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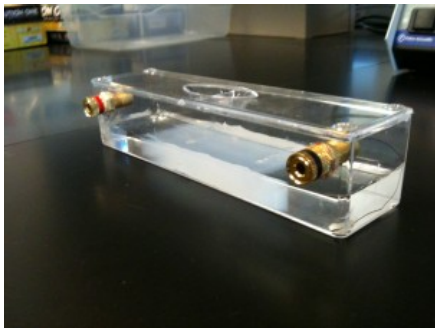
Cheapass science – How to build a $21 gel box

Posted *by:* Joseph Elsbernd *on:* 21 Oct 3 Comments

Gel Electrophoresis is a very popular technique in biology. Used for the separation of DNA, RNA and even proteins based on molecular. The Gel box is a very simple tool allowing one to run a charge through the gel to separate.



Completed gel box

Disclaimer

The techniques used to make the gel box and the operation of this gel box may be hazardous. Follow this instruction and use these gel boxes at your own risk.

Cost

Below is a rough break down of the cost per gel box. The actual cost could be more because some of

the supplies below are not sold separately and the vendors force you to buy them in packs. Try and plan around making a couple gel boxes to get the most out of your money.

- $2.5 – 4 banana plugs
- $7 – 2 banana jacks
- $6.75 – 3” of platinum wire (0.005” diameter)
- $1 – steel leader
- $2 – gel box
- $0.434 – gel mold
- $1 – plexiglass (for comb)
- 20.68 (27.43 if all platinum)

A note on electrodes:

Platinum can work as either the cathode or the anode. Steel and other materials can be used for the anode (using them as a cathode will cause them to break apart and dissolve into solution). Since platinum is expensive, I chose to use it only as a cathode.

Steel leaders are coated in plastic, to fix this minor problem melt the plastic off with a lighter.

Melting plastic off of a steel leader

What you will need

Tools

- Dremel
- Drill + drill bits
- Screw drivers (assorted)
- Fire (ex: lighter), if using steel leaders.

Supplies

- Piece of acrylic
- Plastic storage boxes (I used “lock tight” and “inter lock” by the Darice company)
- Banana Jack (also called “music binding post”)
- Banana Plug
- Platinum Wire, 0.005” diameter
- 25 gauge wire (other sizes can work, I am not an electrical engineer and do not know what size is best)
- Super glue
- Optional: Hot glue gun and glue sticks
- 6” Steel leaders (used for fishing, can use sterling silver or platinum instead)
- Clear tape
- Marker

How to assemble the components

Make the cables

Cut two 16” pieces of 25 gauge wire (or whatever length and gauge suits you), remove 3/4” of insulation from each end of the wire, and then attach each end to a banana plug per the instructions on the packaging.

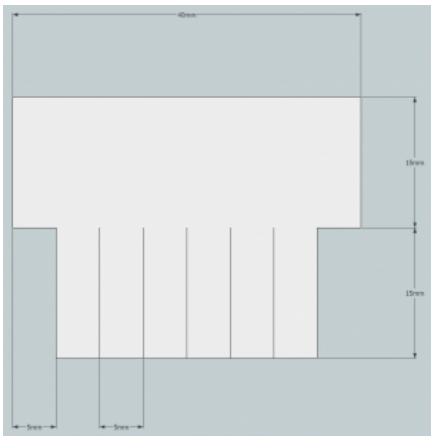
The plugs I bought were solder-free and use two screws to pinch and hold the wire inside of the plug (see image below).

Inner workings of a wire

Assembled wire

Make the gel comb

One side of the plexiglass will have a thin plastic film (both sides may have the protective film, use either side), use a marker to draw the desired comb. The spacing and size of the comb will vary depending on the box size and application. Below is a diagram and explanation for the comb design I used.



Comb diagram

I started out by cutting a 40mm x 30mm piece of plexiglass. Then I drew lines 5mm apart and 15mm long across the length of this square. I then used a dremel to cut along these guidelines. The thickness

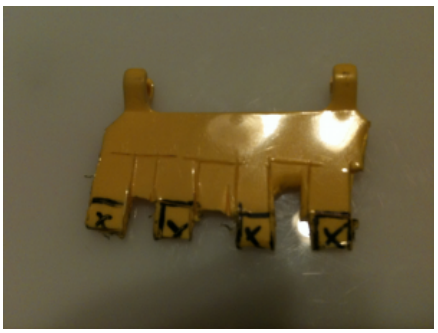
of the cutting tool was 1mm and so it removed 0.5mm from each side of each tooth of the comb. I was left with a gel comb that had six 4mm wide teeth with a 1mm gap between each.

The comb needs a support bar and it is simple to make, simply cut out the shape shown below.

Comb bracket diagram

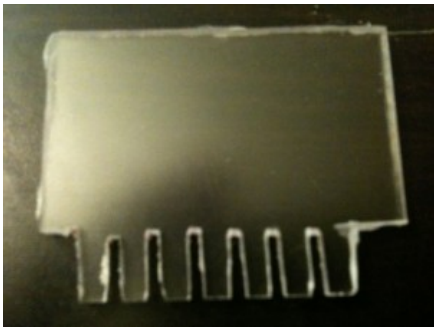
Once this support bar is cut, super glue it to the back of the gel comb. The length of this plexiglass bar should be longer than the width of the gel mold.

Making the comb was the hardest part for me because my hands shake when I concentrate but I nevertheless was able to cut a usable comb after a few tries. Below are a couple of comb examples, some made with and others without a dremel.



My first attempt, I used a razor blade

Gel comb 2



Gel comb 3

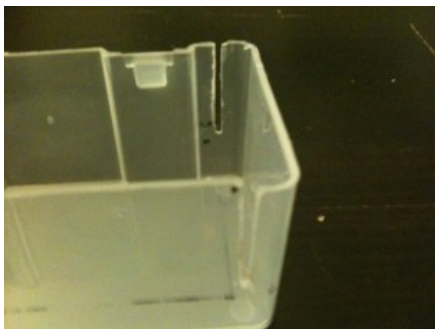
Make the casting tray

Casting tray + comb

The casting tray is simple. Two grooves are going to be cut such that when the gel-comb bar is placed in the grooves, the bottom of the gel comb is suspended 4-5mm above the bottom of the tray.

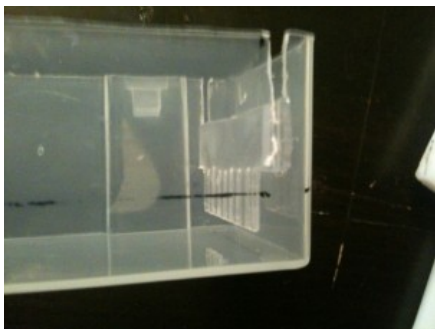
Casting tray, top view

In my case, the grooves ended 13mm above the bottom of the tray and sat 6mm from the end of the tray.



Casting tray, side view

Below is what the casting tray looks like with a comb and comb bar inside.



Casting tray + comb

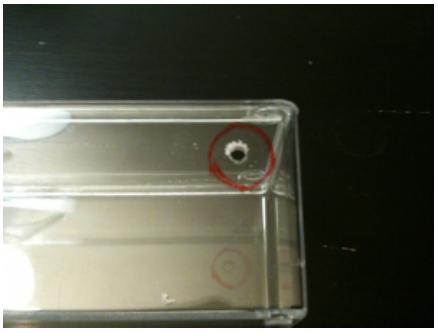
When I purchased the plastic box that was to become the gel box, it was clear from the packaging that each inner surface was flat and straight. You may have already noticed that this was not the case for the casting tray (see image below). The box I used for the casting tray was molded with two

indentations to increase structural strength. Fortunately these indentations were not huge and only reduced the effective width of the gel by a couple of millimeters.

Agarose slab inside of the gel box

Make the gel box

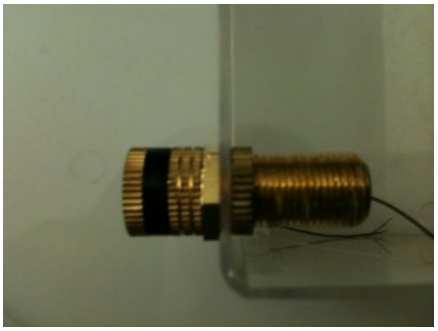
Using the banana plug jack as a template, trace the circumference of the jack onto the gel box (the image below shows this in red). Now we are going to start drilling. When making the holes, start with a small drill bit and make a pilot hole. To make the hole larger, it is best to incrementally move to larger and larger bit sizes. If the largest size bit is used first, it is probable that the plastic will crack.



Drilling a hole

If the gel box being constructed is like mine, that is to say, small, then I advise attaching the electrode to the jack before attaching the jack to the box. My gel box required 3” long electrodes.

The jacks I used work like a typical nut bolt comb and the screw portion pinches the whole thing in place (see the image below).

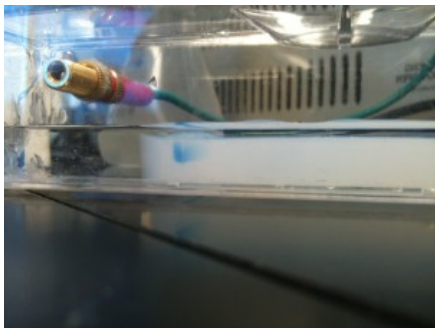


Banana jack

Once the jack is in place the next step is to bend the electrode into an appropriate shape. In my case, that shape was a sideways “U” shape. Since there are two electrodes it is important to make sure that they are approximately the same length, shape, and parallel to each other. If these parameters are not met, then the DNA bands may not migrate straight across the gel. The image below shows how I bent and positioned my electrode.

Gel box, side view showing electrode

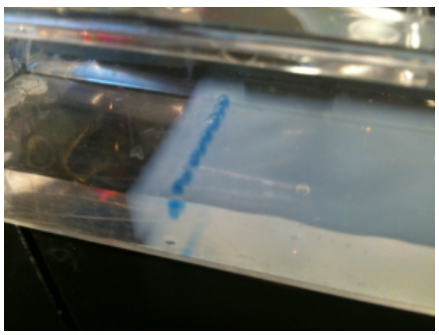
It may be necessary to attach the electrodes to the bottom of the box with a bit of glue (I had good results with super glue and hot-glue). All of the electrode materials I tried using (sterling silver, stranded wire, platinum, steel cable) refused to stay in the position I wanted and in every case adhesive was necessary.



Gel about to be run

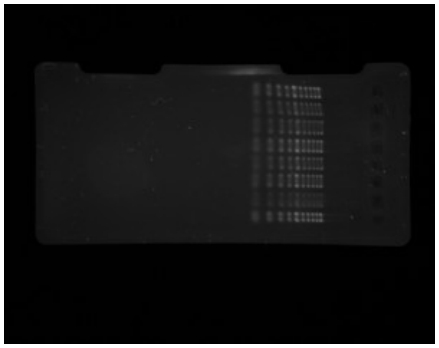
There are some safety issues I should point out. First off, this gel box is more dangerous than commercial gel boxes. The jacks I used to make the gel box have exposed metal and when a gel is running you could electrocute yourself if you connect the two electrodes. The next safety issue is the lid. Most commercial gel boxes integrate their wires into the lid so that when the lid is removed the loop is broken and the electrocution hazard is removed – this gel box does not do that.

There are a number of behavioral things that can be done to avoid this safety issues. I would recommend fixing the lid to the box with some clear tape whenever the box is being used. This will help prevent someone from shocking themselves when trying to remove the gel and should *reduce* the risk of electrocution if the gel box gets tipped over. Another behavioral tip is to always disconnect the wires from the power supply before manipulating the boxes in any way.



Filled wells

Does the gel box work? Yup. Can I reliably follow a simple protocol? Nope.



Gel results

While preparing the molten agarose I forgot about it and the solution boiled for too long and became more concentrated. I had aimed for a 2% gel and got something much higher. Nevertheless, the gel turned out awesome! I ran 5uL of 100bp ladder (Promega) in each well at 70V for 80 minutes. Deviations in band with are due to the gel comb's teeth being uneven. The gel was stained with ethidium bromide for 20minutes and washed with water three times for 5 minutes each.

Bzzzzt

Links to some supplies.

Most of the supplies I used were store bought and I did my best to find the closest online equivalent. I do not endorse or recommend any of the products below, I link them only to help people locate the supplies they may need.

- Bannana Jacks
  - http://www.homedepot.com/h_d1/N-5yc1v/R-202077626/h_d2/ProductDisplay?langId=-1&storeId=10051&catalogId=10053
- Banana plugs
  - http://www.amazon.com/GE-72999-Banana-Plugs-10-Pack/dp/B0057LA80E
- Gel mold
  - http://www.consumercrafts.com/Store/ProductDetails.aspx?clg=jewelry&prd=2025-285(ConsumerCrafts)
- Platinum wire (0.005")
  - www.ebay.com
  - Multiple vendors on eBay sell platinum by the inch.

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3 Responses to "Cheapass science – How to build a $21 gel box"

1. *Chris Cunningham* says:
   October 22, 2011 at 12:57 am

   Nice article, Brosef. Go Cheapass science!

   Reply
2. *jmil* says:
   October 23, 2011 at 5:45 pm

   awesome! thanks for posting this.

   Reply
3. *Cathal* says:
   October 25, 2011 at 9:51 am

   Love it! Gotta try making one of these. Some thoughts:

   A) Making the gel rig shorter means more volts/cm per input voltage, which helps when most people can't get a 100V power supply. It might be worth making mention of this fact in the instructions so people can decide based on their means how long to make the rig.

   B) I can't be certain, but I thought you could use Graphite as an electrode without worrying about dissolution or electrochemistry? At least, graphite is a suggested electrode for the classic water-splitting electrochemistry experiment in school. Again, I haven't tried it.. Definitely worth cautioning against copper wire anyway or cheap jumper wire; it's often copper cored, and when you pass a current through it the whole rig turns blue.

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