

Progress Report 3: February 9 to February 15, 2007

MALDI-MSI Tissue Coating Device

Client: Dr. Amy Harms, Ph.D., Biotechnology Center

Advisor: Professor Brenda Ogle, Biomedical Engineering

Team Members: Laura Piechura (Leader)

Kellen Sheedy (Communicator)

Holly Liske (BWIG)

Jenna Spaeth (BSAC)

Problem Statement

Matrix-assisted laser desorption/ionization mass spectrometric imaging (MALDI-MSI) is an imaging method that allows for label-free spatial analysis of biological tissue samples. This technology can be used to identify and quantify proteins, monitor protein biomarkers, and sequence polypeptide chains, techniques that can be applied to proteomic analysis of disease formation. However, sample preparation methods, especially with regard to the application of the matrix tissue coating, are difficult to control but require accuracy and precision. A device must be developed to apply a fine, uniform coating of light-absorbing compounds in order to simplify the sample preparation process. The goal is to provide a reliable tool to enhance the MALDI-MSI technique in order to speed and simplify potentially life-saving research.

Last Week's Goals

- Complete the PDS in class on Friday, February 9th, and post it on the team webpage.
- As a group, rework the project timeline to include more time for construction and testing now that we know the requirements of the design.
- Continue brainstorming design alternatives and establish a meeting with our client on Friday, February 16th, to discuss our ideas and ensure that we have met her project needs.

Summary of Accomplishments

- We assembled the individual PDS portions completed by each team member on Friday, February 9th, during class. The document was posted on the team webpage.
- On Sunday, February 11th, we met to conduct a formal brainstorming session. We first subdivided design ideas into each individual component of the design, including spraying mechanism, means of containing the spray process, movement of the plate, positioning of the plate with regard to the sprayer, orientation of spray process, and matrix reservoir. Each team member used a post-it note of a different color to describe designs for each component, which were organized on a table and discussed as a group.
- With the new ideas generated at the formal brainstorming session, we met with our client and Dr. Greg Barrett-Wilt, a mass spectrometry specialist and lab member who will use our device in his research, on Tuesday, February 13th, to discuss the possibilities. From the meeting we received lots of feedback that led us to investigate a design involving only one nozzle wide enough to coat the entire plate with one pass, with a fixed, vertical orientation of the spray mechanism and the plate moving past below on a conveyor belt.
- Consequently, we decided to assign each team member a component of this new design idea to research. Jenna researched possible conveyor configurations, Kellen investigated possibilities for the nozzle feature, Holly searched for small, inexpensive motors to drive the plate movement, and Laura looked into the functions of an airbrush and whether we could design a mechanism that will achieve the same result with more regulation of the liquid to gas mixing ratio.

The Week's Goals

- With the research amassed since Tuesday, we will use our class time on Friday, February 16th, to discuss our findings and continue piecing together design alternatives.
- We hope to obtain from our client a contaminated air brush that is no longer used in the spray process, examine the internal mechanisms to discover what controls the liquid to gas mixing ratio, and test the airbrush's capabilities with regard to producing an even matrix coat and controlling the flow rate.
- We would like to have three potential designs finalized by Friday, February 23rd, and possibly a final design selected so that we can begin ordering parts.

Project Difficulties

Now that we understand how to address all of the variables of this project thanks to further discussion with our client and her team, the main difficulty presented to us is a lack of knowledge of how the spraying process appears visually, especially with regard to the size of the cone produced by the airbrush. However, our client kindly offered to recover a contaminated airbrush and allow us to experiment with it, as well as observe a matrix application session. Using the airbrush and watching the actual process with assist us greatly in overcoming this difficulty.

Activities

Team Member	Activities	Time for Week	Total Time
Holly	Group Formal Brainstorming, 2 nd Client Meeting, Research of Design Alternatives (motors)	7.5 hours	14.5 hours
Jenna	Group Formal Brainstorming, 2 nd Client Meeting, Research of Design Alternatives (conveyor)	7 hours	13 hours
Kellen	Group Formal Brainstorming, 2 nd Client Meeting, Research of Design Alternatives (apertures)	7.25 hours	14 hours
Laura	Group Formal Brainstorming, 2 nd Client Meeting, Group Meeting, Research of Design Alternatives (air brush), Progress Report 3	7 hours	14.5 hours

Project Timeline

	2/2	2/9	2/16	2/23	3/2	3/9	3/16	3/23	3/30	4/6	4/13	4/20	4/27	5/4	5/9	5/11
Client Meeting	Δ															
Research Project	Δ	◆														
Write PDS		Δ														
Brainstorm Design Ideas		Δ		◆												
Choose 3 Designs to Enhance				Δ												
Chose 1 Design to Pursue					Δ											
Work on Midsemester Presentation					Δ	◆										
Work on Midsemester Paper					Δ	◆										
Finalize Design					Δ											
Order Materials				Δ												
Build and Test Prototype							Δ						◆			
Work on Poster Presentation												Δ		◆		
Work on Written Report													Δ		◆	
Final Meeting with Advisor																Δ

SPRING BREAK

Results of Formal Brainstorming:

Design Components

	Spray Mechanism	Process Container	Movement of Plate	Position of Plate with regard to Sprayer	Matrix Reservoir
Design Possibilities	<ul style="list-style-type: none"> - continue with single airbrush - utilize an airbrush mounted in a mechanism that can be controlled by a joystick, similar to a carnival game - mount multiple airbrushes in a configuration to cover plate with one pass - build a tube, resembling that of a stationary sprinkler, with multiple very small openings/ nozzles in a single row - manufacture a tube capped with a nozzle with a smaller tube feeding in the matrix that is mounted in the design container so the distance from it to the plate can be adjusted - modifying or employing a mechanism like a nebulizer, used to deliver asthma medication 	<ul style="list-style-type: none"> - enclose the design within a plexiglass box, having the front face open for access to plate; not integrated into design, similar placed over the spraying mechanism - constructing a five-sided plexiglass box with the bottom open and portion of the top removed for spraying from above - building a five-sided box with bottom open, but cutting two small doors in the sides of the box for access to the plate, but that can be closed during spraying - integrating the tubes for matrix and airflow into the design of the device. 	<ul style="list-style-type: none"> - constructing a conveyor that moves plate in one direction through spraying mist, then can reverse directions for next coat - have plate sitting stationary in a frame sized to fit its dimensions; have sprayer moving instead 	<ul style="list-style-type: none"> - plate is positioned underneath sprayer, sprayer's height can be set at increments with clamp or crutch-like stops - plate is positioned underneath sprayer on a platform that can be raised or lowered as necessary - plate is positioned vertically in front of sprayer on a sliding track that can be used to adjust position while sprayer is fixed - both plate and sprayer height are fixed, with other variables used to correct for distance, especially air pressure 	<ul style="list-style-type: none"> - maintain cup design used on the airbrush, ensure that it can rotate from horizontal to vertical - build a reservoir within tube-like sprayer design with a layer that can be rotated out of the way to release the matrix from above - inject matrix directly into the air pressure tubing before it nears that sprayers