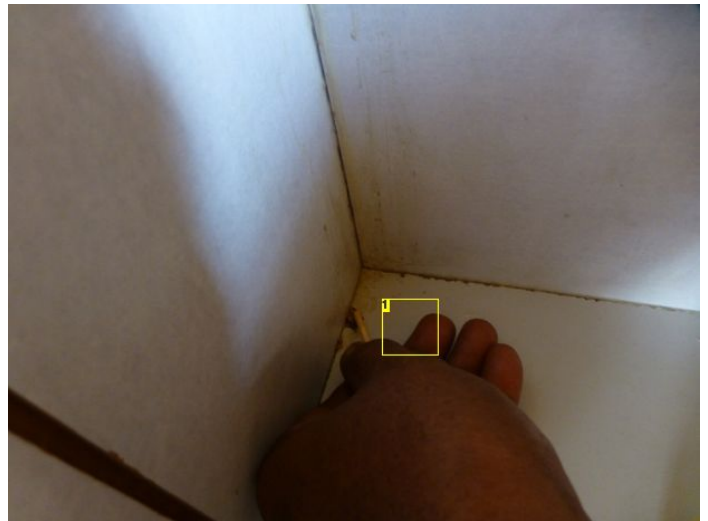


Image Notes

1. Apply epoxy resin liberally on all joints and wipe out excess

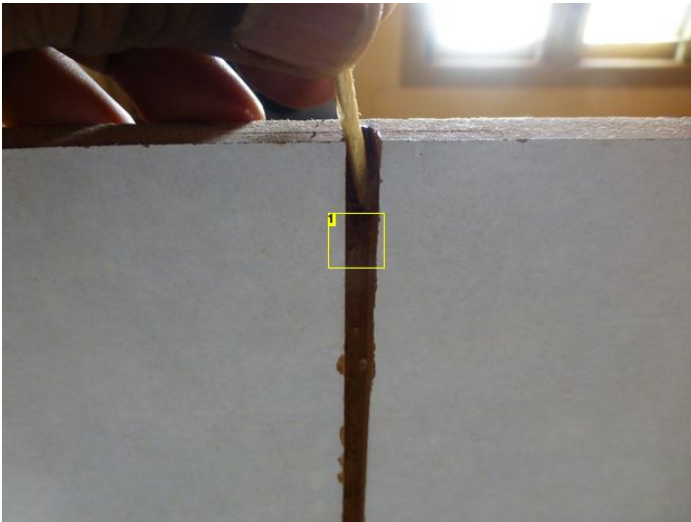


Image Notes

1. apply epoxy resin on the grooves for fixing HEPA filter assembly



Image Notes

1. Fix the HEPA filter assembly and tie with a rope tightly

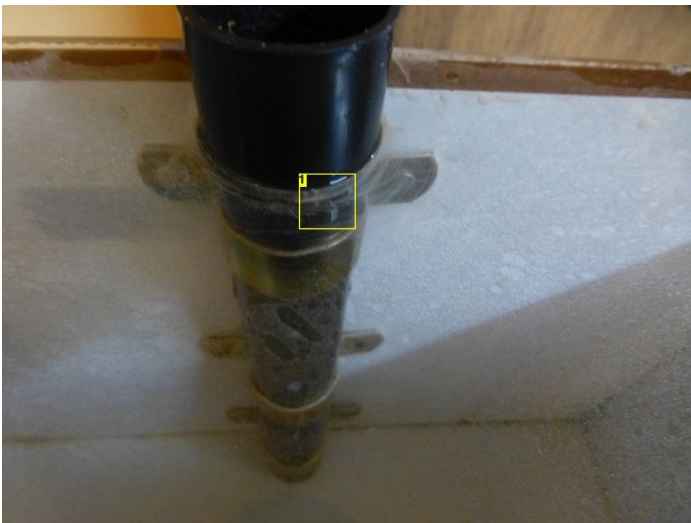


Image Notes

1. Seal the gap with epoxy resin



Image Notes

1. Glue top back cover with epoxy resin. Place distributed load on top

Step 9: Test for Leakage and Airflow with Candle Flame

Allow the joints of the air chamber to cure for 24 hours before testing for the airflow and leakage

- Connect the air hose from the vacuum cleaner and operate in low flow mode. You can increase to High airflow once you are satisfied with the joints.
- Hold a burning candle in front of the HEPA filter with the blower in operation. The air flow should not blow out the candle but flatten the flame.
- Also check for leakage all around by holding the flame near the joints with vacuum cleaner in operation on high flow



Image Notes

1. Vacuum cleaner
2. Hose pipe
3. Laminar Flow Hood (not yet fully assembled.. testing phase)

Step 10: Fixing and Sealing Top Front Cover

- Apply epoxy based resin liberally on top of press board in the front portion
- Place the top front cover in place
- Place weights on top of joints so that the load is distributed evenly as we did for the air chamber
- Wipe out excess glue bleeding out from the joints
- Allow the epoxy resin to cure for 24 hours
- Remove weights after curing.

Now our Flow hood is ready. You can close the air inlet pipe with a lid when vacuum cleaner is not connected to the unit, thus keeping out dust from entering through the air inlet.

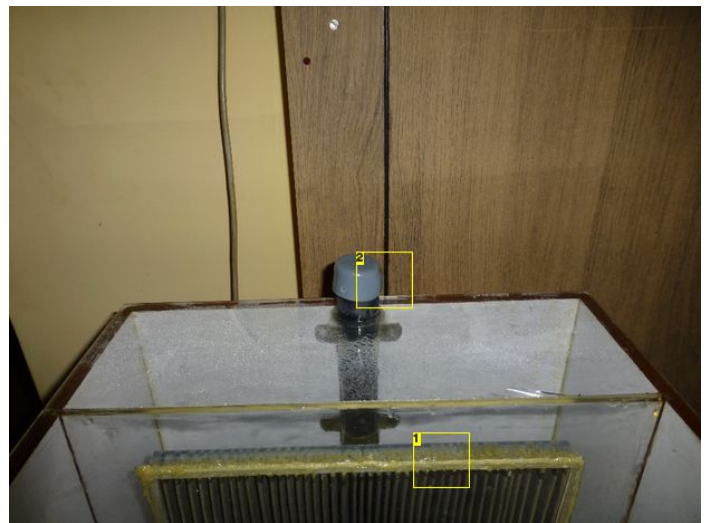
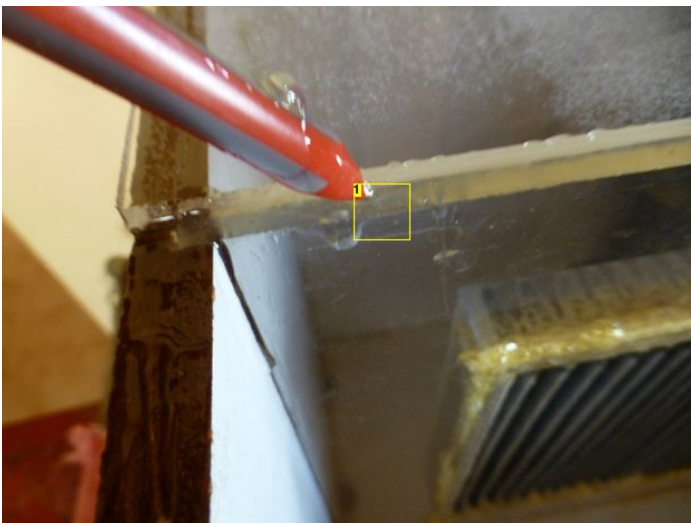


Image Notes

1. Apply epoxy resin liberally

Image Notes

1. Place the top front cover over the glued area
2. Close the air inlet pipe with a lid



Image Notes

1. Flow hood ready after 24 hours curing

Step 11: Wiring

Not much wiring work is involved in our system. Vacuum cleaner has got its own electrical fittings and connections. We need to wire here for lighting with LED and UVC lamp through a two way toggle switch, which will allow any one of these to burn at any time.

- Make a small hole at the side of the chamber nearer to the joint where the HEPA filter groove is provided. You can use a small screw driver to make this hole
- Insert two pieces of double cored wires through this hole, one for the LED light and another for the UVC lamp
- Mark the polarity on the wires correctly. The bulbs won't light up in reverse polarity
- Fix these wires to the top using Anabond instant glue. You can see in the picture that the wires are drawn and fixed along the joint where the HEPA filter frame is fixed. Anabond is instant glue and gets fixed in seconds. So, take care..
- Strip the ends to expose the conductor
- Connect these wires to the two way toggle switch

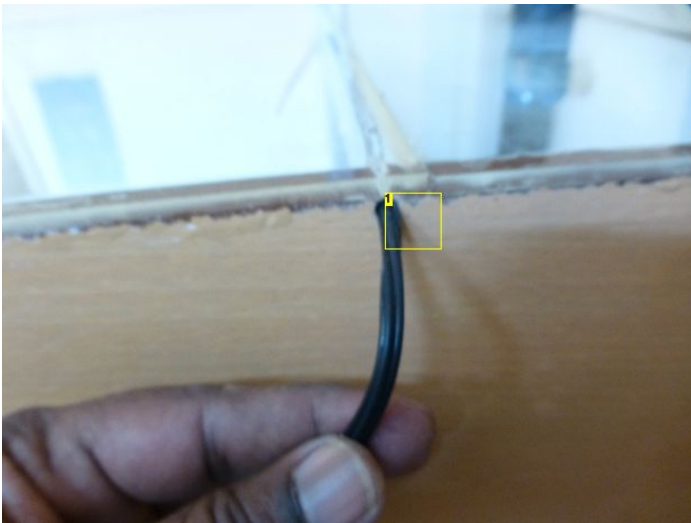


Image Notes

1. Make a small hole and insert wires

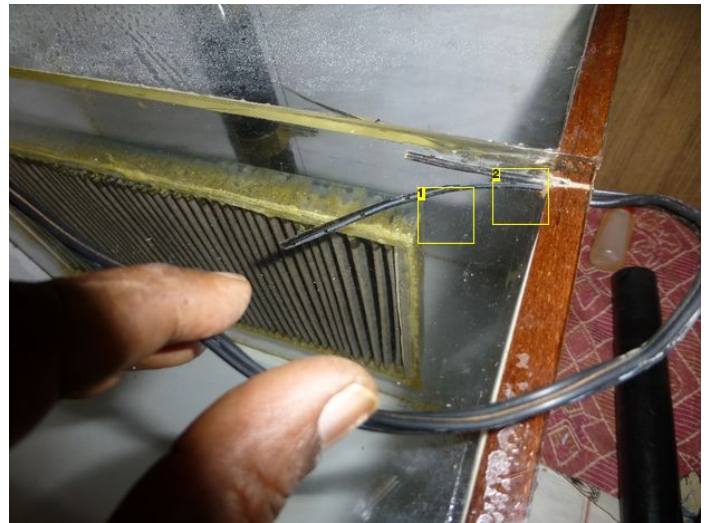


Image Notes

1. Insert wires through the hole
2. Draw the wires through the hole



Image Notes

1. fix the wires to the top using Anabond



Image Notes

1. Strip the wire ends

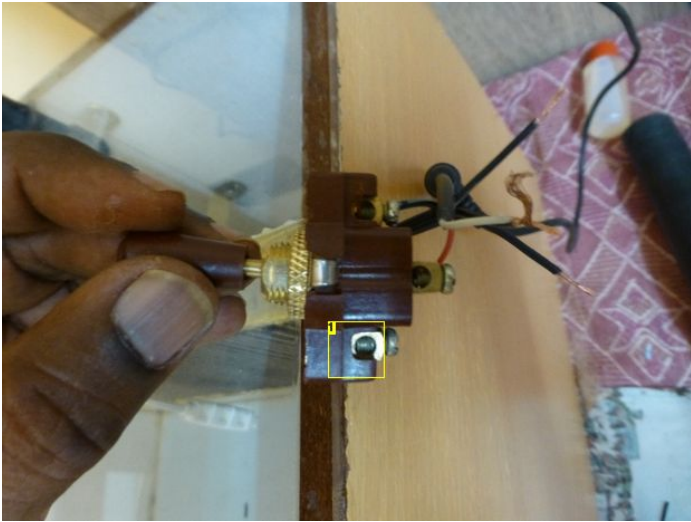


Image Notes

1. connect to the two way toggle switch

Step 12: LED Lighting For The Work Chamber

- Isolate a pair of wires and connect the LED. The LEDs I am using are built-in with all electronics required and lights up on 12 volt power supply.
- Check the polarity
- Connect to power supply and see that the lighting is enough in the chamber. If not, you can add another LED. I think it is enough for me



Image Notes
1. fix the LED to the top with Anabond



Image Notes
1. LEDs with adapter

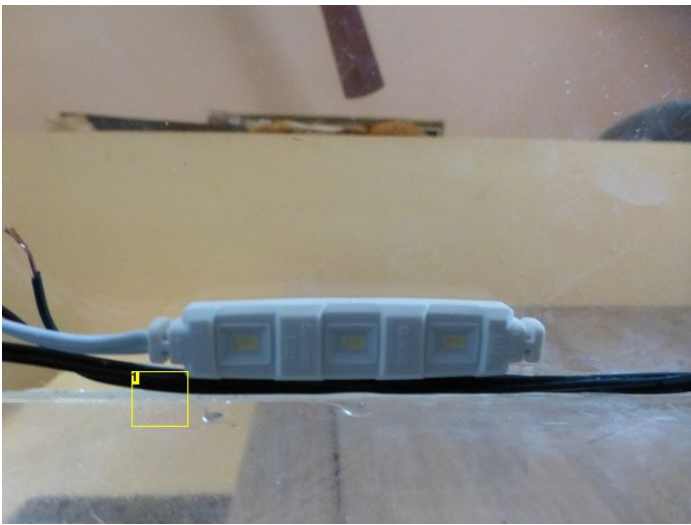


Image Notes
1. connect the LED to the wire

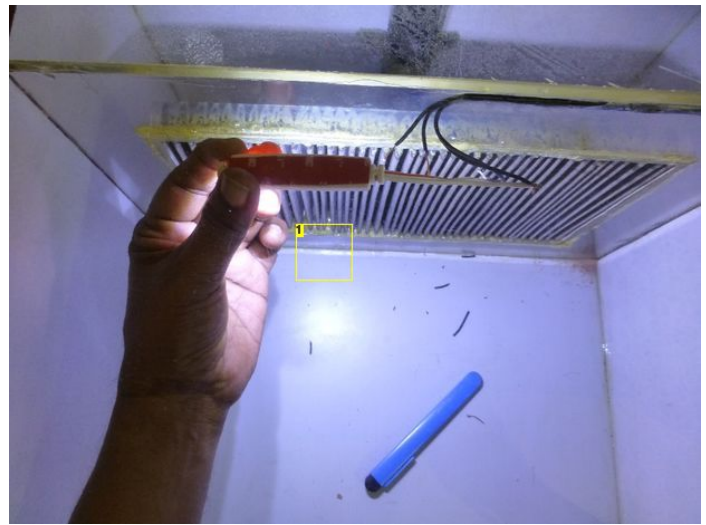


Image Notes
1. Check the lighting through the toggle switch

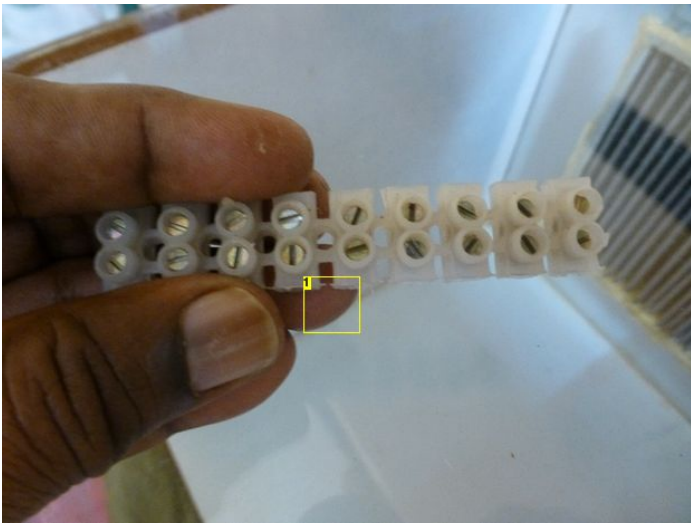


Image Notes
1. Use electrical connectors

Step 13: Add the UV Lamp

A foreword on UV lamp before adding steps on installation

Ultraviolet lamp comes in different wavelengths. The lamp we use here has a very short wavelength of 280 - 100 nanometres (shortly called as nm) that uses ultraviolet light to kill microorganisms. This Ultraviolet rays are called as UVC (A and B have longer and medium wavelengths). This is known as Ultraviolet germicidal irradiation (UVGI). Using a UVGI device in a Laminar Flow Hood creates a deadly effect on micro-organisms and kills them all making a very sterile environment to work with. In a Laminar Flow Hood, redundancy in exposing micro-organisms to UV is achieved by circulating the air repeatedly which ensures multiple passes and will irradiate resistant micro-organisms more than once to break them down. Exposure to this rays are very dangerous, so take care while working with them.

- Attach the UVC lamp to the holder. Do not give power supply
- Cut about 10 centimeter long half round piece of left-over Air pipe. This will act as a shield to the UV rays
- Enclose the UVC lamp inside this shield and attach the assembly to the top of the hood using Anabond
- Connect the wires to the toggle switch
- Connect to the power source and check
- Mark clearly on the toggle switch, the side which lights up the UV lamp
- When you flip over the switch to the center position, both LED and UVC will remain off. Switching over to the other end will light up the LED

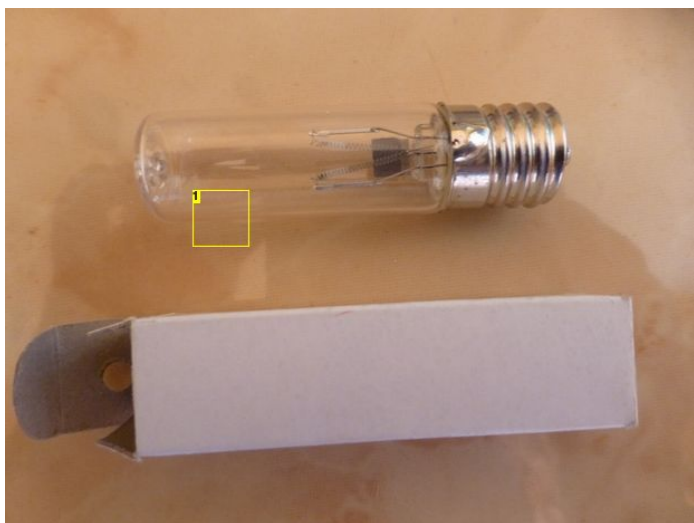


Image Notes
1. UVC Bulb

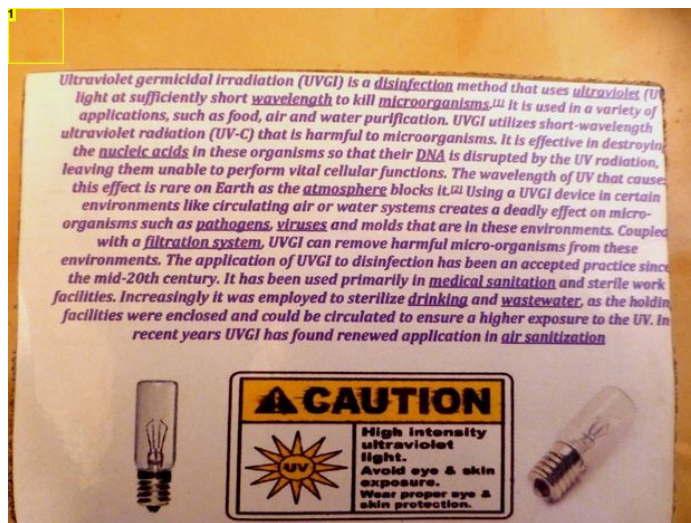


Image Notes
1. Please read this before using UVC lighting



Image Notes
1. Use a holder with a safety switch for UV lamp



Image Notes
1. cut the leftover air pipe into half



Image Notes

1. Use the half-cut pipe to shield the UV rays

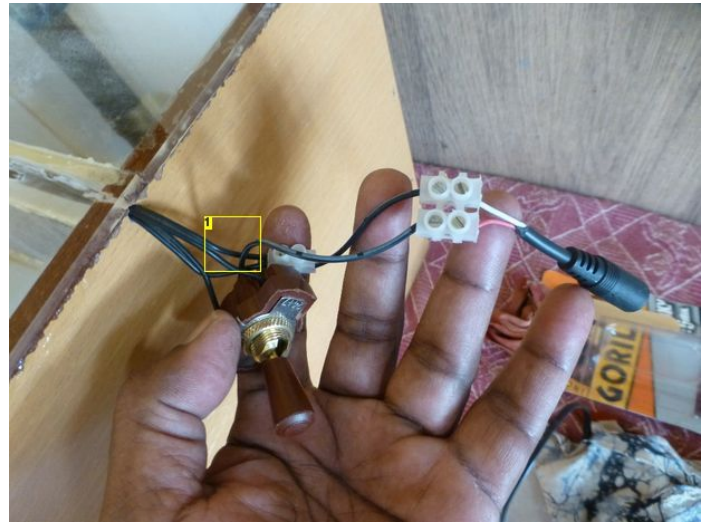


Image Notes

1. connect the LED and UV lamp to the toggle switch

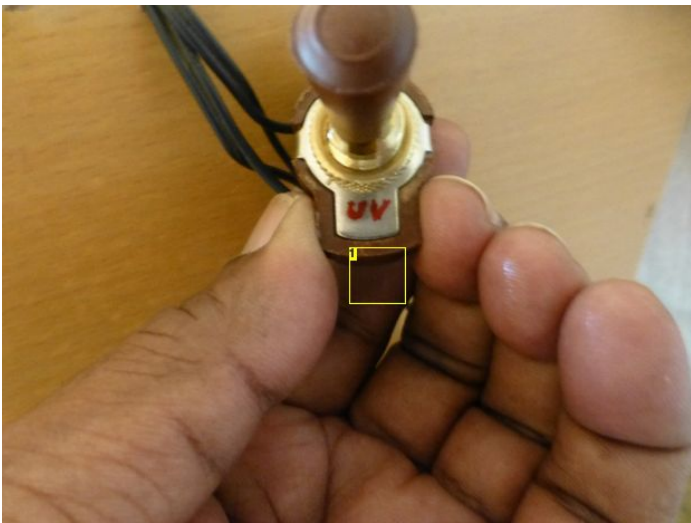


Image Notes

1. Mark the side on toggle switch which will power the UV lamp

Step 14: How To Use Your Laminar Flow Hood...?

How to use the finished Laminar Flow Hood...?

You need a clean room to place and work with the Laminar Flow Hood. Remove all unnecessary items and completely clean the room. Also take care that there is no open windows, doors or any free-flowing air in the room.

- Clean inside of the chamber with medical spirit used for sterilization, using medical cotton
- Close the front cover and switch on the air flow as well the UVC lamp. Leave it for about 10 to 15 minutes.
- Using the toggle switch, light up the work area. The UV lamp is automatically switched off through the toggle switch
- Run the vacuum cleaner for about 10 more minutes prior to start culture
- Remove the front cover. Do not switch off the vacuum cleaner
- Carry out your works using autoclaved / sterilized equipment in the sterile work space

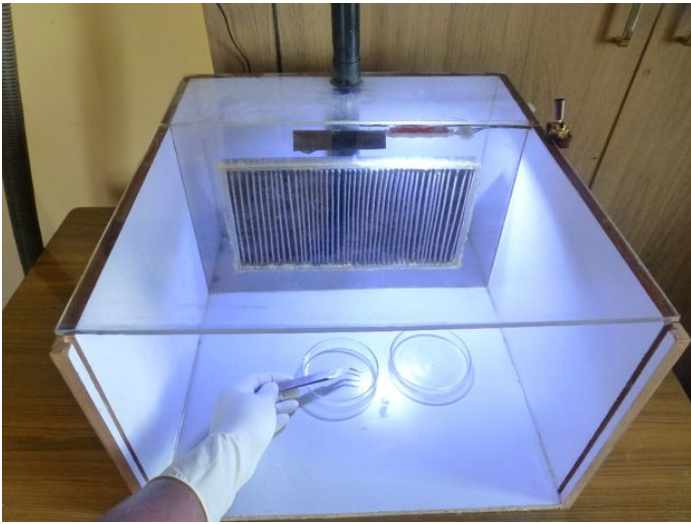


Image Notes
1. Clean the interior with medical spirit

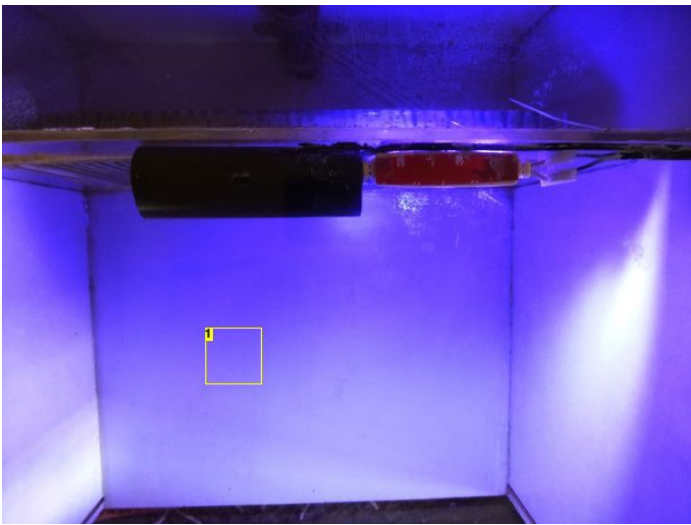


Image Notes
1. Use the toggle switch to turn on LED and UV lamp alternately

Image Notes
1. Ultra violet light

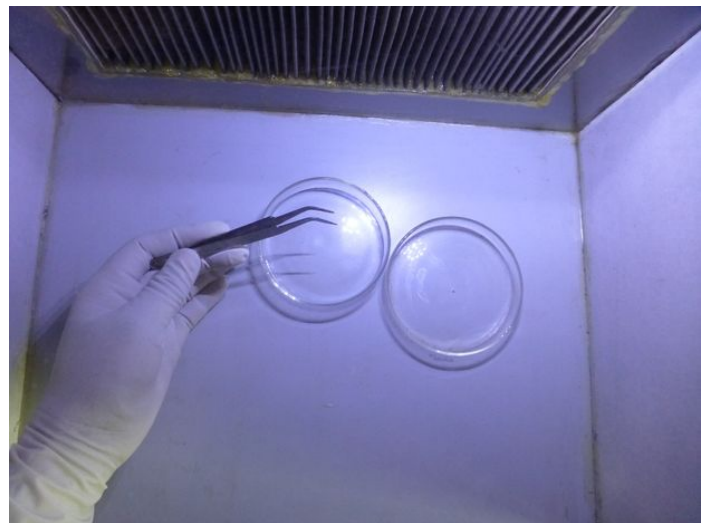
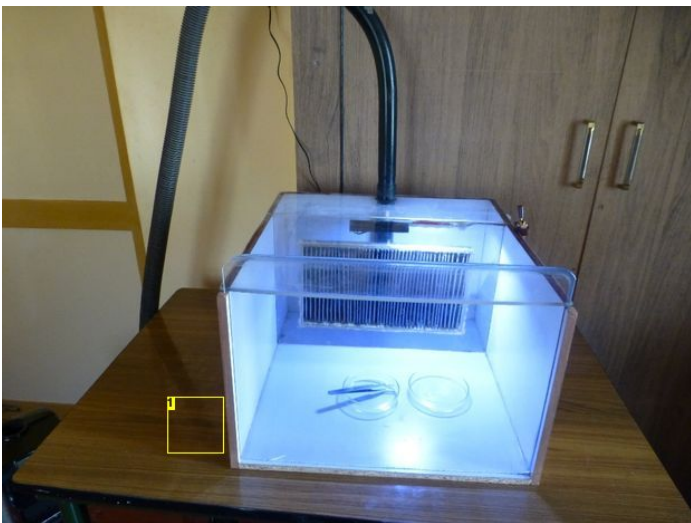


Image Notes
1. Complete assembly with air turned on and LED lighting

Step 15: Safety

Safety First...

- Exposure to the Ultraviolet light from the UVC lamp is very dangerous. Never expose any part of your body to UV light and never see the light with naked eyes. The rays may cause permanent damage to your skin and eyes
- Most of the tools used for the construction are very sharp. Take care while using these tools

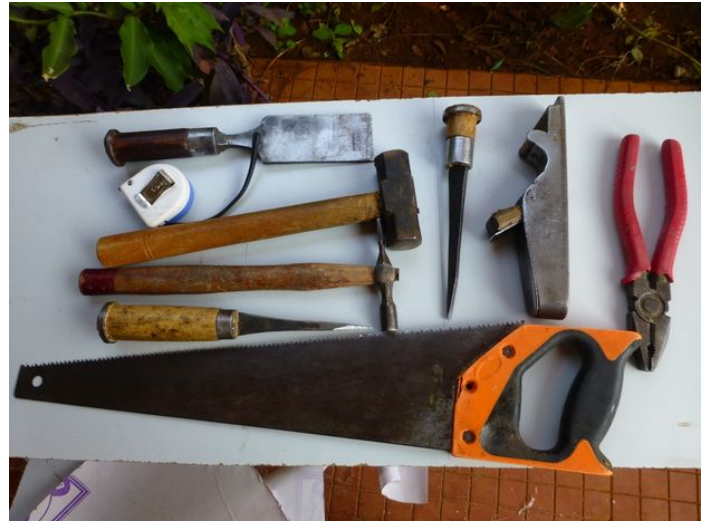
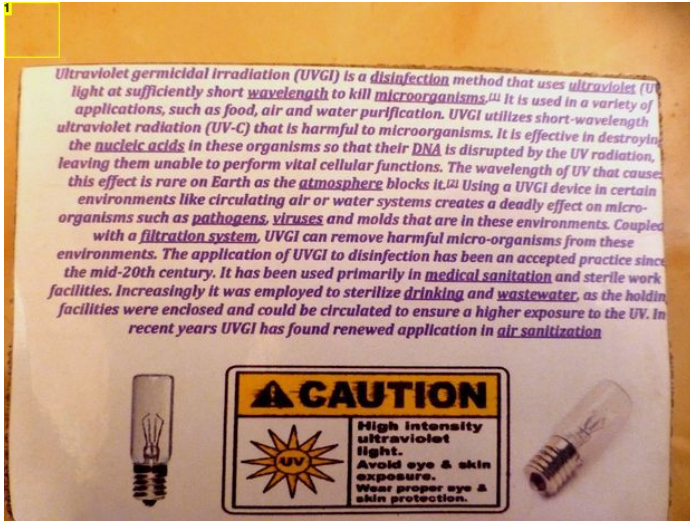


Image Notes

1. Please read this before using UVC lighting

Step 16: Conclusion

The total cost of the DIY Laminar flow hood worked out to 12000 Indian Rupees, (that is about 200 US Dollars) including the cost of Vacuum cleaner. If you already own a good quality vacuum cleaner, then you will have to spend about 4000 Rupees only for the other materials.

Please offer your comments and suggestions for any improvement in the above design.

