BME Design-Fall 2023 - Rishi Mereddy
Complete Notebook

PDF Version generated by

Roshan Patel

on

Dec 15, 2023 @08:44 PM CST

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Team contact Information

PRESLEY HANSEN - Sep 08, 2023, 2:01 PM CDT

Last Name	First Name	Role	E-mail	Phone	-Office Room/Building
Brockman	Joshua	Advisor			
Puccinelli	John	Client			
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Qiu	Cherry	Communicator	cbqiu@wisc.edu	314-813-0838	
Presley	Hansen	BSAC	pmhansen3@wisc.edu	262-266-0385	
Patel	Roshan	BWIG	rgpatel3@wisc.edu	414-759-2117	
Han	Edward	BWIG	exhan@wisc.edu	669-294-0637	
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-

Project description

PRESLEY HANSEN - Dec 15, 2023, 2:38 PM CST

Course Number: BME 200/300

Project Name: Low-Cost Cell Culture Incubator For Inverted Microscopes

Short Name: Cell Culture Incubator

Project description/problem statement:

The goal for this team is to create a low-cost cell culture incubation chamber for an inverted microscope that is capable of live cell imaging. An internal environment of 37 C, 5% CO2, and 95-100% humidity must be maintained over a long duration of time, without affecting the microscope's optics or functionality. Maintaining even heating and humidity across the chamber is necessary to prevent gradients that will form condensation on the viewing surfaces. Current commercially available systems are extremely expensive, large, and enclose the entire microscope making it difficult to assemble and remove in between uses. Because of their size, they also hinder the use of the microscope in general.

About the client:

Our client is Dr. John Puccinelli, Associate Chair of the Undergraduate Program, BME Design Curriculum Coordinator, and our professor for BME 200/300. Dr. Puccinelli teaches a tissue engineering course in ECB 2001 and plans to use this device for up to two weeks each year for education purposes.

2023/09/15 - Client Meeting 1

CHERRY QIU - Sep 18, 2023, 12:14 PM CDT

Title: Client Meeting 1

Date: 2023/09/15

Content by: Cherry Qiu

Present: Whole team

Goals: Further define what Dr. Puccinelli want

Content:

- incubator should be made to fit incubators in ECB 1002
- Past team had co2 issues: killed their cells
    - Condensation issues as well.
    - Cell cultures will be in medium, required humidity
    - Biggest issue was visibility
- Sanitation required, ethanol, no autoclave
- Measure for exact requirements
- Try to make temp uniform
- Sensors are expensive
- Ultimately wants two
- Less wires maybe?

Conclusions/action items:

Create PDS based on what Dr. Puccinelli described during the meeting.

2023/09/15 - Advisor Meeting 1

Roshan Patel - Sep 15, 2023, 12:36 PM CDT

Title: Advisor Meeting 1

Date: 2023/09/15

Content by: Roshan Patel

Present: Whole Team

Goals: Set expectation & Talk about concerns

Content: Communicated expectations on documentation and titling.

Conclusions/action items: Continue to meet with advisor throughout the semester. Name documents correctly in the future.

2023/09/29 - Advisor Meeting 2

PRESLEY HANSEN - Dec 15, 2023, 2:31 PM CST

Title: Advisor Meeting 2

Date: 09/29/2023

Content by: Rishi Mereddy

Present: Whole Team

Goals: Discuss design ideas and get a better sense of direction for which design to ultimately go for

Content:

- Discussed the idea of removing condensation using designs such as car windshield with electrics heating elements to prevent condensation.

- The idea of maintaining a uniform water surface, since the microscope can see through water, and that also would remove the condensation theoretically.

- Ask Dr. P about phase contrast, since that is something that he requires for the incubator.

- Discussed the need for drawings and models in the design matrix and how important it to communicate our ideas

Conclusions/action items: Finish design matrix and add drawings, try to begin testing ASAP. Start preparing for the preliminary presentation and distributing work.

2023/10/13 - Advisor Meeting 3

PRESLEY HANSEN - Dec 15, 2023, 2:31 PM CST

Title: Advisor Meeting 3

Date: 10/13/2023

Content by: Rishi Mereddy

Present: Whole Team

Goals: Speak about the process of developing the final deliverables and how the presentations went

Content:

He said that our presentation went well, and that it looks like we've made good progress. He did cite concerns about Cherry not speaking enough. But other than that, he gave us ITO film given by the client, which we plan on adding the following week. The team decided on the layer of water design, but the idea of just using the ITO film is becoming more appealing.

Conclusions/action items: We are happy the preliminary presentations went well and are now able to begin fabrication immediately with the gift of the ITO film from the client. We add the ITO film next week and then see what the teams wants to do after that, with regards to ITO film design or layer of water.

2023/10/20 - Advisor Meeting 4

PRESLEY HANSEN - Dec 15, 2023, 2:31 PM CST

Title: Advisor Meeting 4

Date: 10/20/2023

Content by: Rishi Mereddy

Present: Whole team

Goals: Discuss the preliminary design feedback and the issues with our report

Content:

The report overall went well, but some glaring issues came from the humidity calculation which was incorrect and cited wrong, some of testing protocol, especially the the optical testing need to be rewritten to actually gather quantitative data. The testing needs to take place longer than minutes, should be more like hours long in order for real usable data. The humidity calculation needs to be redone or corrected for use in the final report. Other than that, the rest of the report looked good and we are at a good place moving forward toward the show and tell.

Conclusions/action items: The team will work to rectify the issues of the preliminary report and presentation. Moving forward, we are focused on fabrication and testing protocol development. We are also preparing for the show and tell approaching.

2023/12/1 - Advisor Meeting 5

PRESLEY HANSEN - Dec 15, 2023, 2:32 PM CST

Title: Advisor Meeting 5

Date: 12/1/2023

Content by: Rishi Mereddy

Present: Rishi, Cherry, Roshan, Presley, and Edward

Goals: Explain issues preventing progress

Content: We explained the current situation of the ITO and the broken CO2 sensor. We understood that the lack of progress is concerning and explained the future steps. He wanted to meet again before the poster presentation to make sure we have progressed enough and for some quantitative results.

Conclusions/action items: Fix issues with ITO film and water pump ASAP and begin condensation testing as soon as possible. Get started on the poster when possible and practice before next friday.

2023/12/5 - Advisor Meeting 6

PRESLEY HANSEN - Dec 15, 2023, 2:32 PM CST

Title: Advisor Meeting 6

Date: 12/5/2023

Content by: Rishi Mereddy

Present: Rishi Mereddy

Goals: Update and demonstrate progress

Content: Showed the newly working ITO film and updated design. Explained the issue with the beefcake relay and how it is not working for some reason but how the film works very well with a DC power supply. He told me to test for the condensation by first doing a control with no power added and then take pictures and use ImageJ to quantify the number of water droplets in each picture I take, I was thinking 9 pictures per control test and 3 control test in order to acquire enough data for statistical power. Then we planned on taking bringing the water supply to where the DC power is and then recording the non-control tests like that. Doing this we will ideally have enough quantitative data for the poster presentation and final report. Finally, we spoke about finding a mathematical way to calculate the dew point.

Conclusions/action items: Do all of the condensation testing today and do statistical analysis on it and hopefully create some type of chart. Also create a new protocol for this type of testing.

2023/12/14 - Advisor Meeting 7

PRESLEY HANSEN - Dec 15, 2023, 2:32 PM CST

Title: Advisor meeting 7

Date: 12/14/2023

Content by: Rishi Mereddy

Present: Whole team

Goals: Final meeting with advisor to go over expectations and any questions

Content:

Basically went over the whole semester and how we thought it was. Brockman went over how we should look into the rubric more and make sure we have all the small things such as ethical condensation and such. The rubric also looks into how we should use Math/Chemistry and Physics. This is not too hard with our design since the chem comes from the use of Bicarbonate as a buffer and physics is done by the light refraction and such from the microscope light and more such as phase contrast.

Conclusions/action items: Get the report done and then go over the rubric to make sure we have everything.

2023/09/18 - Team meeting #1

Rishi Mereddy - Sep 25, 2023, 4:39 PM CDT

Title: Team Meeting #1

Date: 09/18/2023

Content by: Rishi Mereddy

Present: Whole Team

Goals: Discuss client expectations, think about possibly changing the current heating element and CO2 design

Content:

- We decided to keep the current CO2 design, due to the ease of compatibility of it with a Arduino microcontroller.

- The team then began to discuss how to tackle the condensation problem that the group last semester was dealing with, we decided that maintained a uniform temp of the glass would fix this problem and in combination with a film that is anti condensation may completely remove this obstacle. More research is need at this front.

- The rough draft of the PDS was gone over, the only problem that came up was a lack of sources/citations, which will be fixed.

- The team talked about the current heating element, and how it is a good idea and already fabricated, we are thinking of possibly shrinking the design the possible make heat transfer better.

Conclusions/action items: Research more into anti-condensation measures, looks at ways to shrink the current design, fix the issues discussed about the PDS, and start on a design for the new anti-condensation method.

2023/09/27 - Team Meeting #2

Rishi Mereddy - Sep 29, 2023, 3:00 PM CDT

Title: Team Meeting #2

Date: 09/27/2023

Content by: Rishi Mereddy

Present: Rishi, Presley, Edward, Roshan, Keleous

Goals: Share design ideas with each other and get a good start on the design matrix

Content:

- Shared ideas, primary one being the discovery of ITO film by Roshan which is a conductive film that current can run through in order to generate heat and maintain uniform temperature across the glass

- Rishi presented research about light transmissions properties of glass and pla under condensation, he discovered that glass with condensation is as good as PLA without condensation which points the team in the direction of switching to glass for its superior light transmission properties.

- The idea of having a layer of water that the petri dish would rest in was brought up by Presley, Edward and Roshan. Since everything is in contact with the water, the microscope could look through it like there was no water at all and with out condensation.

- We started on the design matrix and created the criteria.

Conclusions/action items: Decide on the 3 designs for the matrix and then meet up one more time to score them and then create the discussion section together.

2023/10/6 - Team meeting #3

Roshan Patel - Oct 06, 2023, 12:42 AM CDT

Title: Team meeting #3

Date: 2023/10/6

Content by: Roshan

Present: Rishi, Presley, Edward, Roshan, Keleous

Goals: Practice and tweak the presentation

Content:

- Practiced Presentation as a group

- Discussed potential improvements

- Obtained prototype

- Rishi worked on distributing the time to different slides in order to fit within the time requirement.

- Keleous led a discussion of practice questions that we may be asked after the fact.

- Presley worked on the sketches that we will be using in the presentation.

- Edward fixed wording throughout the presentation so that it more clearly conveys our points.

Conclusions/action items: Begin fabricating with the proper materials

2023/10/06 - Design 1: Layer of Water Design

PRESLEY HANSEN - Dec 15, 2023, 2:27 PM CST

Title: Preliminary Design 1: Layer of Water Design

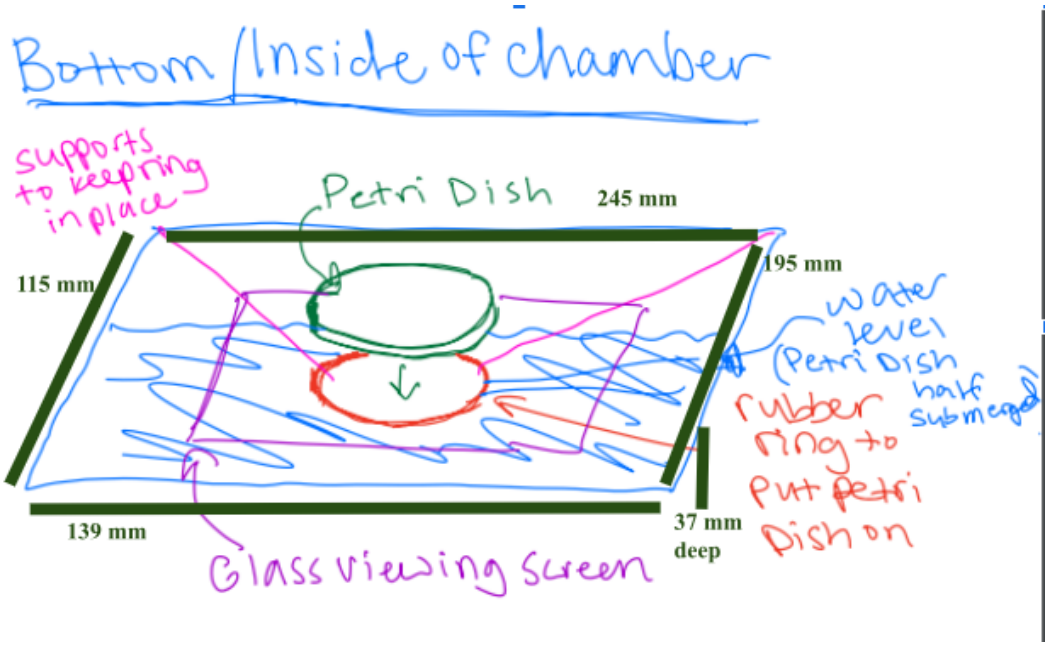
Date: 2023/10/06

Content by: Presley Hansen

Present: N/A

Goals: To create a sketch of the layer of water design

Content:



Design one consists of a 245x195x37mm black acrylic chassis manufactured by the team from previous semesters. It has two viewing screens made of glass. There will be a thin layer of water at the bottom of the chamber. This layer of water will prevent condensation on the bottom viewing screen because there is a uniform medium. A rubber ring will be secured at the bottom of the chamber and the petri dish will be placed on a rubber ring to prevent movement. It will also prevent an uneven distribution of water from forming below the petri dish, which would affect the medium the light would travel through. The water level will be as tall as necessary for the bottom of the petri dish to be completely submerged, but not the top of the dish.

Conclusions/action items: Sketch out design ideas 2 and 3

2023/10/06 - Design 2: ITO Film Design

PRESLEY HANSEN - Dec 15, 2023, 2:27 PM CST

Title: Preliminary Design 2: ITO Film Design

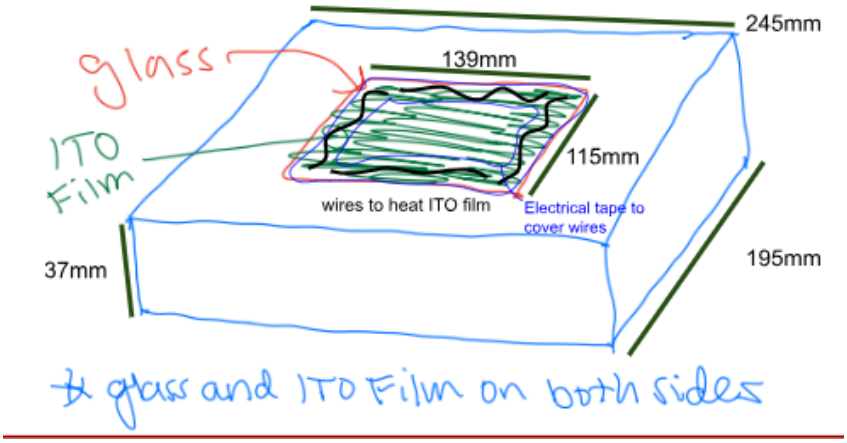
Date: 2023/10/06

Content by: Presley Hansen

Present: N/A

Goals: To create a sketch for the ITO Film design

Content:



This design consists of the same base chassis used in Design 1. Both viewing screens will be made out of glass but with an added layer of indium-tin-oxide (ITO). ITO is a transparent and conductive material. Both layers will be connected to an Arduino that will run charge through the copper wires connected to the ITO. This will heat the ITO and as a result, heat the glass underneath it. The heated glass will then no longer be able to form condensation due to uniform heating. Electrical tape will cover the wires to prevent shock from accidentally touching the wires.

Conclusions/action items: Create a sketch of Design 3.

2023/10/06 - Design 3: Heated Wire Design

PRESLEY HANSEN - Dec 15, 2023, 2:29 PM CST

Title: Preliminary Design 3: Heated Wire Design

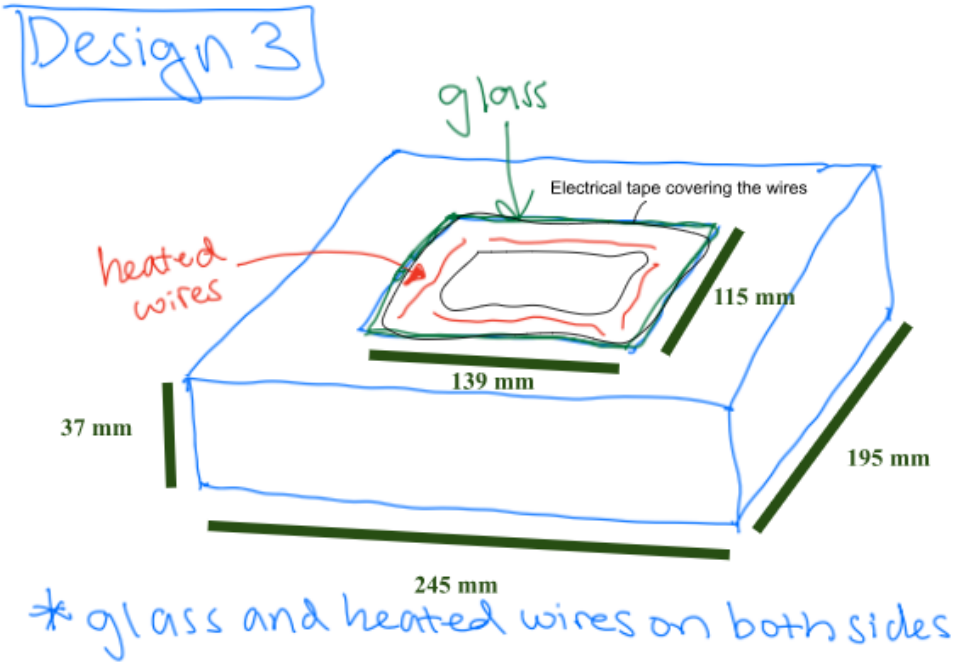
Date: 2023/12/15

Content by: Presley Hansen

Present: N/A

Goals: To create a sketch of the heated wire design

Content:



Design three will have the same chassis and glass viewing screens as design one and two. On the viewing screens, there will be copper wires around the edges. These wires will be connected to an Arduino that will run current through them and monitor the temperature inside the chamber. This design's benefits come primarily in cost, as it does not include the ITO on either side of the chamber. The glass and copper wire upgrade to the existing design will be very inexpensive and should fix the condensation problem. Electrical tape will cover the wires to prevent shock from accidentally touching the wires.

Conclusions/action items: Create design matrix and decide on a design to pursue.

2023/10/11 - ITO

Roshan Patel - Oct 11, 2023, 4:35 PM CDT

Title: ITO

Date: 2023/10/11

Content by: Roshan Patel

Present: N/A

Goals: Understand ITO better

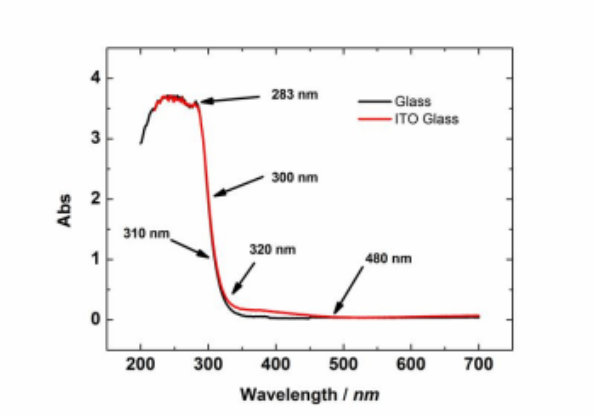
Content:

- ITO (Indium-Tin-Oxide) is a material that is conductive and almost as transparent as glass.

- It is an n-type semiconductor

- It is often used in touch screens, televisions, and windows.

- Does not inhibit cell growth (Proc IEEE/EMBS Conf on Microtechnologies in Medicine & Biology (261-4);2002)



Conclusions/action items:

Rishi Mereddy - Nov 01, 2023, 12:41 PM CDT

Conclusion/action items: Learn more about ITO film in use with incubators and look into how we can apply this to our design

2023/10/19 - ITO Film Price

Rishi Mereddy - Nov 01, 2023, 1:23 PM CDT

Title: ITO Film Price

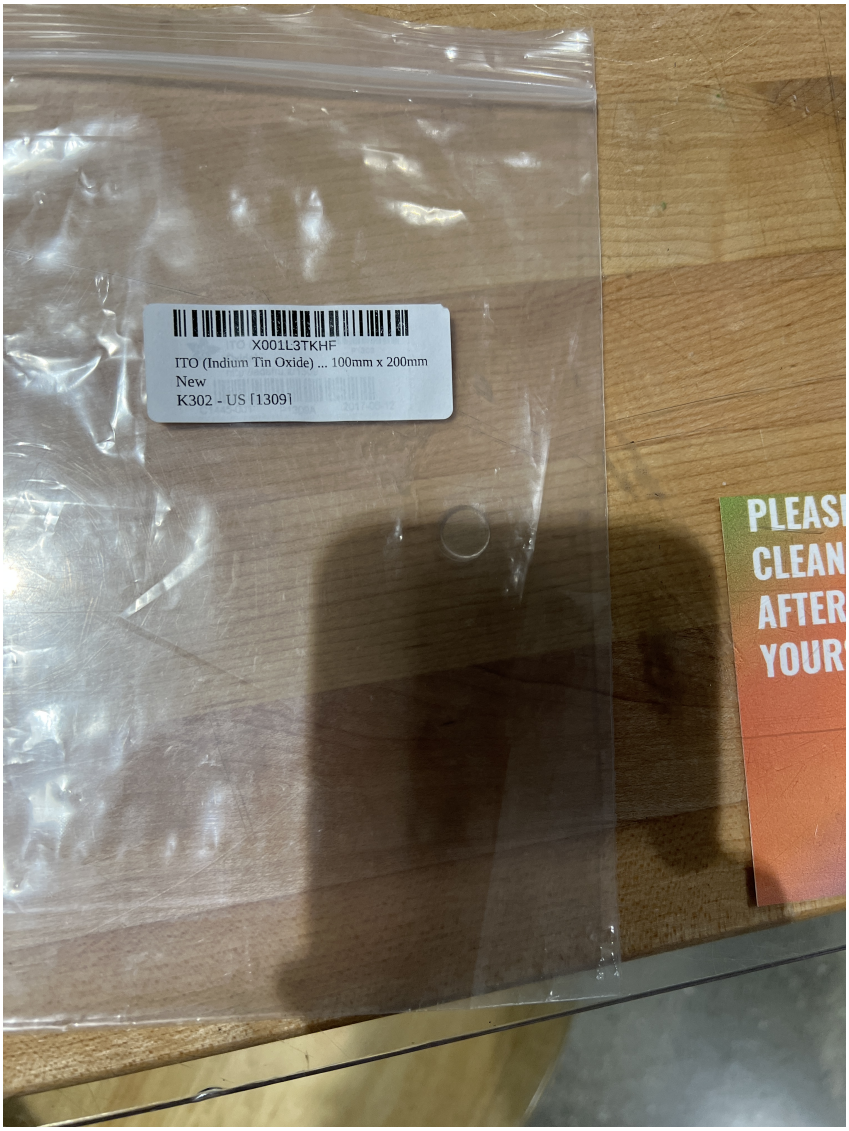
Date: 10/19/2023

Content by: Rishi Mereddy

Present: Rishi Mereddy

Goals: Record the price of the ITO Film

Content:



Costs $12

Conclusions/action items: Add this to out chassis and see if we will need to buy another sheet for the other side.

2023/12/14 - Expense Spreadsheet

Rishi Mereddy - Dec 14, 2023, 2:53 PM CST

Title: Expense Spreadsheet

Date: 12/14/2023

Content by: Keleous Lange

Present: Keleous, Rishi

Goals: Generate a expense spreadsheet to organize and know the exact cost of each component of the design

Content:

Item	Description	Manufacturer	Part Number	Quantity	Cost Each	Total
Category 1: Incubator						
3D Printed Casing	Sides of Incubator	Makerspace		1	$20.00	$20.00
Plastic Latches	Secure Lid to Incubator	Cambro	Cambro 60264	4	$4.69	$18.76
ITO film	Heats Glass/Polycarbonate layer to prevent fogging	KDJ Electronics		1	$12.50	$12.5
Rubber Lining Tape	Lines the 3D printed sides of incubator	Makerspace		1	$0.00	$0.00
Lower ITO film	ITO (Indium Tin Oxide) Coated PET Plastic - 100mm x 200mm	Adafruit		1	$14.32	$14.32
Category 2: Components						
3/8x12 Stainless Steel Tube	Heated water will flow through	K & S Precision Metals	87119	1	$6.00	$6.00
3.8 in. Compression Brass Coupler	To connect stainless steel tube to water pump	Everbuilt	20715323	2	$3.65	$7.30
1.5mm Tube Connector	Connection between CO2 Tank and Incubator	Fisher Scientific	35031	1	$14.96	$14.96
Project Total:	$93.84					

Conclusions/action items: With the final cost of $93.84, the team successfully met the cost requirements of the client.

2023/10/19 - Fabrication of ITO film on top of current Chassis

Rishi Mereddy - Nov 01, 2023, 11:51 AM CDT

Title: Fabrication of ITO film on top of current Chassis

Date: 10/19/2023

Content by: Rishi Mereddy

Present: Rishi, Roshan, Keleous, and Edward

Goals: Get the ITO film integrated with the current design

Content:

The ITO film was added to the top of the glass using black electrical tape, we also added copper tape on either side of the ITO film which will allows us to connect alligator clips to either side and run current through it to generate the heat require to remove the condensation. The pictures of this are attached below.

Conclusions/action items: Adding the film was very successful and now we have to move on to either adding another ITO film to the other side for designing the rubber ring for the layer of water design.

Rishi Mereddy - Nov 01, 2023, 11:52 AM CDT

Download

72054999697__447EFCD0-11B0-4CF9-A6F0-1DCED28E077F.heic (1.53 MB) Images of the ITO film added chassis

Rishi Mereddy - Nov 01, 2023, 11:52 AM CDT

Download

72054996180__C0AA34D7-0299-4394-902D-39B5C16F1914.HEIC (1.6 MB) Images of the ITO film added chassis

2023/11/04 - Show and Tell Notes

PRESLEY HANSEN - Nov 04, 2023, 12:28 PM CDT

Title: Show and Tell Notes

Date: 2023/11/04

Content by: All team members

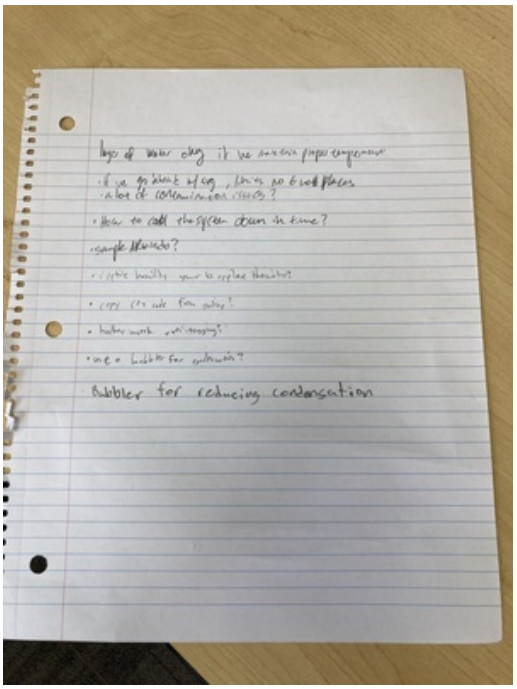
Present: All team members

Goals: To write down helpful feedback from classmates during Show and Tell.

Content:

Conclusions/action items: Most people said to move forward with two layers of ITO instead of the water design. Some other classmates asked some good questions and offered other insight that we will think about.

PRESLEY HANSEN - Nov 04, 2023, 12:28 PM CDT



Download

IMG_7105.jpg (3.58 MB)

2023/11/10 - Arduino Code

EDWARD HAN - Dec 15, 2023, 2:23 PM CST

Date: 2023/11/10

Content by: Edward Han

Present: Roshan, Edward

Goals: To create arduino code to implement CO2 control of the incubator and temperature control of the glass

Content:

```
int const CS; // input CO2 solenoid
int const VA; // CO2 valve
int const TS; // temperature value or voltage
int const IF; // ITO film

int CO2_floor;
int temp_floor
int DR; // duty ratio


void setup() {
  pinMode(CS, INPUT);
  pinMode(VA, OUTPUT);
  pinMode(TS, INPUT);
  pinMode(IF, OUTPUT);
  analogWrite(IF, DR);

}
```

```
void loop() {
  if(analogRead(CS) < CO2_floor){
    digitalWrite(VA, HIGH);
  }
  else{
    digitalWrite(VA, LOW);
  }
  /** if(analogRead(TS) < temp_floor){
    analogWrite(IF, DC);
  }
  else{
    digitalWrite(IF, LOW);
  } **/
  delay(1000);

}
```

Conclusions/action items: After beginning fabrication and deciding on pin numbers and voltage, change the variables to those numbers.

EDWARD HAN - Nov 15, 2023, 1:22 PM CST

Download

sketch_nov9a.zip (2.69 kB)

2023/12/13 - Final Design Sketch

Roshan Patel - Dec 13, 2023, 5:54 PM CST

Title: Final Design

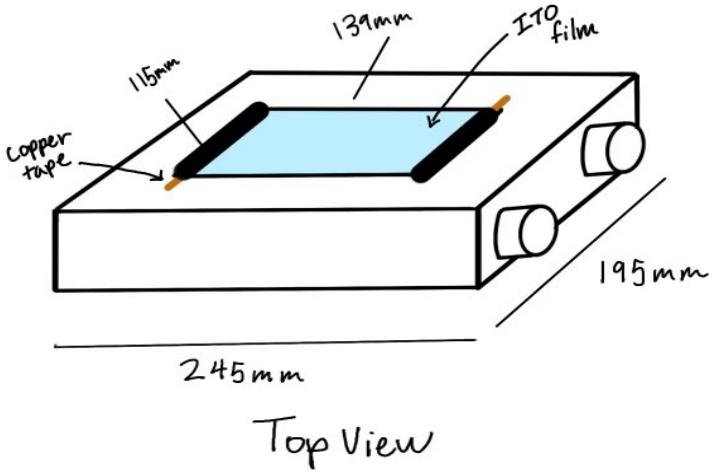
Date: 2023/12/13

Content by: Roshan

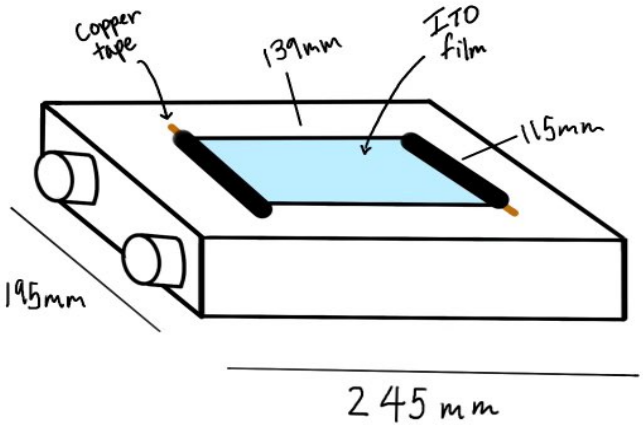
Present: N/A

Goals: create drawings of our final design

Content:



Top View



Bottom view

Conclusions/action items: N/A

2014/12/15 - Final Design Photo and CAD

PRESLEY HANSEN - Dec 15, 2023, 2:19 PM CST

Title: Final Product Photo and CAD

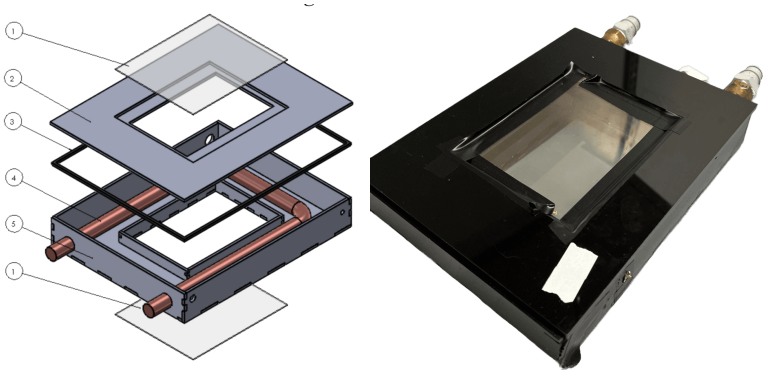
Date: 2023/12/15

Content by: Presley Hansen

Present: N/A

Goals: To create an exploded CAD model of the final design

Content: Final product photo and CAD



Conclusions/action items: N/A

2023/11/19 - Revised Optical Testing Protocol

Rishi Mereddy - Dec 14, 2023, 7:04 PM CST

Title: Revised optical testing protocol

Date: 11/19/2023

Content by: Rishi Mereddy

Present: Rishi Mereddy

Goals: To comprehensively evaluate the optical clarity of the microscope glass under normal incubation conditions, employing both quantitative and qualitative analyses, with a specific emphasis on addressing potential interference from water droplets.

Content:

Protocol for Condensation Testing in Cell Culture Incubator

Objective

To assess the effectiveness of ITO (Indium Tin Oxide) film in reducing condensation within a cell culture incubator by comparing the number of water droplets and the percent area covered in control versus experimental conditions.

Equipment and Materials

- Cell culture incubator with viewing screen
- ITO film capable of being run at 20V
- Microscope with camera attachment
- ImageJ software for image analysis
- Standardized grid for defining zones on the viewing screen

Procedure

Setup

1. **Preparation of the Incubator**:
   - Ensure that the incubator is clean and the viewing screen is clear of any obstructions.
   - Mark the viewing screen into 9 equal zones for consistent image capturing.

2. **Equipment Calibration**:
   - Calibrate the microscope and camera setup to ensure consistent magnification and focus across all zones.
   - Set the ITO film to operate at 20V and verify the voltage with a multimeter.

Data Collection

Control Test

3. *Incubation for Condensation Formation*:

- Run the cell culture incubator for 45 minutes without the ITO film activated to allow for natural condensation build-up.

4. *Image Capturing*:

- Using the microscope with the camera attachment, capture images from each of the 9 zones on the viewing screen.

- Ensure that each image is taken at the same magnification and focus level.

5. *Image Analysis (Control)*:

- Open the captured images in ImageJ software.

- Use the counting feature to enumerate the number of water droplets in each image.

- Utilize the software to calculate the percent area covered by condensation in each zone.

Experimental Test

6. *ITO Film Activation*:

- Activate the ITO film and maintain the incubator at an internal temperature of 38 degrees Celsius.

- Run the incubator for another 45 minutes with the ITO film activated.

7. *Image Capturing (Post-ITO Film Activation)*:

- Repeat the image capturing process for each of the 9 zones as performed in the control test.

8. *Image Analysis (Experimental)*:

- Analyze the new set of images using ImageJ to determine the number of water droplets and the percent area covered post-ITO film activation.

Data Recording

9. *Documentation*:

- Record all measurements in a structured data sheet.

- Ensure that the data for control and experimental conditions are clearly labeled.

Data Analysis

10. *Statistical Analysis*:

    - Compare the number of droplets and percent area covered between the control and experimental images.

    - Use appropriate statistical tests to determine the significance of any observed differences.

Notes

- Ensure that all images are taken in a consistent manner to reduce variability in your results.

- Maintain the internal temperature of the incubator at 38 degrees Celsius throughout the experiment.

- Document any deviations from the protocol or any issues encountered during the experiment.

Safety Considerations

- Follow all laboratory safety guidelines when working with electrical equipment and the cell culture incubator.

- Ensure that the ITO film is correctly insulated and handled to prevent electrical hazards.

Conclusions/action items: With this new protocol, we are able to effectively test the optical clarity of the incubator windows.

2023/11/19 - Revised Cell Proliferation Test Protocol

Rishi Mereddy - Nov 19, 2023, 3:30 PM CST

Title: Revised Cell Proliferation Test Protocol

Date: 11/19/2023

Content by: Rishi Mereddy

Present: Rishi Mereddy

Goals: Generate a protocol to compare cell proliferation in the team's designed incubator against a traditional incubator, employing a systematic approach with an emphasis on quantitative analysis

Content:

Experimental Design:

1. Cell Culture Setup:

- Initiate cell cultures of the same type in both the team's designed incubator and the control traditional incubator.
- Ensure consistent culture conditions, including media, seeding density, and environmental parameters.

2. Proliferation Period:

- Allow cells to proliferate for a designated period (e.g., 5 days).
- Perform daily inspections using an inverting microscope in the tissue engineering lab.

3. Image Capture:

- Capture images of each cell culture at 24-hour intervals using the inverting microscope.
- Ensure consistent image capture settings for both incubators.

4. Image Analysis:

- Import all captured images into ImageJ for quantitative analysis.
- Utilize ImageJ's measurement tools to quantify the following:
- Cell count per image at each time point.
- Proliferation rate based on the increase in cell count over time.

5. Success Criteria:

- A successful test will demonstrate comparable proliferation between the team's incubator and the traditional incubator.
- Quantitative analysis should reveal similar trends in cell count and proliferation rate over the 5-day period.

Additional testing:

1. Statistical Analysis:

- Apply statistical tests to assess the significance of any observed differences.
- Use appropriate statistical methods (e.g., t-tests or ANOVA) to determine if variations in cell proliferation are statistically significant.

2. Control Parameters:

- Ensure that both incubators are well-calibrated and maintained throughout the experiment.
- Monitor and record environmental parameters (temperature, CO_2 levels, etc.) to account for any potential factors influencing cell proliferation.

3. Documentation:

- Maintain a detailed record of the experimental setup, including any deviations or unexpected events.
- Document any observations made during the inspections that may impact cell proliferation.

Conclusions/action items: Using the revised protocol, cell proliferation can be tested effectively and statistical analysis can be run if required.

2023/11/19 - Temperature Testing Protocol

Rishi Mereddy - Nov 19, 2023, 3:54 PM CST

Title: Temperature Testing Protocol

Date: 11/19/20243

Content by: Rishi Mereddy

Present: Rishi Mereddy

Goals: To assess the accuracy and reliability of the thermistor in measuring and maintaining the internal temperature of the incubator, aiming for a target of 37°C ± 0.5°C

Content:

Thermistor Calibration:

1. Procedure:

- Calibrate the thermistor using the resistance values provided on the Arduino website.
- Ensure accurate calibration to establish a reliable baseline for temperature measurements.

2. Calibration Verification:

- Confirm the accuracy of the calibrated thermistor by comparing its readings with a reference thermometer.

Accuracy Testing:

1. Experimental Setup:

- Operate the incubator under normal conditions, with the thermistor recording temperature through the Arduino IDE.
- Place a secondary digital thermometer within the incubator for comparative purposes.

2. Recording Duration:

- 14 consecutive days, considering the intended usage period of the incubator.

3. Sampling Interval Adjustment:

- Sampling interval to record temperature every 10 minutes to balance data granularity and practicality.

4. Data Analysis:

- Analyze the recorded data to assess the thermistor's ability to maintain temperatures within 37°C ± 0.5°C throughout the extended recording period.
- Compare the thermistor readings with those from the secondary digital thermometer.

5. Success Criteria:

- The thermistor should accurately maintain temperatures within 37°C ± 0.5°C over the 14-day testing period.
- Record temperatures must remain within a 1°C deviation from the secondary digital thermometer.

Extended Testing Considerations:

1. Real-world Conditions:

- Mimic real-world conditions as closely as possible during the extended testing period.

- Monitor and document any variations in environmental factors that may influence temperature readings.

Conclusions/action items: With the extended duration of this revised protocol, we will be able to analyze the incubators ability to maintain it's temperature goals for the two week extended use case.

2023/11/19 CO2 Testing Protocols

Title: CO2 Testing Protocols

Date: 2023/11/19

Content by: Cherry Qlu

Present: Cherry Qiu

Goals: Accurately measure and maintain CO2 levels at 5% with a 0.5 margin

Content:

CO2 Testing Protocol

Calibration:

1. Procedure:

- Calibrate CO2 sensor to room conditions
- Increase and decrease the CO2 to check if the sensor could measure broad changes in CO2 level.

Accuracy Testing

1. Experimental Setup:

- Connect the incubator to the heated water pump and turn on the pump.
- Connect the incubator to the CO2 tank and insert the CO2 sensor and solenoid valve.

2. Recording Duration:

- 14 consecutive days, when considering the intended usage of the incubator.

3. Sampling Interval Adjustment:

- The sampling interval will be set to 10 minutes to balance data quality and practicality.

4. Data Analysis:

- Analyze the recorded data to assess the solenoid's ability to maintain CO2 levels within 5% CO2 ± 0.5% throughout the extended recording period.
- Compare readings with a secondary CO2 Sensor

5. Success Criteria:

- The solenoid should accurately maintain CO2 levels within 5% CO2 ± 0.5% over the 14-day testing period.
- The recorded level of CO2 must be within 0.5% of the secondary sensor.

Extended Testing Considerations:

1. Real-world Conditions:

- Mimic real-world conditions as closely as possible during the extended testing period.
- Monitor and document any variations in environmental factors that may influence CO2 readings.

Conclusions/action items:

Implement testing protocol

2023/11/16 - Initial Temperature Testing Using ITO Film

Rishi Mereddy - Nov 19, 2023, 5:23 PM CST

Title: Initial Temperature Testing using ITO Film

Date: 11/16/2023

Content by: Rishi Mereddy

Present: Rishi Mereddy

Goals: Understand the electrical properties of the ITO Film and see how quickly it heats much and how much power it requires.

Content:

I set up the ITO film to a bread board and arduino, picture below. I first set it to apply 3.3 V to the film, but no noticeable temperature gain was detected by my thermometer, which lead me to apply 5V, the max of the arduino uno. After 45 minutes of waiting, the temperature did not change. I used a digital multimeter to see if current was flowing, which I did confirm. The results of my experimentation showed that we need to apply much more voltage to the ITO film using a beefcake relay to make our solution usable.

Conclusions/action items: Acquire a beefcake relay, conduct some experimentation with the amount of power being applied and test the longevity of out solution.

2023/12/3 - Fixing heating issues with ITO film

Rishi Mereddy - Dec 05, 2023, 4:21 PM CST

Title: Fixing heating issues with the ITO film

Date: 12/3/2023

Content by: Rishi Mereddy

Present: Roshan, Edward

Goals: Figure out the issue stopping the ITO from heating

Content:

New ITO was ordered in case the film was the issue. We did testing again with the copper tape in different orientations, and it would still not heat up. The problem ended up being that the acrylic box itself was a short and placing the copper tape on on the film and electrical tape fixed all the issues with the heating. Now that 20v, 0.25A the film is heating up rather quickly and was noticeably warmer when a hand was placed near the film, not in contact.

Conclusions/action items: With the film now working as intended, the team will plan on testing the temperature gain at different voltages with the film.

2023/12/4 - Temperature Testing

Rishi Mereddy - Dec 05, 2023, 4:47 PM CST

Title: Temperature testing

Date: 12/4/2023

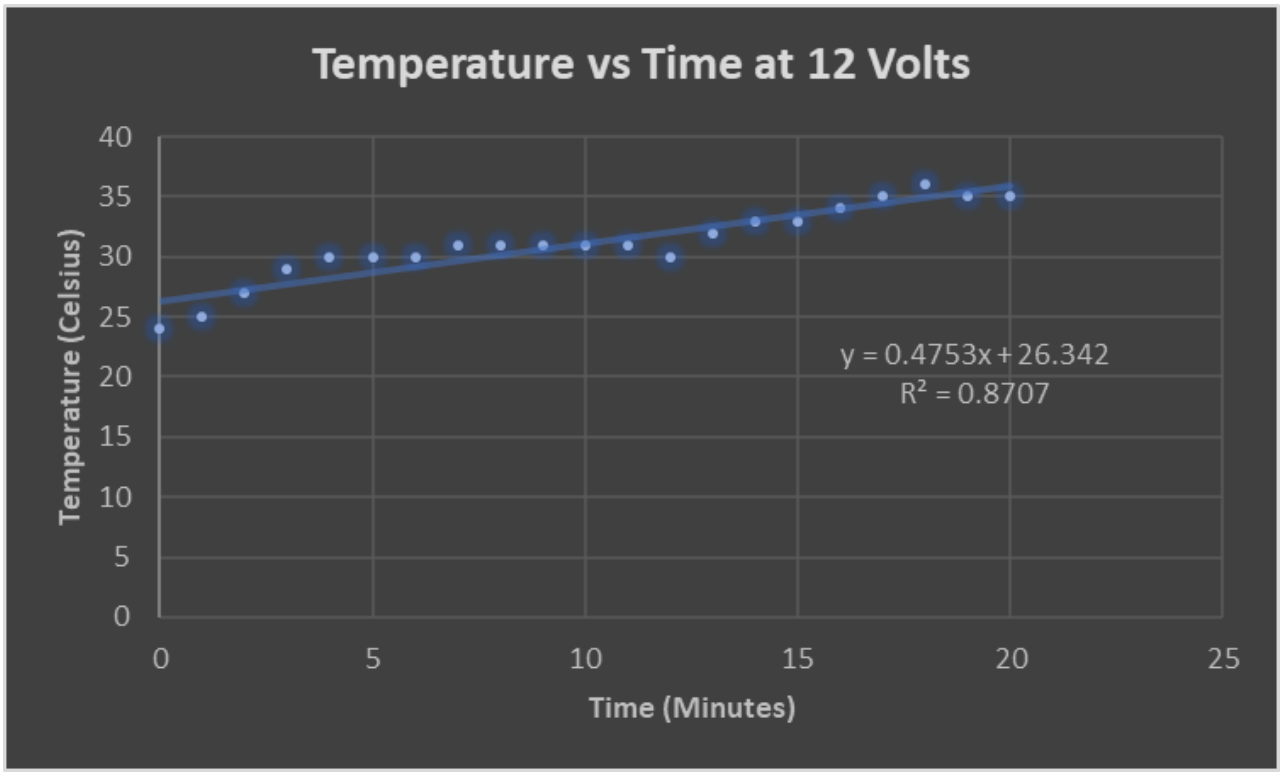
Content by: Rishi Mereddy

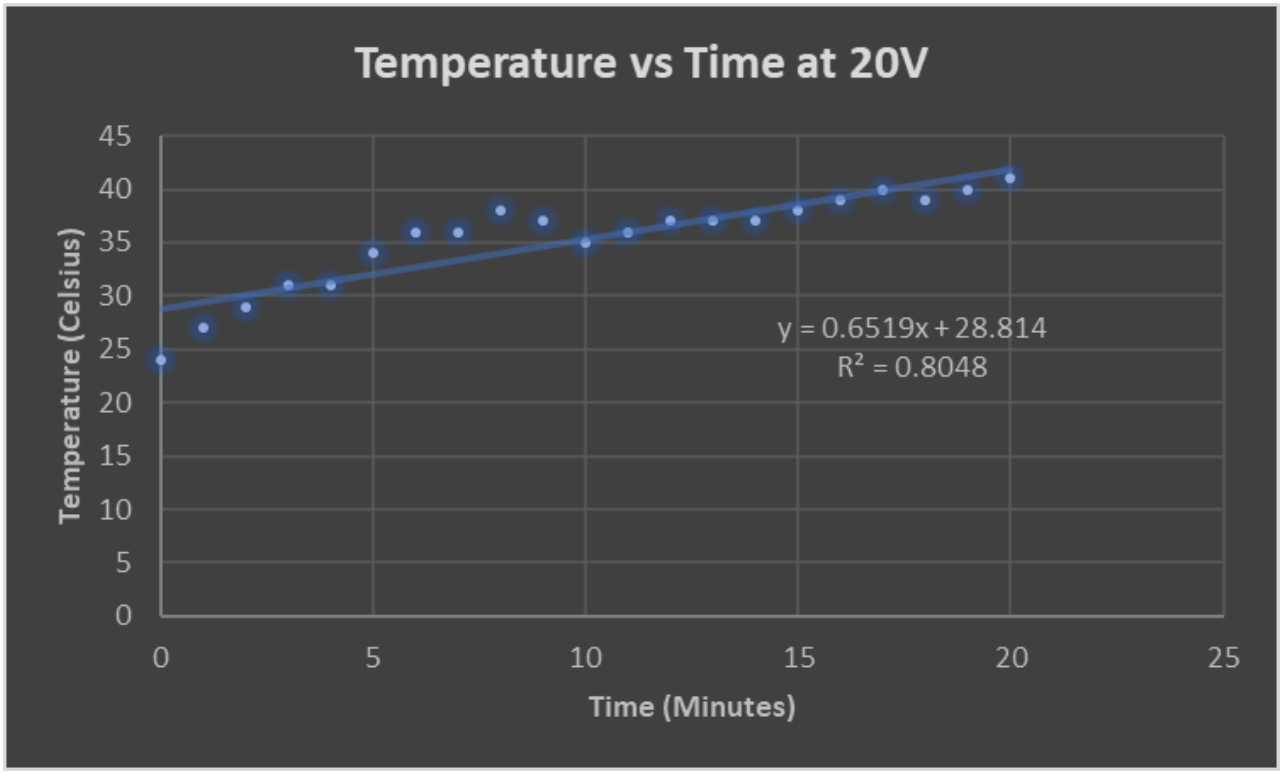
Present: Rishi, Edward

Goals: Generate graphs of the temperature testing at different voltages.

Content:

I attached the second ITO film on the bottom on the prototype and then connected each to a DC power supply and applied 12V initially while recording temperature with a thermistor on a digital multimeter. We recorded the temperature every minute and placed the data in a excel sheet to generate scatter plots.
An issue I ran into was using the beefcake relay instead of the DC power supply, I cannot figure out how to connect it to the film correctly for it to supply enough power.





Conclusions/action items: These are promising results and show that the film can get warm enough fast enough for our use case and we will perform condensation test tomorrow. I will also ask the advisor for steps moving forward due to the complications with the beefcake relay.

2023/12/5 - Condensation testing

Rishi Mereddy - Dec 07, 2023, 1:33 AM CST

Title: Condensation testing

Date: 12/5/2023

Content by: Rishi Mereddy

Present: Rishi Mereddy

Goals: Finish condensation testing

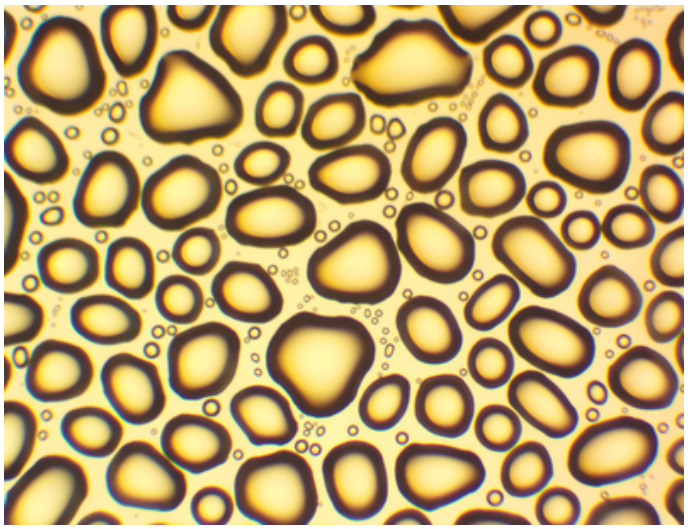
Content:

I ran the condensation testing, basically starting with a control group with no power added to the ITO film and then taking images at 9 zones on the window and counting the number of droplets after 45 minutes of running the setup. I then did this again with the power supply attached and did 2 trials per set up. I wanted to do more, but I was already there for 6 hours. I have images added below to show the set ups and will attach my excel sheet I used for testing.

Overall the film worked amazing, basically removed all condensation but in zone 9 or the bottom right, I am assuming this was due to bad contact between the film and the window in that location, but other than that, my solution using ITO film works wonders and fixes the main problem with the incubator originally. The only issue I may see the that the bottom ITO may affect the cell cultures, since it is heating up the glass below it to around 40 degrees C. Which is not too bad, but also not ideal.

Conclusions/action items: Testing went very well for me and I will begin statistical analysis shortly in MATLAB and try to visualize the data.

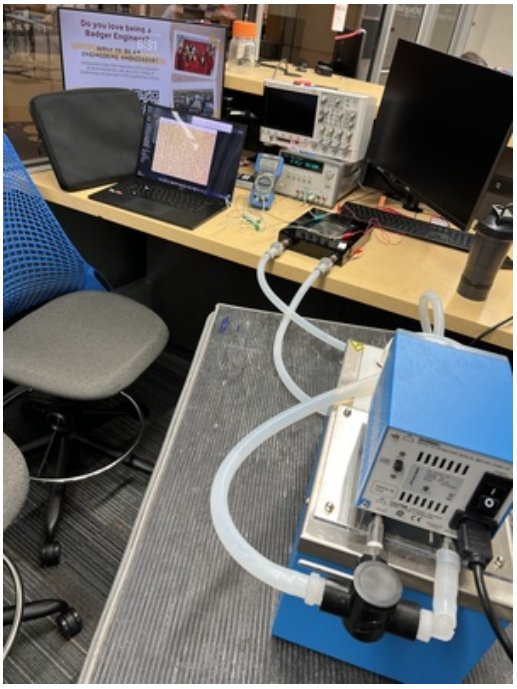
Rishi Mereddy - Dec 07, 2023, 1:36 AM CST



Download

Test2Zone4.png (15.6 MB) Example of a control zone where ITO film is not powered, leading to this condensation

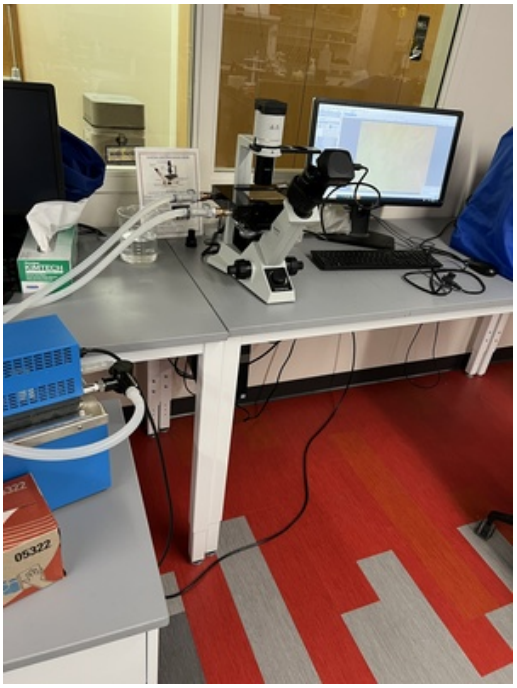
Rishi Mereddy - Dec 07, 2023, 1:35 AM CST



Download

IMG_4731.JPG (4.22 MB)

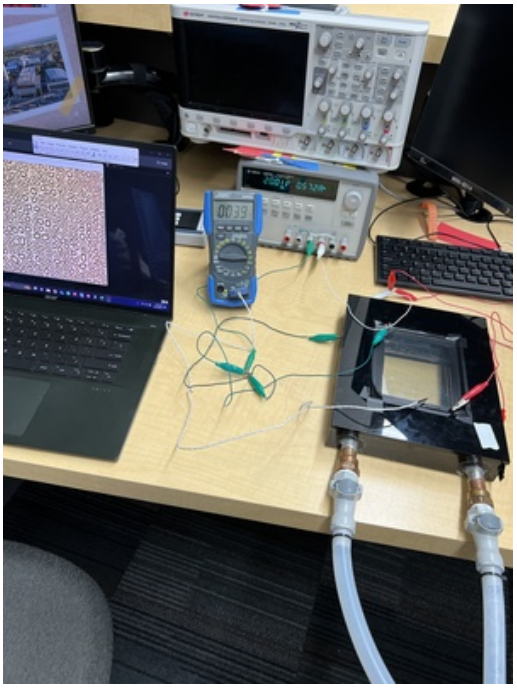
Rishi Mereddy - Dec 07, 2023, 1:36 AM CST



Download

IMG_4730.JPG (3.74 MB) Control ITO film, using a microscope to visualize condensation

Rishi Mereddy - Dec 07, 2023, 1:35 AM CST



Download

IMG_4732.JPG (4.16 MB) ITO film setup when attached to power

Rishi Mereddy - Dec 07, 2023, 8:07 AM CST

Download

Condensation_Testing.xlsx (19.5 kB) Excel sheet of data, average temperature of ITO film was 39 degrees Celsius and interior temp of 38 degrees

2023/12/7 - Statistical Analysis of condensation testing

Rishi Mereddy - Dec 14, 2023, 2:48 PM CST

Title: Statistical Analysis for condensation testing

Date: 12/7/2023

Content by: Rishi Mereddy

Present: Rishi Mereddy

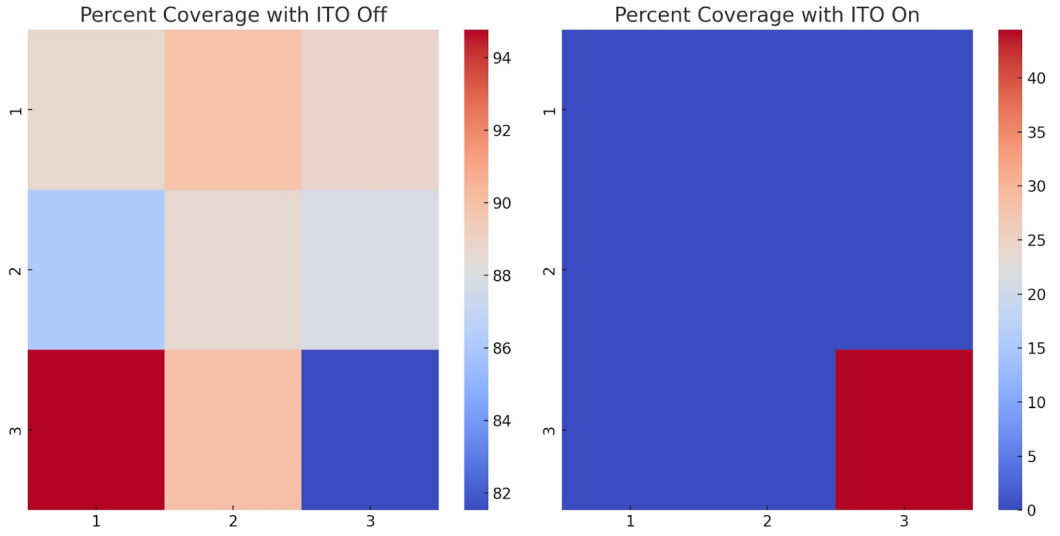
Goals: Generate figures and conduct basic stats

Content:

I ran the code in MATLAB, attached in the project files section, and got these results below, I wanted to generate a heat map to visualize how well the ITO film worked.

Table of common stats below. And heat map generated.

Statistic	ITO Off	ITO On
Mean Droplets	565.72	18.06
Median Droplets	614.00	0.00
Std Dev Droplets	208.45	51.07
Mean Coverage (%)	88.48%	4.94%
Median Coverage (%)	88.62%	0.00%



For the statistical analysis, common descriptive statistics were calculated, as shown in Table x, paired t-tests were run for the quantity of droplets and percent coverage of droplets on the viewing windows. The results from the paired t-test for the number of water droplets with the ITO film were as follows: t-value: 8.219 , p-value: 3.594e-05. The results for the percent coverage of water droplets was: t-value: 14.246, p-value: 5.742e-07. These results indicate that the addition of ITO film was extremely statistically significant.

Conclusions/action items: Very good results that show that we did solve the condensation problem. Now we just need to incorporate these results and charts into the final report

2023/12/14 - Temperature Testing of Internal Environment

EDWARD HAN - Dec 14, 2023, 10:00 AM CST

Title: Temperature Testing of Internal Environment

Date: 12/14/2023

Content by: Edward Han

Present: Edward Han, Roshan Patel

Goals: Finish temperature testing

Content:

I ran the temperature testing by running current through each ITO film until each reached 37 degrees C, then starting the water heater. While testing, the right pipe in the incubator came loose so minimal water was used in the water well as to prevent leakage. Temperatures were taken each minute for 15 minutes as temperature seemed to stabilize around minute three.

Temperature was able to be maintained above 37 degrees C, but often increased beyond that to 38 and 39 degrees. At the end of testing, the top ITO film was noticeably hot, and we think this temperature increase may be due to the voltage being ran through the ITO film being too high, affecting the temperature of the internal environment.

Time	Temp
0	31
1	34
2	35
3	38
4	38
5	38
6	37
7	37
8	38
9	37
10	38
11	39
12	39
13	39
14	39
15	37

Conclusions/action items: We were able to maintain a temperature of 37 degrees with a margin of two degrees, future teams should work on repairing the piping and finding the right voltage amount to run through ITO film.

2023/09/22 - Team Cell Cuties PDS

Rishi Mereddy - Sep 29, 2023, 2:40 PM CDT

Title: Team Cell Cuties Product Design Specifications

Date: 09/22/2023

Content by: Whole Team

Present: N/A

Goals: Finish the PDS

Content:

Attached Below

Conclusions/action items: Based on the PDS generate designs for the design matrix and then finally decide upon a final design to go forward with.

Rishi Mereddy - Sep 29, 2023, 2:40 PM CDT

Product Design Specifications: Microscope cell culture incubator

Client: Dr. John Puccinelli
Advisor: Dr. Joshua Brockman
Team: Rishi Mereddy *(Leader)*
Cherry Qui *(Communicator)*
Presley Hanson *(BSaC)*
Edward Han *(BWIG)*
Roshan Patel *(BWIG)*
Kaleeus Lange *(BPMG)*
Date: September 22nd, 2023

Problem Statement

This project team serves to develop a low cost cell culture incubation chamber that is compatible with an inverted microscope and capable of live cell imaging. This incubation chamber must be able to maintain an internal environment of 37 C, 5% CO_2, and 95-100% humidity over a long duration of time, without compromising the integrity of the microscope's optics or functionality. Spacial consideration should be taken to maintain even heating and humidity across the chamber as gradients can result in evaporation from low volume cultures such as microfluidic devices. Current commercially available systems are prone to these issues and are extremely expensive. Commercial systems also tend to be large and enclose the entire microscope making it difficult to assemble and remove and between uses. Because of their size, they also hinder use of the microscope in general.

Client Requirements

- No condensation can form on the viewing screen of the incubator
- Cannot hinder the optics of the microscope
- Must be able to be cleaned with ethanol
- Make the temperature across the incubator and cell culture as uniform as possible
- Limit the amount of wires if possible

Design requirements

This device description should be followed by list of all relevant constraints, with the following list serving as a guideline. (Note: include only those relevant to your project):

Download

2023_17_09_-_Cell_Cuties_PDS_V1.pdf (117 kB)

2023/09/29 - Team Cell Cuties Design Matrix

Rishi Mereddy - Sep 29, 2023, 2:45 PM CDT

Title: Team Cell Cuties Design Matrix

Date: 09/29/2023

Content by: Rishi Mereddy

Present: Whole Team

Goals: Finalize the Design Matrix

Content:

Attached Below

Conclusions/action items: Based on the design matrix, we will primarily move forward with the layer of water design, but the high score of the ITO design allows us to pivot in case this design does not work.

Rishi Mereddy - Sep 29, 2023, 2:45 PM CDT

DESIGN MATRIX: Microscope cell culture incubator

Client: Dr. John Puccinelli
Advisor: Dr. Joshua Brockman
Team: Rishi Mereddy *(Leader)*
Cherry Qui *(Communicator)*
Presley Hansen *(BSE&C)*
Edward Han *(BWIG)*
Roshan Patel *(BWIG)*
Kaleeus Lange *(BPMG)*
Date: September 29th, 2023

Design Matrix Criteria

- *Durability:* Considers how long the parts of the design could be expected to last with consistent use. A higher score represents a design that would not be expected to break even with long-term use. A low score means that the design would likely be prone to breaking down.
- *Reliability:* Considers how consistently and to what standard the design would fulfill its intended purpose of defogging the glass. A higher score means that the design is expected to consistently and totally solve the fogging issue. A low score means that the design is expected to infrequently or poorly solve the fogging issue.
- *Ease of Fabrication:* Considers which designs would require the least amount of effort and strenuousness to fabricate correctly. A higher score indicates a design that can be fabricated with less effort while lower scores represent higher effort.
- *Cost:* Considers the amount of money needed to fabricate and maintain each design. Low scores indicate a higher cost and higher scores indicate a lower cost.
- *Safety:* Consider how safe each design is to use. Low scores indicate a less safe design and higher scores indicate a safer design.
- *Ease of Use:* Considers how easily the client will be able to use each design. Low scores indicate a design that will be harder to use (involve more moving parts) and higher scores indicate a design that will be easier to use.

Download

2023_09_27_-_Team_Cell_Cuties_Design_Matrix.pdf (286 kB)

2023/10/9 - Team Cell Cuties Preliminary Presentation

Rishi Mereddy - Oct 06, 2023, 3:51 PM CDT

Title: Team Cell Cuties Preliminary Presentation

Date: 10/6/2023

Content by: Rishi Mereddy

Present: N/A

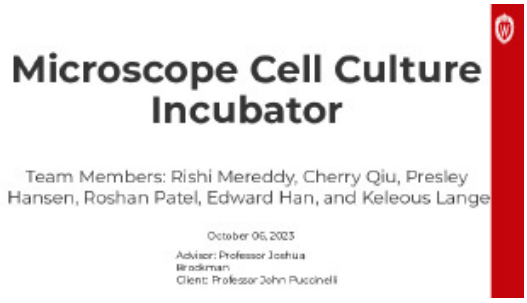
Goals: Finish the prelim presentation

Content:

Attached Below

Conclusions/action items: With the presentation complete and presented to the advisors and a small audience, the team can move on to the preliminary report and get a strong start on that and try to move further to the actual fabrication of our design.

Rishi Mereddy - Oct 06, 2023, 3:51 PM CDT



Download

2023_10_6_-_Team_Cell_Cuties_Preliminary_Presentation.pdf (1.19 MB) Team Cell Cuties Preliminary Presentation

2023/12/7 - MATLAB code for statistics

Rishi Mereddy - Dec 14, 2023, 2:47 PM CST

Title: MATLAB code for statistics

Date: 12/7/2023

Content by: Rishi Mereddy

Present: Rishi Mereddy

Goals: Publish the working code in LabArchives

Content:

Attached below

Conclusions/action items: N/A

Rishi Mereddy - Dec 14, 2023, 2:47 PM CST

```
% Averaged data for Control tests
droplets_off = [614, 351, 343, 700, 823.5, 651, 227.5, 524, 857.5];
percent_coverage_off = [88.6165, 89.6915, 80.016, 86.1845, 88.6875, 87.9135,
  94.7765, 93.8885, 81.5271];

% Averaged data for ITO tests
droplets_on = [8, 8, 8, 8, 0, 0, 0, 0, 162.5];
percent_coverage_on = [8, 0, 0, 0, 0, 0, 0, 0, 44.4931];

% Reshape the data into 3x3 matrices
droplets_off_matrix = reshape(droplets_off, [3, 3]);
percent_coverage_off_matrix = reshape(percent_coverage_off, [3, 3]);
droplets_on_matrix = reshape(droplets_on, [3, 3]);
percent_coverage_on_matrix = reshape(percent_coverage_on, [3, 3]);

% Create a custom colormap
cmap = [linspace(1, 1, 50)', linspace(1, 0, 50)', linspace(0, 0, 50)';
  linspace(1, 0.8, 50)', zeros(50, 1), zeros(50, 1)];

% Create heatmaps for percent coverage
figure;
subplot(2, 2, 1);
heatmap(percent_coverage_off_matrix, 'Colormap',
  cmap, 'GridVisible', 'on');
title('Percent Coverage with ITO Off');

subplot(2, 2, 2);
heatmap(percent_coverage_on_matrix, 'Colormap',
  cmap, 'GridVisible', 'on');
title('Percent Coverage with ITO On');

% Create bar graphs for number of droplets
subplot(2, 2, [3, 4]);
bar([1:9; 1:9]', [droplets_off; droplets_on]', 'grouped');
set(gca, 'XTickLabel', {'Zone 1', 'Zone 2', 'Zone 3', 'Zone 4', 'Zone
  5', 'Zone 6', 'Zone 7', 'Zone 8', 'Zone 9'});
ylabel('Number of Droplets');
legend('ITO Off', 'ITO On');
title('Comparison of Number of Droplets');

% Paired t-test for droplets
[h_droplets, p_droplets, ci_droplets, stats_droplets] = ttest(droplets_off,
  droplets_on);

% Paired t-test for percent coverage
[h_coverage, p_coverage, ci_coverage, stats_coverage] =
  ttest(percent_coverage_off, percent_coverage_on);

% Display results
fprintf('Droplets Test: t(%d) = %0.3f, p = %0.3e\n', stats_droplets.df,
  stats_droplets.tstat, p_droplets);
```

Download

BME300code.pdf (77.8 kB) PDF of MATLAB code

2023/12/15 - Team Cell Cuties Final Report

Rishi Mereddy - Dec 15, 2023, 8:43 PM CST

Title: Team Cell Cuties Final Report

Date: 12/15/2023

Content by: Rishi Mereddy

Present: Whole Team

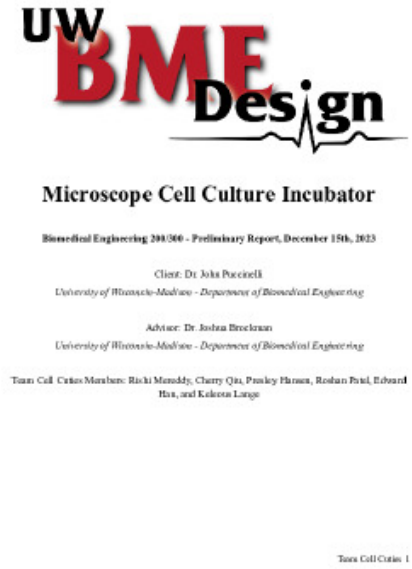
Goals: Generate a final report to consolidate the semester's progress

Content:

Attached

Conclusions/action items: Report is finished and it was a successful semester

Rishi Mereddy - Dec 15, 2023, 8:43 PM CST



Download

Team_CellCuties_Final_Report_1_.pdf (3.71 MB) PDF of Final Report

2023/09/15 - BSAC Meeting #1

PRESLEY HANSEN - Sep 15, 2023, 12:48 PM CDT

Title: BSAC Meeting #1

Date: 09/15/23

Content by: Presley Hansen

Present: Presley Hansen

Goals: Go to the first BSAC Meeting and talk with fellow BME students

Content:

- introductions made in small group discussion with BME 200 students

- in small group discussion, we discussed questions we had and how our projects were going

- we got in groups with BME 200, 300, and 400 students and they gave us advice for the class this semester

Conclusions/action items: The next BSAC meeting is September 29th

2023/09/29 - BSAC Meeting #2

PRESLEY HANSEN - Sep 29, 2023, 5:12 PM CDT

Title: BSAC Meeting #2

Date: 09/29/23

Content by: Presley Hansen

Present: Presley Hansen

Goals: Attend BSAC Meeting #2 and talk with fellow BSAC's

Content:

-brief introductions

-talked about how our projects are coming along including our design matrix and preliminary design presentations

-asked questions to the faculty

Conclusions/action items: Had a chance to meet/talk to the faculty and pose any concerns/get any questions answered

2023/10/13 - BSAC Meeting #3

PRESLEY HANSEN - Nov 04, 2023, 12:39 PM CDT

Title: BSAC Meeting #2

Date: 2023/10/13

Content by: Presley Hansen

Present: Presley Hansen

Goals: Attend BSAC Meeting #3 and talk with BSAC's

Content:

-small group discussion about how preliminary presentations went, and feedback about the preliminary report, PDS, and preliminary notebook.

-large group discussion about a summary of these topics

Conclusions/action items: Had a chance to discussion team progress and any issues with BSACS

2023/10/27 - BSAC Meeting #4

PRESLEY HANSEN - Nov 04, 2023, 12:41 PM CDT

Title: BSAC Meeting #2

Date: 2023/10/27

Content by: Presley Hansen

Present: Presley Hansen

Goals: Attend BSAC Meeting #4 and talk with BSAC's

Content:

-small group discussion about design and testing progress and course planning for next semester

-large group discussion on a summary of these topics

Conclusions/action items: Had a chance to see how other teams are doing with their designing and testing and got some helpful feedback on course planning for next semester.

2023/11/10 - BSAC Meeting #5

PRESLEY HANSEN - Nov 29, 2023, 10:29 PM CST

Title: BSAC Meeting #2

Date: 2023/11/10

Content by: Presley Hansen

Present: Presley Hansen

Goals: Attend BSAC Meeting #5 and talk with BSAC's

Content:

-attend mentorship workshop

-small group discussion about show and tell

-any course planning difficulties for next semester?

Conclusions/action items: Listened to a great presentation about mentors and mentees. Next BSAC meeting is 12/1!

2023/12/01 - BSAC Meeting #6

PRESLEY HANSEN - Dec 03, 2023, 6:20 PM CST

Title: BSAC Meeting #2

Date: 2023/12/01

Content by: Presley Hansen

Present: Presley Hansen

Goals: Attend BSAC Meeting #6 and talk with BSAC's

Content:

discuss in small groups:

-discuss how show and tell was

-discuss plans for the rest of the semester

-discuss any roadblocks faced

-discuss if notebook has continued being updated

-discussion final presentation plans

discussion in a large group setting

Conclusions/action items: Had some good conversations with the other BSAC's about how their projects were going. Also got some good advice from a teacher who was sitting at our table.

2023/09/14 - Basics of Cell Cultures

Rishi Mereddy - Sep 14, 2023, 10:11 PM CDT

Title: Basics of Cell Cultures

Date: 09/14/2023

Content by: Rishi Mereddy

Present: N/A

Goals: Learn more about cell cultures and how they work.

- The environment the cells are in GREATLY affects the proliferation levels and differentiation and such. Too much heat, or acidity, CO2 levels, ETC. can cause undesired results.

- This explains why the conditions of the incubator chamber are so strict.

- I see that the need to remove the original cells from the original media and onto another in order to create a new subculture and cause even more cell proliferation is important. The design should allow for easy disassembly inorder to do as such.

- If this incubator will be used for different cell types, it should be easy to sterilize using an autoclave or UV therapy or another kind of sterilization technique that is compatible with the material of the incubator.

Work Cited :

[1] R. I. Freshney, *Basic principles of cell culture*. Wiley Online Library, 2006, pp. 3–22.

Conclusion: I know understand the very basics of cell culture media and how it works. I see some things that belong in the PDS, such as the ability to reuse the incubator with different cell types and make it easy to sterilize. The team and I will use this knowledge to aid in the design project.

2023/10/3 - Basic on the importance of phase contrast in cell culture microscopy

Rishi Mereddy - Oct 03, 2023, 4:23 PM CDT

Title: Basic on the importance of phase contrast in cell culture microscopy

Date: 10/3/2023

Content by: Rishi Mereddy

Present: N/A

Goals: Learn about phase contrast and why the client says it is important

Content:

- Phase contrast microscopy enhances the contrast between cellular components and their surroundings, making it easier to observe and study these cells without the need for staining or fixation.

- Live cell imaging: You can monitor cellular processes, such as cell division or migration, in real-time without causing harm to the cells.

- No need for the use of dye and such in order to see the transparent cells.

- We basically just need to make sure the light is consistent and that the films we use changes all the light in the same way in order to give all the the like equal phase shift which means that phase contrast is still possible.

Conclusions/action items: Phase contrast microscopy is important in cell culture microscopy because it allows for the visualization of transparent cells, facilitates live cell imaging, minimizes sample manipulation. I believe that the ITO film will be fine and allows for the phase contrast that the client requires.

2023/10/11 - ITO's temperature uniformity in cell culture

Rishi Mereddy - Oct 11, 2023, 11:33 AM CDT

Title: ITO's temperature uniformity in cell culture

Date: 10/11/2023

Content by: Rishi Mereddy

Present: N/A

Goals: Learn more about ITO to see if we should incorporate into our layer of water design

Content:

- In this study, these used the ITO as the primary heating source for the cells.

- The primary point of their incubator was to maintain temperature uniformity for the cells.

- The heater worked very well, maintaining great uniformity, is very optically transparent and dealt with no condensation problems.

- An added benefit is how precisely you can control the temperature using a microcontroller.

- The study also points out how this design could allow for the use of microscopes during incubation, which is the exact plan of the team's project.

Lin, J. L., Wu, M. H., Kuo, C. Y., Lee, K. D., & Shen, Y. L. (2010). Application of indium tin oxide (ITO)-based microheater chip with uniform thermal distribution for perfusion cell culture outside a cell incubator. *Biomedical microdevices*, *12*, 389-398.

Chicago

Conclusions/action items: Continue with adding the ITO film to the top glass of the layer of water design. This will allow us to pivot to a ITO film on both side design, incase the layer of water becomes to challenging to fabricate and maintain. The ITO film has clear benefits, as shown above, but the cost is the only drawback.

2023/14/09 - Notes on Solenoid Valve in order to control CO2 levels

Rishi Mereddy - Sep 14, 2023, 9:23 PM CDT

Title: Notes on Solenoid Valve in order to control CO2 levels

Date: 09/14/2023

Content by: Rishi Mereddy

Present: N/A

Goals: Learn more about CO2 control and how to do it in an inexpensive way

Content:

- This paper offers a very inexpensive way to use a solenoid valve, micro controller, and CO2 supply in order to effectively control CO2 levels in a desired environment.

- A solenoid valve is basically an electrically controlled valve which works very well with gasses and is very precise due to its automatic nature.

- The valve can be used in our design project to control the CO2 levels and maintain them at the desired level.

- In combination with a CO2 sensor of some sort, aswell as a microcontroller to control the valve, I believe this will be an very good way to control the CO2 levels for the cells to proliferate.

- A see that a relay of some sort (beefcake?) maybe be necessary in order to power everything safely.

Work cited:

[1] H. Chen and J. Markham, “Using microcontrollers and sensors to build an inexpensive CO2 control system for growth chambers,” Applications in Plant Sciences, vol. 8, no. 10, p. e11393, 2020, doi: https://doi.org/10.1002/aps3.11393.

Conclusions/action items:

A initial design can come from this. The use of the method listed above will greatly lower expenses and is shown to work with living organisms. But learning the code in order to do this may prove to be challenging.

2023/14/09 - Micro-CO2 Incubator Design

Rishi Mereddy - Sep 14, 2023, 10:27 PM CDT

Title: Micro-CO2 Incubator Design

Date: 09/14/2023

Content by: Rishi Mereddy

Present: N/A

Goals: Learn about competing designs to see what has currently been achieved in the field

Content:

- This is a very old design, from 1983, but the concept is very similar to the design project we are doing.

- This design seems over complicated, but parts of it such as the thermistor, gas duct, and thermal coil can be used in our design in a cheaper fashion.

- I now understand that the point of control CO2 is to control how much is dissolved in the cell culture media and as a result control the pH, which affect cell proliferation and health.

- I like the modular petri dish design and will bring it up to the team to possibly incorporate.

- The coil design may eliminate the condensation problem associated with using water pumps to maintain the temperature. If a coil/heating element is wrapped around the petri dish, it coudl heat the cell culture media without causing condensation.

Work Cited:

[1] C. Ince, D. L. Ypey, M. M. Diesselhoff-Den Dulk, J. A. Visser, A. De Vos, and R. Van Furth, “Micro-CO2-incubator for use on a microscope,” *Journal of Immunological Methods*, vol. 60, no. 1–2, pp. 269–275, 1983.

Conclusions/action items: I learned about a competing design form the past with elements that the team could possibly use for our design.

2023/17/09 - Information on different heating element designs

Rishi Mereddy - Sep 17, 2023, 10:25 PM CD

Title: Information on different heating element designs

Date: 09/17/2023

Content by: Rishi Mereddy

Present: N/A

Goals: Learn more about different heating element designs in order to move away from the copper pipe water design

Content:

- A metal shell around the petri dish in order to maintain 37 degrees C may prove to be effective aswell as reduce overall size of the contraption

- A milled copper or aluminum shell seems to be quite expensive and not feasible with the given budget.

- Heating with water is possible but would create a lot of condensation.

- Heating tape may be an option, due to its low cost and ease of use. https://www.amazon.com/Flexible-Polyimide-Adhesive-Heating-10mmx93mm/dp/B09RWXXVN7/ref=asc_df_B09RWXXVN7/?tag=hyprod-20&linkCode=df0&hvadid=563617786483&hvpos=&hvnetw=g&hvrand=11070081450983085 52&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9018948&hvtargid=pl1647662939221&th=1

- I believe wrapping the petri dish in a copper foil and then attaching the heat tape will maintain optimal temperatures without creating condensation.

[1] S. R. Heidemann, P. Lamoureux, K. Ngo, M. Reynolds, and R. E. Buxbaum, “Open-dish incubator for live cell imaging with an inverted microscope,” *Biotechniques*, vol. 35, no. 4, pp. 708–716, 2003.

Conclusion/Action Items: Look more into heating tape and bring this idea up with the team for possible inclusion into the project.

2023/09/25 - Design Ideas for Anti-Condensation efforts

Rishi Mereddy - Sep 25, 2023, 8:35 PM CDT

Title: Design Ideas for Anti-Condensation

Date: 09/25/2023

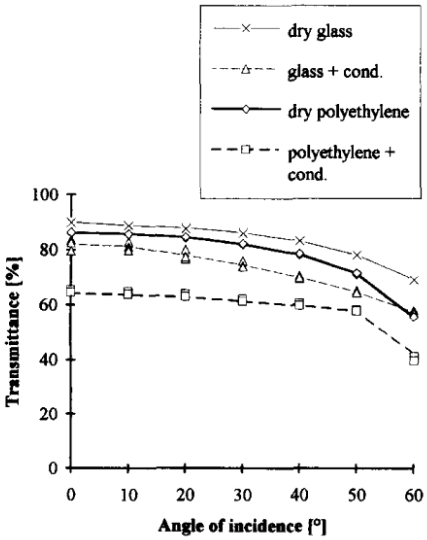
Content by: Rishi Mereddy

Present: N/A

Goals: Find ways to reduce condensation

Content:

A research paper I was reading quantified the light emission of PLA and glass when dry and when covered in condensation. It was shown that Dry glass had the greatest light transmission followed by Dry PLA, then Glass with condensation. The previous group used PLA and had very bad issues with condensation with it. Using glass may help this greatly, and since glass has a better thermal conductivity than PLA aswell, it may help with the uniformity of the temperature aswell.



[1] J. G. Pieters, J. M. Deltour, and M. J. Debruyckere, "Light transmission through condensation on glass and polyethylene," *Agricultural and Forest Meteorology*, vol. 85, no. 1, pp. 51–62, 1997, doi: https://doi.org/10.1016/S0168-1923(96)02393-3.

Conclusions/action items: Bring up using glass in the design matrix and now look more into films that can be added on to the glass to completely remove said condensation.

2023/09/25 - Design Ideas for Design Matrix

Rishi Mereddy - Sep 25, 2023, 9:08 PM CDT

Title: Design Ideas for the Design Matrix

Date: 09/25/2023

Content by: Rishi Mereddy

Present: N/A

Goals: Generate 3 designs to share with the group for the design matrix

Content:

1st Design: Improve on previous groups wiper design by using a vertical wiper that has a knob you can drag across which will wipe the entire interior of the glass and will be manual.

2nd Design: Switch to using glass, do to the better light transmission properties and then apply a anti condensation film to that.

3rd Design: Increase the insulation throughout he entire enclosure, making sure specifically , the windows are heavily insulated, to minimize the temperature difference and therefore minimize the condensation associated with that

Conclusions/action items: Share ideas with the group and decide on a final three and then start on the design matrix with the rest of the group.

Cell Culture Science

CHERRY QIU - Sep 15, 2023, 8:03 AM CDT

Title: Cell Culture Science

Date: 9/13/2023

Content by: Cherry Qiu

Present: Cherry Qiu

Goals: Learn about Cell Culture

Content:

-Cell cultures are a laboratory methods that foster the growth of either eukaryotic or prokaryotic cells in physiological conditions.

-Origins date back to the 20th century, use to study various biological systems including tissue growth and maturation and virus biology.

-In a clinical context, cell cultures are most commonly used to create model systems that study basic cell biology, replicate disease mechanisms, or investigate the toxicity of novel drug compounds.

-Using cell cultures in this context allows for the ability to manipulate genes and molecular pathways.

Segeritz, Charis-P., and Ludovic Vallier. “Cell Culture: Growing Cells as Model Systems in Vitro.” Edited by Morteza Jalali et al., *Basic Science Methods for Clinical Researchers*, U.S. National Library of Medicine, 2017, www.ncbi.nlm.nih.gov/pmc/articles/PMC7149418/#:~:text=Cell%20culture%20refers%20to%20laboratory,prokaryotic%20cells%20in%20physiological%20conditions.

Conclusions/action items:

Study cell cultures further to develop the perfect environment to maintain in our incubator

Zeiss Microscope Incubation

CHERRY QIU - Sep 15, 2023, 8:15 AM CDT

Title: Zeiss Microscope Incubation

Date: 9/15

Content by: Cherry Qiu

Present: Cherry Qiu

Goals: Learn more about competing designs

Content:

-This system is only supported for Zeiss 200M, Observer Range, and LSM 800/880 Elyra microscopes.

-Incubation system and Thermal specifications include

- Temperature Range Ambient +1 oC to 42 oC
- Temperature Stability ± 0.3 oC
- Temperature Homogeneity ± 0.3 oC across the XY axis of a motorised stage system.

- Vibration free heating system

Conclusions/action items: Learn more about the mechanics of this incubator and apply it to our own design

Inverted microscope structure

CHERRY QIU - Sep 28, 2023, 11:19 PM CDT

Title: Inverted Microscope Structure

Date: 9/28/2023

Content by: Cherry Qiu

Present: Cherry Qiu

Goals: To learn more about the structure of inverted microscopes.

Content:

- Invented in 1850 by J. Lawrence Smith

- The light source and condenser are above the stage and pointing downwards.

- The objectives and turret are below the and point upwards.

- The stage is usually fixed in place.

- The focus is adjusted by moving the objective lenses along a vertical axis to either bring it closer or further from the sample.

- There can be four to six objective lenses depending on the model.

Conclusions/action items:

Apply the basic structure of an inverted microscope to our design to make sure that the cell culture is clearly visible.

Antifog Spray

CHERRY QIU - Sep 28, 2023, 11:46 PM CDT

Title: Anti Fog Materials

Date: 9/28/2023

Content by: Cherry Qiu

Present: Cherry Qiu

Goals: Learn more about the mechanics of anti fog spray

Content:

-Reduces the surface tension of the surface

-Causes the water droplets to slide off the surface rather than adhering to the lenses in the form of a fog.

- Surfactants solutions applied to the lens surface, they are not permanent.

-Hydrophilics work by creating a adhesive surface for the water and releasing it towards the edge of the surface. This means that the surface will briefly fog up before it clears up.

Conclusions/action items:

This is a potential solution to our fogging issue with the previous design.

Science behind Condensation

CHERRY QIU - Sep 28, 2023, 10:55 PM CDT

Title: Condensation Science

Date: 9/28/2023

Content by: Cherry Qiu

Present: Cherry

Goals: Understand condensation and what causes it

Content:

-Condensation is the deposition of a liquid or solid from its gaseous form.

- Typically occurs on surfaces that are cooler than the gas

-Substance will condense when the pressure exerted by the vapor is greater than vapor pressure of the solid or liquid.

https://www.britannica.com/science/condensation-phase-change

Conclusions/action items:

Apply basic condensation science to create an anti-fogging design.

09/14/23 - Cell culture and live cell imaging research

PRESLEY HANSEN - Sep 14, 2023, 8:25 PM CDT

Title: Research on cell culture and live cell imaging

Date: 09/14/23

Content by: Presley Hansen

Present: Presley Hansen

Goals: To learn some background information about cell culture and live cell imaging

Content:

Cell culture

- The removal of cells from a plant or animal and placed in a favorable artificial environment for their subsequent growth
- Cell culture is one of the major tools used in cellular and molecular biology
- It provides excellent model systems for studying the normal physiology of cells and the effects of drugs and toxic compounds on the cells

https://www.thermofisher.com/us/en/home/references/gibco-cell-culture-basics/introduction-to-cell-culture.html

Incubation chamber

- Used to grow and maintain plants and microbiological cells
- Designed to maintain optimal temperature, humidity, light, pressure, vacuum and other conditions such as the carbon dioxide (CO2) and oxygen content of the atmosphere inside the chamber

http://newmeditech.com/secure/incubation-chamber/#:~:text=An%20incubation%20chamber%20is%20a,the%20atmosphere%20inside%20the%20chamber.

Conclusions/action items: Learned a little about cell culture and an incubation chamber. Start brainstorming the beginning of designs.

09/14/23 - Inverted Microscope and Incubation Chamber Research

PRESLEY HANSEN - Sep 14, 2023, 8:29 PM CDT

Title: Research Inverted Microscope and Incubation Chamber

Date: 09/14/23

Content by: Presley Hansen

Present: Presley Hansen

Goals: To get background information on inverted microscopes and incubation chambers

Content:

Inverted microscope

- An inverted microscope is a microscope with its light source and condenser on the top while the objectives and turret are below the stage pointing up

https://en.wikipedia.org/wiki/Inverted_microscope

Incubation chamber

- Used to grow and maintain plants and microbiological cells
- Designed to maintain optimal temperature, humidity, light, pressure, vacuum and other conditions such as the carbon dioxide (CO2) and oxygen content of the atmosphere inside the chamber

http://newmeditech.com/secure/incubation-chamber/#:~:text=An%20incubation%20chamber%20is%20a,the%20atmosphere%20inside%20the%20chamber

Conclusions/action items: I learned what an inverted microscope was and a little bit about incubation chambers. We need to work on the PDS, the next progress report, and start brainstorming designs.

09/20/23 - Alternate heating ideas

PRESLEY HANSEN - Sep 20, 2023, 8:27 PM CDT

Title: Alternate heating ideas

Date: 09/20/23

Content by: Presley Hansen

Present: N/A

Goals: To research ideas for heating our incubator and keeping it at a more uniform level

Content:

- one idea for heating is filling the chamber with water. water temperature changes much more slowly than air temperature so it will be much easier to heat the chamber.

- another idea is using the same copper piping as the last group to heat the chamber. We could add more piping in different places to try and even out the heat distribution or we could place little fans in the chamber to help with heat flow.

- we could also put a thermal film on the inside walls of the chamber to help it maintain heat.

Source:

https://lairdthermal.com/thermal-technical-library/application-notes/heating-and-cooling-incubator-chambers#:~:text=Using%20a%20similar%20casing%20to,chamber%2C%20while%20others%20add%20fans.

Conclusions/action items: Brainstormed ideas for heating the incubator. Keeping the copper piping may be the best course of action and maybe adding more piping or a thermal film along with it.

09/20/23 - Humidity conservation ideas

PRESLEY HANSEN - Sep 20, 2023, 8:46 PM CDT

Title: Humidity conservation ideas

Date: 09/20/23

Content by: Presley Hansen

Present: N/A

Goals: To brainstorm ideas for maintaining at least 95% humidity in the incubator but keeping no condensation

Content:

- one idea is to keep a layer of water at the bottom of the chamber which will create humidity in the chamber. We will probably have to find a way to prevent condensation then.

- another idea is to keep a wet sponge at the bottom of the chamber. this should be easier to produce and may create less condensation than the layer of water.

- to keep condensation minimal on the screen of the chamber, one idea is to heat the outside of the chamber with some sort of lamp/light. Condensation can form if the outside air temperature is much cooler than the inside of the chamber.

- another idea to limit condensation is a transparent adhesive anti-condensation film. The previous group tried anti-condensation spray but not films. This film could prevent the formation of condensation on the screen of the chamber which would greatly improve seeing into the incubator through the microscope.

Sources:

https://extension.psu.edu/programs/4-h/get-involved/teachers/embryology/teacher-resources/supporting-subject-matter/incubation/science-of-incubation/humidity-and-ventilation#:~:text=An%208%2Dinch%20pie%20tin,to%20increase%20the%20evaporating%20surface.

https://www.solarfilm.it/gb/transparent-anti-condensation-film.html#:~:text=Transparent%20adhesive%20anti%2Dcondensation%20film,between%20internal%20and%20external%20environment.

Conclusions/action items: Brainstormed ideas to create/keep humidity while keeping condensation limited. Using a transparent adhesive anti-condensation film seems like a good idea to try. Our group needs to work on creating some preliminary designs.

09/26/23 - Condensation formation and commercial ideas

PRESLEY HANSEN - Sep 27

Title: Condensation formation and commercial ideas

Date: 09/27/23

Content by: Presley Hansen

Present: N/A

Goals: To get a clear definition of how condensation forms and research some commercial ideas for solving it.

Content:

- Condensation generally occurs in the atmosphere when warm air rises, cools, and loses its capacity to hold water vapor.

http://ww2010.atmos.uiuc.edu/(Gh)/guides/mtr/hyd/cond/home.rxml#:~:text=Condensation%20is%20the%20change%20of,condenses%20to%20form%20c

- Condensation occurs when warm air collides with cold surfaces (or with too much humidity). When warm air comes into contact with a chilly surface, it coc and releases the water, which turns into liquid droplets on the cold surface. "Adequate ventilation is the only way of preventing condensation."

https://www.envirovent.com/help-and-advice/why-ventilate/condensation-problems/what-causes-condensation/#:~:text=Condensation%20occurs%20when%20warm%20air,droplets%20on%20the%20cold%20surface.

Ideas on how condensation can be limited:

- a film that can be placed on the polycarbonate viewing window

- is there a way to have some sort of vent/tube where the water can be released but keep the humidity and CO2 levels stable?

- find a new material besides polycarbonate that is better at reducing condensation

- some sort of fan?

- a mat or sponge at the bottom of the chamber to collect extra water vapor

- maintaining a constant air temperature

- heat the outside of the chamber so the air on both sides matches and there isn't a gradient difference.

Conclusions/action items: Possible ideas for limiting condensation were formed. Trying a film on a new material besides polycarbonate would be interesti maybe adding a sponge to the bottom of the chamber. This week, we will be working on sketches and our design matrix.

09/28/23 - Glass conductivity

PRESLEY HANSEN - Sep 29, 2023, 5:45 PM CDT

Title: Glass conductivity

Date: 09/28/23

Content by: Presley Hansen

Present: N/A

Goals: To find out if glass is a better material to use than plastic

Content:

- The previous group used plastic for their viewing screen but it fogged up very easily, so I'm wondering if there is a better material that can be used instead of glass that would get rid of condensation.

-Glass and metal absorb and retain heat longer than plastic, so residual water will evaporate more quickly from glass or metal. There is residual water on the viewing screen, so making it out of glass will allow for the water to be evaporated easier.

-We will still need to find a way to heat the glass to get rid of the condensation, but it will be easier with glass instead of plastic.

https://www.mcgill.ca/oss/article/you-asked/why-does-plastic-stay-wet-dishwasher-whereas-glass-comes-out-dry#:~:text=This%20value%20also%20determines%20how,quickly%20from%20glass%20or%20metal.

Conclusions/action items: Glass should be used over plastic because it will be easier to vaporize the condensation on the viewing screen. We are thinking of using wires to heat the glass but we will have to test/think about this idea further when prototyping.

10/05/23 - Phase shifts

PRESLEY HANSEN - Oct 06, 2023, 1:04 AM CDT

Title: Phase shifts

Date: 10/05/23

Content by: Presley Hansen

Present: N/A

Goals: Learn more about phase shifts to understand the background to keeping a constant medium

Content:

- When a wave travels through a medium, different frequencies travel at different speeds. The wave undergoes a phase shift.

- Phase shifts can affect the interference between waves where waves interfere to produce bright and dark fringes. The phase shift is the difference in the position of the wave at a given point in time compared to its position at the same point in another location.

https://www.collimator.ai/reference-guides/what-is-a-phase-shift#:~:text=This%20occurs%20when%20waves%20travel,the%20case%20of%20light%20waves.

Conclusions/action items: Learned more about phase shifts. Need to further practice the preliminary presentation and prepare the preliminary document with the team for Wednesday

09/15/23 - Final Products From Previous Groups

PRESLEY HANSEN - Sep 20, 2023, 7:19 PM CDT

Title: Final Products From Previous Groups

Date: 09/15/23

Content by: Presley Hansen

Present: Presley Hansen

Goals: To become familiar with previous final products from previous groups.

Content:

Spring 2023

- they made an incubation chamber with copper tubing to allow for the heated water pump to heat the water bath.

- they have a transparent top for microscopic imaging

- Arduino microcontroller used to receive and send data for collection

improvements to design

- need to figure out a better way to prevent condensation

- need more uniform heat distribution

- save as much space as possible

Conclusions/action items: We will probably use inspiration from this project and spend most of our time tweaking and finding ways to improve it. Next course of action is to work on the PDS and start sketching beginning designs.

09/14/23 - Brainstorming ideas

PRESLEY HANSEN - Sep 15, 2023, 12:37 PM CDT

Title: Brainstorming ideas

Date: 09/14/23

Content by: Presley Hansen

Present: Presley Hansen

Goals: to come up with beginning ideas about building the cell culture incubator

Content:

- Build a chamber small enough to fit on the stage of the inverted microscope

- it cannot get in the way of the optics of the microscope or hinder its ability

- maybe use tubing to maintain the temperature, CO_2 levels, and humidity

- somehow build in sensors so these levels can be recognized

Conclusions/action items: How can we make this microscope low-cost but make it easy to use

10/05/23 - Accomplishments from this week

PRESLEY HANSEN - Oct 06, 2023, 1:08 AM CDT

Title: Accomplishments from this week

Date: 10/05/23

Content by: Presley Hansen

Present: N/A

Goals: To go over what I did this week

Content:

- Had a zoom meeting with the team to go over slides in the preliminary presentation

- Talked about designs 1, 2, and 3 with the team and sketched them

- Finished the design matrix

- Prepared my slides and practiced them

- Had an in-person meeting with the team to practice the slides

- Did further research

Conclusions/action items: Reviewed the accomplishments from this week. Next week we need to work on the preliminary document.

2023/12/03 - Biosafety and Chemical Safety Training

PRESLEY HANSEN - Dec 03, 2023, 11:44 PM CST

Title: Biosafety and Chemical Safety Training

Date: 2023/12/03

Content by: Presley Hansen

Present: Presley Hansen

Goals: To complete the biosafety and chemical safety training courses.

Content: final quiz scores attached*

Conclusions/action items: Completed the biosafety and chemical safety training courses

PRESLEY HANSEN - Dec 03, 2023, 11:44 PM CST


12/3/23, 11:34 PM Biosafety Required Training Quiz 2023: PRESLEY HANSEN

Submission Details

Grade: 22.5 / 25

Biosafety Required Training Quiz 2023

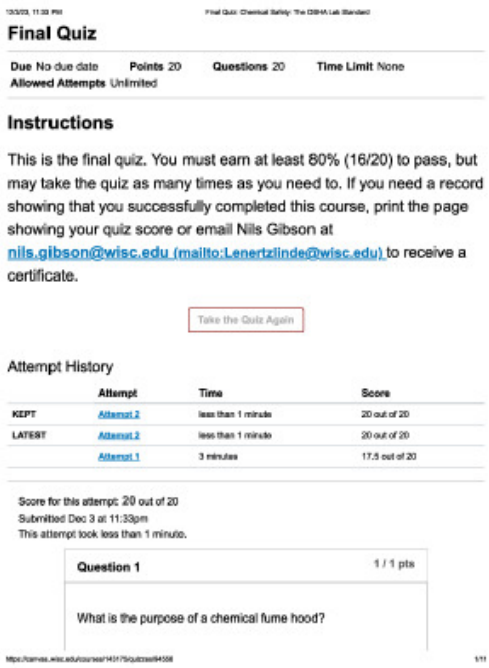
PRESLEY HANSEN submitted Dec 3 at 10:57pm

https://canvas.wisc.edu/courses/[illegible]/assignments/[illegible]/submissions/[illegible] 1/3

Download

Biosafety_Required_Training_Final_Quiz_Score.pdf (37.5 kB)

PRESLEY HANSEN - Dec 03, 2023, 11:45 PM CST



12/3/23, 11:33 PM Final Quiz: Chemical Safety: The OSHA Lab Standard

Final Quiz

Due No due date **Points** 20 **Questions** 20 **Time Limit** None
Allowed Attempts Unlimited

Instructions

This is the final quiz. You must earn at least 80% (16/20) to pass, but may take the quiz as many times as you need to. If you need a record showing that you successfully completed this course, print the page showing your quiz score or email Nils Gibson at nils.gibson@wisc.edu (mailto:Lenertzlinde@wisc.edu) to receive a certificate.

Take the Quiz Again

Attempt History

	Attempt	Time	Score
KEPT	Attempt 2	less than 1 minute	20 out of 20
LATEST	Attempt 2	less than 1 minute	20 out of 20
	Attempt 1	3 minutes	17.5 out of 20

Score for this attempt: 20 out of 20
Submitted Dec 3 at 11:33pm
This attempt took less than 1 minute.

Question 1 1 / 1 pts

What is the purpose of a chemical fume hood?

https://canvas.wisc.edu/courses/141175/quizzes/84558 1/11

Download

Chemical_Safety_Training_Final_Quiz_Score.pdf (115 kB)

9/15/23 - Cell Culture Environment

EDWARD HAN - Sep 15, 2023, 1:14 PM CDT

Title: Cell Culture Science

Date: 9/15/2023

Content by: Edward Han

Present: Edward Han

Goals: Learn about Cell Incubator optimal conditions and potential difficulties

Content:

Cell Incubation Conditions

- Cell population may unexpectedly fluctuate due to cell conditions as well as genomic variation
    - cells with low passage number may minimize this
- Necessary conditions outlined in the project description are necessary for healthy cells
    - (37 °C) as native body temperature is best for growth
    - “CO_2 gas serves to maintain in vivo pH”
    - “High humidity prevents evaporation of growth media”
    - Opening incubator doors may temporarily disrupt these conditions
    - Positioning of certain devices contribute to these conditions

https://www.qiagen.com/us/knowledge-and-support/knowledge-hub/bench-guide/animal-cell-culture/cell-culture-conditions/cell-culture-conditions#:~:text=Cell%20cultures%20should%20be%20incubated,and%2For%20lower%20CO2%20concentrations.

https://assets.thermofisher.com/TFS-Assets/LED/Specification-Sheets/PF-CO2-SMARTNOTE-EN.pdf

Conclusions/action items:

Study ways to maintain stable incubator conditions

10/1/23 - Petri Dish Interactions With Water

EDWARD HAN - Oct 01, 2023, 8:05 PM CDT

Title: Petri Dish Interactions with Water

Date: 10/1//2023

Content by: Edward Han

Present: Edward Han

Goals: Learn about whether or not it is okay to put petri dishes in water

Content:

Petri dishes may not be entirely waterproof as commercially available petri dishes are for the most part not waterproof so it would depend on the cell culture and the preferred medium. The lids are ofany issuesten loose, so as long as the petri dish is not submerged there will not be any issues.

Conclusions/action items:

Find out whether or not the cells to be used will survive if submerged

https://hyphalfusion.network/t/is-petri-dish-which-is-watery-from-condensation-still-viable/155

https://www.amazon.com/ask/questions/Tx1C9SZPML88H2O#:~:text=No%2C%20our%20petri%20dishes%20are,something%20that%20works%20for%20you.

9/20/23 - Incubator Heating Methods

EDWARD HAN - Sep 20, 2023, 7:46 PM CDT

Title: Microscope Fogging countermeasures

Date: 9/20/2023

Content by: Edward Han

Present: Edward Han

Goals: Learn about potential ways to heat the incubator

Content:

Incubator heating methods

- current, water heater method
- "Using thermoelectrics instead of compressor-based thermal management solutions provide a more efficient and cost-effective option"

Conclusions/action items:

Study most efficient way from list of heating methods

https://lairdthermal.com/thermal-technical-library/application-notes/heating-and-cooling-incubator-chambers

9/15/23 - Telescope Optics Conditions

EDWARD HAN - Sep 26, 2023, 9:42 PM CDT

Title: Telescope Optics Conditions

Date: 9/15/2023

Content by: Edward Han

Present: Edward Han

Goals: Learn about conditions of Telescopes that may cause difficulties as they may also apply to microscopes

Content:

Humidity

- Telescope optics may be damaged by high humidity
- Inner workings of the telescope must remain dry
    - Unused sockets should remain closed
    - Protective caps can be used

https://www.baader-planetarium.com/en/downloads/dl/file/id/1418/product/0/important_care_tips_for_astronomical_instruments.pdf

Temperature

- Unequal temperatures can cause degraded image quality
- High temperatures may affect optics glue
    - optical aberrations due to the misalignment of the lenses may occur
- Fog may leave permanent spots on lenses

https://www.telescope.com/How-To-Thermally-Optimize-Your-Telescope/p/116953.uts#:~:text=The%20longer%20the%20optical%20path,is%20enough%20to%20degrade%20images.

https://starlust.org/how-to-store-your-telescope-safely/

Conclusions/action items:

Study ways to counteract issues caused by conditions in the incubator

9/20/23 - Microscope Fogging Countermeasures

EDWARD HAN - Sep 20, 2023, 7:35 PM CD

Title: Microscope Fogging countermeasures

Date: 9/20/2023

Content by: Edward Han

Present: Edward Han

Goals: Learn about why microscopes fog and how to counteract it

Content:

Reasons for telescope fogging

- "The lens fogging occurs due to an imbalance between the temperature of the eyepiece, airway cavity, and relative humidity of the environment resulting in condensation of small water droplets"

Countermeasures

- anti-fog solution, either as a spray or towelette
- a warming bath containing water at 120 degrees F
- render surface super hydrophobic

Conclusions/action items:

Study most efficient way from list of countermeasures

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7640865/

https://www.researchgate.net/publication/23559042_Use_of_a_Warming_Bath_to_Prevent_Lens_Fogging_during_Laparoscopy

https://link.springer.com/article/10.1007/s11998-015-9678-z

10/11/23 - Condensation Effect on Visibility

EDWARD HAN - Oct 11, 2023, 4:15 PM CDT

Title: Condensation Effect on Visibility

Date: 10/11//2023

Content by: Edward Han

Present: Edward Han

Goals: Learn about why condensation affects visibility

Content:

Due to the law's of refraction (formula below), light from our eyes that enter droplets refract off the spherical in a multitude of directions, and more than once. This causes vision through the droplets to be unclear. However, a uniform layer of water would cause all light to refract in the same direction, causing vision to be clear past it.

Conclusions/action items:

A uniform layer of water will be clear while condensation droplets will not

10/20/23 - Conductive Tape Types

EDWARD HAN - Oct 20, 2023, 9:43 AM CDT

Title: Conductive Tape Types

Date: 10/20//2023

Content by: Edward Han

Present: Edward Han

Goals: Find out what type of conductive tape would be optimal for our product

Content:

Conductive Adhesive vs Non-Conductive Adhesive: conductive adhesive conducts electricity of both sides while the other only conducts on the non-adhesive surface. Shouldn't matter as we are folding the tape on itself for the part where alligator clips go.

Isotropic vs Anisotropic: Isotropic tapes conduct in every direction, other only conducts in one axis

Material: Can be made from many materials, including cooper, aluminum, and conductive alloys

- Copper: high conductivity, blocks magnetic and electrical waves, good for grounding and shielding
- Aluminum foil: Lower conductivity than copper but good electrical performance and shielding. More cost-effective
- Tinned copper foil: Same conductivity as copper, but more resistant to humidity and extreme temperatures. Won't oxidize, better durability.

Conclusions/action items:

The best type of conductive tape to use would be anything using tinned copper foil, the other aspects don't matter too much.

https://robertmckeown.com/blog/conductive-tapes-guide/#:~:text=Tapes%20with%20conductive%20adhesive%20conduct,on%20the%20non%2Dadhesive%20surface.

11/1 - How Electricity Runs Through ITO

EDWARD HAN - Nov 01, 2023, 6:07 PM CDT

Title: How Electricity Runs Through ITO

Date: 11/1//2023

Content by: Edward Han

Present: Edward Han

Goals: Find out how to evenly heat ITO glass

Content:

Any voltage applied to ITO film should evenly distribute throughout the film and thus heat the glass evenly as well. Our team does not have to worry about points through which current is passed through.

Conclusions/action items:

Passing any current through ITO film should evenly heat the film.

https://diamondcoatings.co.uk/ito-coated-heated-train-windows/#:~:text=A%20voltage%20is%20applied%20to,a%20window%20with%20wiggle%20wires.

11/10/23 - Glass Cracking Temperature

EDWARD HAN - Nov 10, 2023, 12:16 PM CST

Title: Glass Cracking Temperature

Date: 11/10//2023

Content by: Edward Han

Present: Edward Han

Goals: Find out what temperature is safe to keep glass at

Content:

heat above 300 degrees Fahrenheit may cause glass to crack or shatter. heat above 500 degrees Fahrenheit may deform glass.

Conclusions/action items:

We should keep the ITO heat below 300 degrees, which should be trivial given that our target temperature is 97.5 degree Fahrenheit

https://www.berlinpackaging.com/insights/packaging-resources/answers-to-questions-about-glass-breakage#:~:text=Glass%20is%20a%20poor%20thermal,at%20302%E2%80%93392%C2%B0F.

12/1/23 - Effect of High CO2 on Cell Cultures

EDWARD HAN - Dec 01, 2023, 5:18 PM CST

Title: Effect of High CO2 on Cell Cultures

Date: 12/1/23

Content by: Edward Han

Present: Edward Han

Goals: Learn about effect of high CO2 on cell cultures

Content:

High CO2 will reduce cell growth but will not ultimately kill cell cultures.

"Elevating pCO2 from 50 to 150 mmHg under controlled osmolality (about 350 mOsm/kg) resulted in a 9% reduction in specific cell growth rate. "

https://pubmed.ncbi.nlm.nih.gov/15903242/

Conclusions/action items:

It is possible to test cell conditions by eyeballing high CO2 content to test other variables

12/15/23 - Chemistry Application of CO2 in Incubators

EDWARD HAN - Dec 15, 2023, 11:39 AM CST

Title: Chemistry Application of CO2 in Incubators

Date: 12/15/23

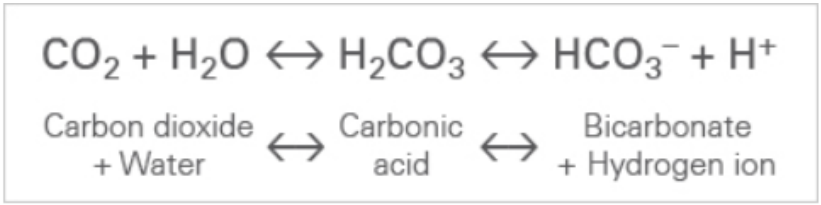
Content by: Edward Han

Present: Edward Han

Goals: Learn the chemistry related reason why cells require a specific CO2 level

Content:

CO2 level maintenance is required to maintain a stable pH, where many cell cultures use the bicarbonate buffer system which works using the following chemical reactions.



With this buffer, the pH will be stable around the desired level given a suitable amount of CO2

https://ibidi.com/content/372-carbon-dioxide-co2-levels-and-ph-of-the-medium#:~:text=The%20ambient%20carbon%20dioxide%20

Conclusions/action items:

CO2 levels are necessary to maintain a proper pH for cell cultures to thrive

10/10/23 - Competing Design - Okolabs

EDWARD HAN - Oct 10, 2023, 8:54 PM CDT

Title: Competing Design - Okolabs

Date: 10/10/2023

Content by: Edward Han

Present: Edward Han

Goals: Find out how competing designs address issues

Content: **https://www.oko-lab.com/live-cell-imaging/cage-incubator**

This competing design creates an enclosure around the entire microscope instead of just the petri dish.

Temperature

A temperature unit that uses warm air is used to set the correct temperature.

CO2

A gas chamber made of tubes and a petri dish stage is used to control carbon dioxide.

Humidity and Condensation

A water trap is used between the humidifier and the gas chamber where the petri dish is stored to prevent condensation..

Other

They use magnets to lock petri dishes and slides in place.

Conclusions:

Many of the methods used by this company is effective but require parts that put our design over our budget. We can consider using magnets to fix our petri dish in place for our water based designs.

12/1/23 - Sensor Testing

EDWARD HAN - Dec 01, 2023, 5:20 PM CST

Title: Sensor Testing

Date: 12/1/23

Content by: Edward Han

Present: Edward Han

Goals: report about sensor testing

Content:

CO2 sensor broke, but temperature and humidity levels are probable. The relay must be plugged in for CO2 sensor and other sensors to begin working.

Conclusions/action items:

Calibrate temperature and humidity sensors

9/26/23 - Anti-Fogging Design Ideas

Title: Anti-Fogging Design Ideas

Date: 9/26/2023

Content by: Edward Han

Present: Edward Han

Goals: Brainstorm ideas to combat fogging on the microscope

Content:

Prior research has shown that there are two ways to combat fogging, preventing fogging by reducing temperature gradient and reducing the effect of fogging

Reducing Temperature Gradient or Removing Humidity

1.) constantly measure temperature of both the incubator and the microscope lens, use heating method such as electromagnetic heating to match the temperatures

- impractical due to complicated nature, limited funds, and potential damage to microscope

2.) insulate the microscope lens from outside heat

- example products already made, such as that in second link

3.) use enclosure with dehumidification

- would need to transport microscope each use even if such an environment existed on campus. Client would like microscope to remain in the lab

Reducing the Effect of Fogging

1.) Use anti-fogging spray on microscope lens

- previous team already attempted, did not find success

2.) Make an opening to be able to wipe down the fogged side

- inconvenient, may break the system due to opening, may not be completely effective

3.) automatic wind wipers on incubator viewing panel

- previous team already attempted, did not find success

Conclusions/action items:

Think of designs implementing one of the aforementioned methods to combat microscope fogging

https://www.sciencedirect.com/science/article/abs/pii/S0017931022010584

https://www.aliexpress.us/item/2255800011470114.html?gatewayAdapt=glo2usa4itemAdapt

https://www.microbehunter.com/microscopy-forum/viewtopic.php?t=7668

10/10/23 - Alternate Heating Ideas

EDWARD HAN - Sep 27, 2023, 2:52 PM CDT

Title: Alternate Heating Ideas

Date: 9/27/2023

Content by: Edward Han

Present: Edward Han

Goals: Brainstorm ideas to heat the incubator other than the current water heating method

Content:

The previous design of the incubator uses a heated water as a method to evenly heat the incubator. Our client has indicated that he would like to move away from this heating method.

1.) Use multiple, high watt lightbulbs within the incubator

Lightbulbs would all need to be individually connected, and would take up alot of space. unsure if the heating from lightbulbs will heat evenly enough or reach the full cell culture.

2.) Put a heating tray/heating pad below the cell culture

These tend to be used for temperatures above 130 degrees. This can be mitigated by surrounding it with sand or some other medium, but this may inadvertedly kill the cells.

3.) Run wires through the incubator and heat those

Unsure if the heating from these wires would heat the whole incubator evenly

Conclusions/action items:

Think of designs implementing one of the aforementioned methods to heat the incubator

https://ask.metafilter.com/116552/Electricians-Craftspeople-Help-me-build-a-box-that-gets-hot

9/27/23 - Design Idea 1

EDWARD HAN - Sep 27, 2023, 3:03 PM CDT

Title: Design Idea 1

Date: 9/27/2023

Content by: Edward Han

Present: Edward Han

Goals: Detail a potential design idea for the incubator

Content:

The previous team seemed to have issues mainly with the carbon dioxide levels and the fogging of the microscope. Though their heating method was not optimal, it was able to maintain the correct temperature. Thus, for our first design I think it would be feasible to keep all working components and work mostly on the microscope fogging and CO2 level maintenance. For CO2 maintenance, their pump method seems to work but the code should be revised. For the microscope fogging, I believe we should attempt multiple solutions, including the fog-proof lens as proposed by other group members as well as anti-fogging spray and heat insulation pads for the microscope. I believe our first model should use fog resistant lenses as previous teams did not record attempting to do so.

Conclusions/action items:

Decide on a design idea for our first design matrix

10/1/23 - Fixing Petri Dish in Place

EDWARD HAN - Oct 01, 2023

Title: Fixing Petri Dish in Place

Date: 10/1/2023

Content by: Edward Han

Present: Edward Han

Goals: Brainstorm ideas to keep a partially submerged petri dish in place

Content:

Ideas for fixing a p

1. weigh down the petri dish
   the buoyancy may be quite high due to the high volume of the petri dish. The relatively low weight may cause the petri dish not to sink enough
2. use a high friction materials to place the petri dish on
   rubber, sandpaper, and rough objects in a disk shape are standardly used to stop objects on top of it from rotating or sliding
3. Make pegs in a shape around a circular area to put the petri dish in

Conclusions/action items:

Pick from and study ideas to fix petri dish in place

https://pressbooks.bccampus.ca/universityphysicssandbox/chapter/archimedes-principle-and-buoyancy/#:~:text=surface%20and%20float.-,If%20the%20buoyant%20force%20is%20less%20than%20the%20object's%20weight,or%20entirely%20in%2

https://www.iqsdirectory.com/articles/friction-material.html

10/10/23 - Car Heating Wires Idea for Top Surface

EDWARD HAN - Oct 11, 2023, 2:56 PM CDT

Title: Car Heating Wires for Top Surface

Date: 10/10//2023

Content by: Edward Han

Present: Edward Han

Goals: Present a possible solution to heat top surface

Content:

The lines on the rear window of cars are small wires designed to heat the window to remove condensation when the defroster button is active. It removes condensation in minutes, meaning if it is activated before condensation forms there will be none. This design is viable for the top surface especially as we are not viewing the sample through the top window, light just needs to pass through. This design would not impair the light in a way such that the viewing of the sample will be negatively affected. This would be implemented by running small wires across the surface instead of around it as our previous designs indicate, which would help with even heating.

Conclusions/action items:

Think of designs implementing one of the aforementioned methods to heat the incubator

https://ask.metafilter.com/116552/Electricians-Craftspeople-Help-me-build-a-box-that-gets-hot

11/16/23 - Voltage Needed to Heat ITO Film

EDWARD HAN - Nov 16, 2023, 11:05 PM CST

Title: Voltage Needed to Heat ITO Film

Date: 11/16//2023

Content by: Edward Han

Present: Edward Han

Goals: Find out how much voltage we need to heat our ITO film

Content:

The Work Function for ITO film is around 4.7 eV, meaning we'd need a voltage of around 4.7V to get the film working. However, ITO films have been used with voltages up to 80V safely, so a higher voltage may be used to allow us to heat the film faster.

Conclusions/action items:

Decide on a voltage to use for heating the ITO film

https://www.advancedenergy.com/en-us/about/news/blog/sputter-deposition-of-indium-tin-oxide-to-pulse-or-not-to-pulse/

https://www.researchgate.net/figure/Current-voltage-characteristics-of-ITO-n-type-a-SiH-thin-film-junctions-after-deposition_fig3_258606085

https://www.sciencedirect.com/science/article/abs/pii/S0040609004015767

9/14/23 - Cell Preferred Environment

Roshan Patel - Sep 14, 2023, 9:17 PM CDT

Title: Cell Preferred Environment

Date: 9/14/23

Content by: Roshan Patel

Present: N/A

Goals: Understand the environment necessary to keep a cell culture alive and how designs accomplish that

Content:

https://www.labcompare.com/General-Laboratory-Equipment/75-CO2-Incubator-Cell-Culture-Incubator/#:~:text=A%20cell%20culture%20incubator%20is,run%20from%200.3%20to%2019.9%25.

- "A cell culture incubator is designed to maintain a constant temperature and high humidity for the growth of tissue culture cells under a CO2 atmosphere. Typical temperature settings range from 4C to 50C, and CO2 concentrations run from 0.3 to 19.9%"

- "Non-corrosive stainless steel interiors are standard, but some newer models feature antimicrobial copper surfaces"

- "Temperature in a CO2 incubator is typically controlled either by a water bath that circulates through the walls of the cabinet (water jacketed CO2 incubator), or by electric coils that give off radiant heat."

https://en.wikipedia.org/wiki/Incubator_(culture)

- "The most commonly used temperature both for bacteria such as the frequently used E. coli as well as for mammalian cells is approximately 37 °C (99 °F)"

- "More elaborate incubators can also include the ability to lower the temperature (via refrigeration), or the ability to control humidity or CO2 levels. This is important in the cultivation of mammalian cells, where the relative humidity is typically >80% to prevent evaporation and a slightly acidic pH is achieved by maintaining a CO2 level of 5%"

Conclusions/action items:

There are many ways to reach the needed CO2, heat, and humidity. We will need to decide on what best fits our design requirments.

9/13/23 - Preliminary Competing Design Research

Roshan Patel - Sep 14, 2023, 9:09 PM CDT

Title: Preliminary Competing Design Research

Date: 9/13/23

Content by: Roshan Patel

Present: N/A

Goals: Determine competing designs/solutions that currently exist

Content: https://www.thomassci.com/Equipment/CO2-Incubators/_/myTemp-Mini-CO2-Incubators

https://www.thermofisher.com/order/catalog/product/3404?SID=srch-srp-3404

Current designs seem to be more suited for multiple cultures at a time and often lack compatibility with microscopes. However, there are examples that exist that already have the microscope attached as part of the system.

they all share the ability to control CO2, humidity, and temperature (usually 37C)

Conclusions/action items:

Size and compatibility will be the main issues.

2023/09/28 - Competing design for microscope incubator

Title: Competing design for microscope incubator

Date: 2023/09/28

Content by: Roshan Patel

Present: N/A

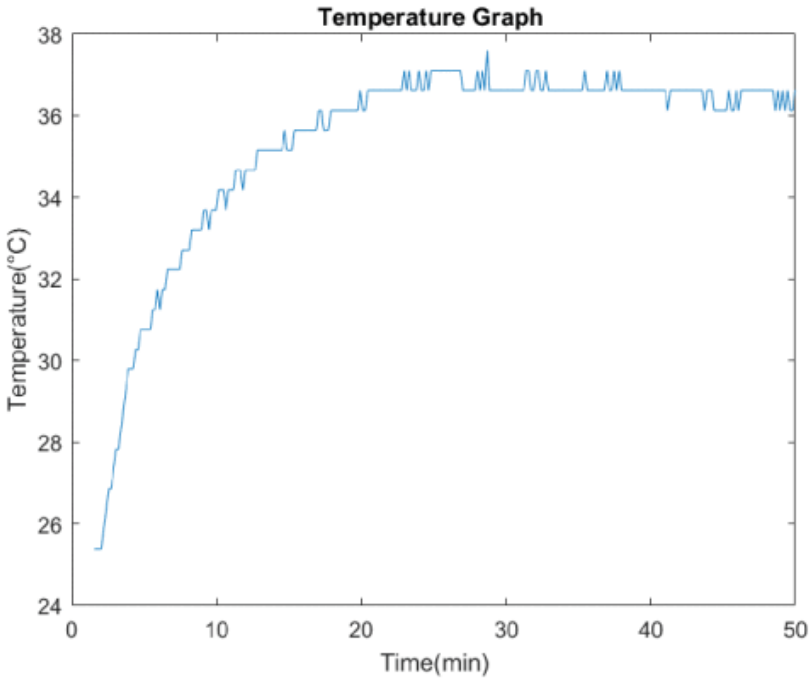
Goals: take away what I can from a design that seeks to solve almost the same issue.

Content:

This design is shockingly similar to what we have already been designing. They also have decided that ITO is a good solution to heating. Hopefully, this means that it will also work well for us.

- The competing design uses a duty cycle to heat the glass. This is done so as to not crack the glass through rapid-temperature change.

- The ITO is the only heating source in their design so it takes a long time to heat up to usable temperature.



Z. Özbilgin, M. F. Toy and S. Akşit, "Low-Cost Top Stage Incubator for Live Cell Imaging Applications," 2021 Medical Technologies Congress (TIPTEKNO), Antalya, Turkey, 2021, pp. 1-4, doi: 10.1109/TIPTEKNO53239.2021.9632885.

Conclusions/action items:

2023/09/21- Anti fogging mechanism

Roshan Patel - Sep 21, 2023, 10:12 PM CDT

Title: Anti-fogging mechanism

Date: 2023/09/21

Content by: Roshan Patel

Present: Roshan

Goals: Better understand solutions for fogging the viewing port that the device currently experiences.

Content:

https://fsicti.com/products/anti-fog-film-sheet/

https://fsicti.com/products/anti-fog-pet-film/

- This film claims to reduce fogging even under high-humidity conditions

https://fsicti.com/wp-content/uploads/2020/05/Vistex-200_275_TDS.pdf

-hydrophilic, water is a clear layer instead of foggy droplets

https://snapguardsolutions.com/products/anti-fog-film-12-in-x-18-in

-cheaper and sold individually

-technical specifications missing

Conclusions/action items:

There are numerous solutions but most only sell in large quantities. There are also cheaper options but specifications are often missing.

2023/09/26 - Brainstorming

Roshan Patel - Sep 28, 2023, 9:08 PM CDT

Title: Brainstorming

Date: 2023/09/26 copied to notebook on 2023/09/26

Content by: Roshan

Present: Roshan

Goals: Brainstorm solutions for heating the glass viewing port

Content:

Issue: Condensation causes the viewport of the incubator to be unusable.

Past attempts at solving: anti-fogging spray and wiper design

Potential Solutions:

- antifogging film: probably of poor quality but it might work

-heating glass by blowing hot air over it: cumbersome and not ideal for a compact workspace

-conductive film for glass: potentially good. Should look into further what materials work and if its cost-effective

-heating through wires: most likely dangerous so not the best

Conclusions/action items:

Look further into the conductive glass film

2023/09/28 - ITO for Reducing Condensation

Roshan Patel - Sep 28, 2023, 8:12 PM CDT

Title: ITO for Reducing Condensation

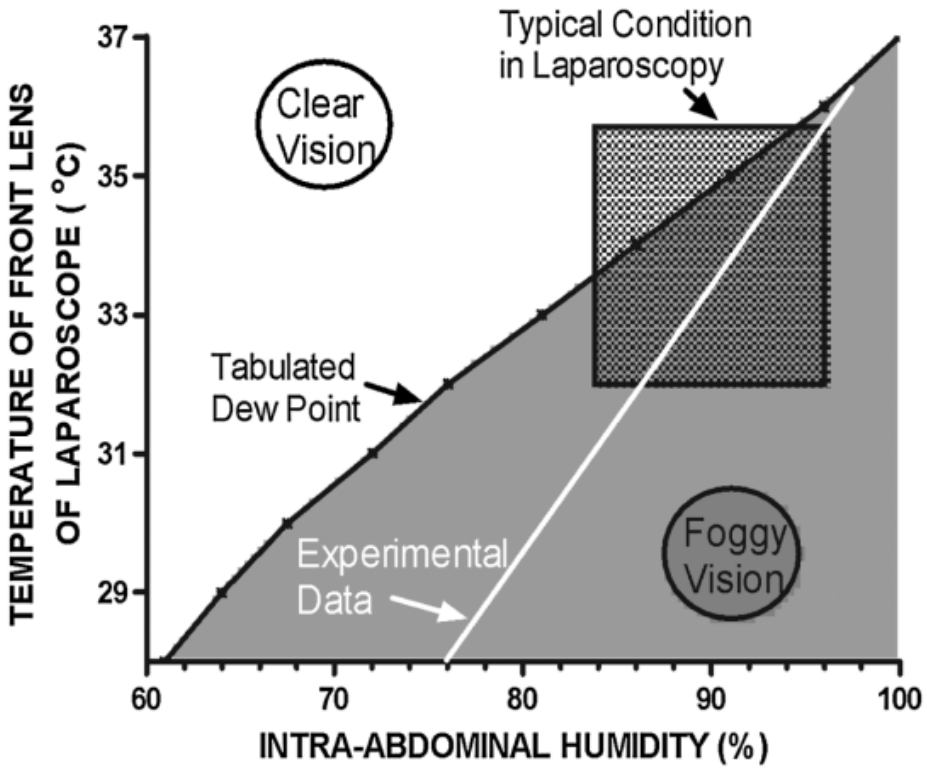
Date: 2023/09/27

Content by: Roshan

Present: Roshan

Goals: Better understanding of the proper use of ITO as a heating element, or replacement, for glass.

Content:



The study used ITO (Indium Tin Oxide) to reduce fogging on the lens of a laparoscope. ITO works well for this because it is a conductive transparent material that can be warmed through added voltage. Heat from voltage is given by the square of the voltage over the resistance.

https://ieeexplore-ieee-org.ezproxy.library.wisc.edu/abstract/document/8940341

R. Fayad, H. Hajj-Hassan and M. Hajj-Hassan, "Transparent ITO-based Heater for Prevention of Laparoscopic Lens Fogging," 2019 Fifth International Conference on Advances in Biomedical Engineering (ICABME), Tripoli, Lebanon, 2019, pp. 1-4, doi: 10.1109/ICABME47164.2019.8940341.

Conclusions/action items:

If used, we could program a given voltage into the ITO through the same board that is used to control the solenoid. This, theoretically, would solve the fogging issue indefinetly

2023/9/14 - Cell Culture Background

KELEOUS LANGE - Dec 15, 2023, 2:33 PM CST

Initial Research

Cell Cultures refers to laboratory methods that enable the growth of cells in physiological conditions - NIH

https://www.healthcare.nikon.com/en/ss/cell-image-lab/knowledge/process.html

4 Stages of cell culture: Lag, Log, stationary, decline

Cells need to be checked under a microscope to determine if they are viable, the distribution is even, there are no foreign objects, and to check the cell morphology.

Cells metabolize the nutrients in the cell culture medium and depletes them, resulting in the need to switch out the nutrients.

Incubator notes:

The whole job is to maintain optimal amounts of CO2, humidity, and heat so that the cells have an ideal growing environment.

My main concern is being able to manage the amount of CO2 in the container, meaning that we will have to use a CO2 sensor and a way to stop/start the flow of CO2 into the machine.

Humidity would also be difficult to regulate in a cheap manner because it's not easy to control, especially since we're trying to heat the incubator.

2023/11/03 - ITO Microscope Initial Visibility Test

KELEOUS LANGE - Nov 29, 2023, 12:20 PM CST

Title: ITO Microscope Initial Visibility Test

Date: 2023/11/03

Content by: Keleous Lange

Present: Roshan, Presley, Edward, Cherry, Rishi, Keleous

Goals: To determine if the ITO is completely transparent against the glass and under the microscope. Also, to see if putting the film on the bottom is a viable option.

Content:

Pictures shown below

Conclusions/action items:

The ITO is transparent and will not cause issues if on the bottom of the frame where inverted microscope visual comes from.

KELEOUS LANGE - Nov 29, 2023, 12:20 PM CST

Download

IMG_2836.HEIC (2.04 MB) Roshan observing the transparency of the ITO and the ITO with the polycarbonate.

KELEOUS LANGE - Nov 29, 2023, 12:20 PM CST

Download

IMG_2837.HEIC (2.11 MB) Roshan observing the transparency of the ITO and the ITO with the polycarbonate.

2023/11/10 - Hot Water Pump Testing/Learning

KELEOUS LANGE - Nov 29, 2023, 12:26 PM CST

Title: Water Bath Testing

Date: 2023/11/10

Content by: Keleous Lange

Present: All

Goals: To learn how to use the water bath properly and without harming ourselves or others nearby.

Content: See attached images

Conclusions/action items: We were able to heat up the water but ran into issues with running the pump and creating a water loop with the machine.

KELEOUS LANGE - Nov 29, 2023, 12:27 PM CST

Download

IMG_2839.HEIC (2.16 MB) The group testing the hot water pump with the device.

KELEOUS LANGE - Nov 29, 2023, 12:27 PM CST

Download

IMG_2840.HEIC (1.71 MB) The group testing the hot water pump with the device.

2023/11/17 - Electrical Tape/Cleaning off the machine

KELEOUS LANGE - Dec 07, 2023, 12:56 PM CST

Title: Electrical Tape/Cleaning off the machine

Date: 2023/11/17

Content by: Keleous Lange

Present: All

Goals: To deal with the exposed wire problem/clean off the machine

Content:

To help with the exposed wire problem, we put electrical tape over most of the exposed wire part so that it wasn't a problem for when we started running more current through it.

Conclusions/action items:

KELEOUS LANGE - Dec 07, 2023, 12:55 PM CST

Download

IMG_2843.HEIC (1.96 MB) Cleaning off the screen to see change in visibility

2023/12/15 - Effect of pH on cell proliferation

KELEOUS LANGE - Dec 15, 2023, 2:48 PM CST

Title: Effect of pH on cell proliferation

Date: 12/15

Content by: Keleous Lange

Present:

Goals: To research and discover the effect of pH on cell proliferation

Content:

This article is regarding wound closing, but the general principle is that cell proliferation works best when the pH level is set consistently, which is exactly what the CO2 does in our incubator. The recommended pH level is around 5.5, which is why we use CO2, since adding CO2 to our environment lowers the pH level below neutral.

https://pubmed.ncbi.nlm.nih.gov/28370923/

Conclusions/action items:

2023/09/20 - Non-Fogging Alternative Research

KELEOUS LANGE - Sep 22, 2023, 12:02 PM CDT

Title: Non-Fogging Alternative Research

Date: 9/20/2023

Content by: Keleous Lange

Present:

Goals: To find a non-fogging alternative to the polycarbonate that is currently on the box

Content:

As of right now, the current ideas that I have toward a non-fogging alternate to the clear film are as follows:

1. A film that prevents this

2. A different material to use instead of polycarbonate that is known not to fog

3. Insulation; this is also to prevent condensation

4. Non-Fogging spray

So far, the most appealing option is 1 because the last group unsuccessfully tried sprays, but the client seemed to make it known that they didn't experiment too much with it before giving up. Also, the insulation likely isn't going to completely stop the fog, but it might help with condensation so we might have to do some of that anyways.

Background research:

"Essentially, anti-fog coating refers to chemical compounds that are indispensable in preventing condensation of water from forming small droplets on the surface of the plastic material."

"Fogging on plastic products is merely about the condensation of water vapor on the surface of the plastic film. This is basically, the imbalance between the relative humidity and the air temperature."

https://www.weetect.com/anti-fog-coating/

Conclusions/action items:

Based on the information I learned about fogging, I think that the solution that I would like to try would be to create a sealed box with two sheets of the same material slightly separated from each other, with supports keeping them about a quarter inch apart, and sealant used to create a low-humidity environment between the sheets. I think that because the sheet on the bottom can't collect humidity from the air, it won't fog up on the internal side of the box. If it fogs up on the side where the humid environment is, I would like to use an anti-fogging film to fix that problem.

Action Items: the goal is to find another sheet of the same material and create a sealed box that is small enough to contain the system without getting in the way of the microscope.

2023/09/25 - Initial Design Notes

KELEOUS LANGE - Sep 25, 2023, 4:17 PM CDT

Title: Initial Design Notes

Date: 9/25/2023

Content by: Keleous Lange

Present:

Goals:

Content:

The previous group set a solid example for the size and shape of what our solution should look like, however, I think there are some major design flaws that we can work past.

For heating, I think that we should run power through a wire wrapped around the sides of the box and surrounded by thermal insulation. The temperature inside of the incubator will determine the voltage we put into the wire and adjust accordingly via Arduino program

To avoid condensation, I suggest that we heat the polycarbonate using flattened metal or drilled holes in the sides of the sheet that are out of view of the microscope.

To avoid the petri dish from touching the incubator directly as the surfaces might have a different temperature, I think we should insulate directly under the dish along the edges (separate it from the incubator by about 1/8 inch

Conclusions/action items:

If we are to follow the heating the wire directly path, we will need to consider what materials we will use and how we plan to control the electrical path mechanically

2023/09/28 - Glass Heating ideas

KELEOUS LANGE - Sep 28, 2023, 1:55 PM CDT

Title: Glass Heating Ideas

Date: 9/28

Content by: Keleous Lange

Present:

Goals:

Content:

Heating glass comes with certain concerns:

1. Heating glass and having it come in contact with a cool surface could lead to shattering which would kill cells.

2. Heating glass uniformly could be difficult because it's hard to do without altering what the microscope sees beyond the glass.

3. Live metal wires around the glass could be a potential solution but it could also mean there is something that the user would have to actively avoid touching during use, also it could get in the way of the microscope

My current thought process for handling the glass warming problem is to put a sheet of a conductive clear substance on either side of the glass and running current through it so that it warms.

In order to run current through it, we could originally test using copper strips, then we could solder wires to the sheet.

First, however, we need to run preliminary feasibility tests to check to make sure our theory about condensation will work in our application, and my plan to test that is to run the process while running a hair dryer over the glass to see if condensation doesn't form.

Conclusions/action items:

The last sentence I wrote seems like the most adequate action item that we need to complete as soon as the ECB is available.

2023/10/09 - Feasibility Testing Draft

KELEOUS LANGE - Oct 09, 2023, 10:56 AM CDT

Title: Proposed Feasibility testing of heated glass as a method to prevent condensation

Date: 10/9/2023

Content by: Keleous Lange

Present:

Goals:

Content:

As of right now, most sources on the internet that my group-mates have found have determined that glass is more effective than plastic at letting light through, and they've also determined that the condensation will be solved if the glass is warmed, however, I am skeptical of it, as our specific use case requires a very humid environment and the addition of water in the basin will allow for greater condensation.

To test the feasibility of this model, I think the best way to go about doing it is to run the system with water and a petri dish above it from the rubber ring. Then, we should run the system without the use of CO2 because we don't have it programmed yet and we need to figure out if this method is viable before we do anything else. While we run the system with the glass plates instead of the polycarbonate, we should point a hairdryer in a uniform direction towards the glass plate to warm it to a reasonable temperature. We should let the process run for about 20 minutes and observe the condensation that forms each minute via pictures.

Once the test has been completed, we should be able to confirm next steps and form a plan on how to continue with our design process and prototype phase.

Alternatively, instead of using a hairdryer, we can just use a heating element of some sort and put it flush with the top of the glass and remove every couple of minutes to take pictures. This may be more effective

Conclusions/action items:

Run the tests above to make sure that we are on the right path with our solution and determine the effectiveness.

2023/10/11 - Heating Element Logistics

KELEOUS LANGE - Oct 11, 2023, 2:07 PM CDT

Title: Heating Element Logistics

Date: 10/11/2023

Content by: Keleous Lange

Present:

Goals:

Content:

A concern that I have regarding the possible ITO heating element is running current through it without having the system leak.

Some proposals I have to fix this problem are as follows:

1. Metal tape against the ITO and using silicone on the wires where they leave the box.

2. Soldering wires to the ITO and doing the same.

Conclusions/action items:

It's looking like the wires will be held in to the box using the silicone to seal it.

2023/10/19 - Adding Copper to ITO

KELEOUS LANGE - Nov 29, 2023, 11:52 AM CST

Title: Applying Copper tape to machine

Date:

Content by: Keleous Lange

Present: Rishi, Roshan, Edward, Presley

Goals: To attach copper to the ITO film so that it can conduct electricity via alligator clips

Content:

Conclusions/action items: ITO is flush with the box, copper is attached to the ITO in order to conduct electricity. Action items include running current through the ITO and measuring temperature of the glass.

KELEOUS LANGE - Nov 29, 2023, 11:48 AM CST

Download

IMG_2743.HEIC (2.48 MB) Pictures of us attaching ITO to the frame and adding copper wire to the ITO

KELEOUS LANGE - Nov 29, 2023, 11:48 AM CST

Download

IMG_2745.HEIC (2.01 MB) Pictures of us attaching ITO to the frame and adding copper wire to the ITO

KELEOUS LANGE - Nov 29, 2023, 11:48 AM CST

Download

IMG_2747.HEIC (2.94 MB) Pictures of us attaching ITO to the frame and adding copper wire to the ITO

2023/09/29 - BPAG Meeting 1 Notes

KELEOUS LANGE - Sep 29, 2023, 12:24 PM CDT

Title: BPAG Meeting Notes

Date: 9/29/2023

Content by: Keleous

Present:

Goals: Learn about BPAG Responsibility

Content:

For purchasing, we go through Dr. Puccinelli, and we use ShopUW+ to find it.

BPAG is responsible for all purchasing and is the only person who can be refunded for expenses.

Must use a table with all vital information needed to purchase again.

List every part in the final project in a separate table from the preliminary prototyping parts.

Have to submit a proposal for design project funding.

Include shipping cost in items if it's not free

Conclusions/action items:

The content covers my presentation conclusions

2014/11/03-Entry guidelines

John Puccinelli - Sep 05, 2016, 1:18 PM CDT

Use this as a guide for every entry

- Every text entry of your notebook should have the **bold titles** below.
- Every page/entry should be **named starting with the date** of the entry's first creation/activity, subsequent material from future dates can be added later.

You can create a copy of the blank template by first opening the desired folder, clicking on "New", selecting "Copy Existing Page...", and then select "2014/11/03-Template")

Title: Descriptive title (i.e. Client Meeting)

Date: 9/5/2016

Content by: The one person who wrote the content

Present: Names of those present if more than just you (not necessary for individual work)

Goals: Establish clear goals for all text entries (meetings, individual work, etc.).

Content:

Contains clear and organized notes (also includes any references used)

Conclusions/action items:

Recap only the most significant findings and/or action items resulting from the entry.

2014/11/03-Template

John Puccinelli - Nov 03, 2014, 3:20 PM CST

Title:

Date:

Content by:

Present:

Goals:

Content:

Conclusions/action items: