

MALDI-MSI Tissue Coating Device

Product Design Specification

Last Updated: February 9, 2007

Team Members:

- Holly Liske, BWIG
- Laura Piechura, Leader
- Kellen Sheedy, Communications
- Jenna Spaeth, BSAC

Function:

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.

Client Requirements

- The device must be able to spray an even coating of matrix over an 81 cm by 123 cm tissue sample to achieve uniform distribution of the compound.
- The device should be adjustable with regard to spray aperture, air pressure, and the positioning of the plate and sprayer to account for abnormalities in the application process.
- The device must be in an enclosed casing or must be operable within a fume hood as the spraying process involves the production of aerosols and utilized organic solvents.

Design Requirements:

I. Physical and Operational Characteristics

a. *Performance requirements:* This device will be used to apply a coating on tissue samples for MALDI imaging. The distance between the device and the tissue sample needs to be adjustable, and the device needs to be able to move so that it applies a fine, even layer of matrix onto the tissue sample. The pressure of the matrix needs to be adjustable, and precautions should be taken to contain excess matrix that misses the tissue sample. Finally, it should be easy to disassemble so that it can be cleaned after each use.

b. *Safety*: Since this experimentation involves aerosols, all testing should be done in a hood. Safety glasses and gloves should be worn at all times when dealing with the matrix to avoid getting it in the eyes or on skin. Breathing in the matrix should also be avoided.

c. *Accuracy and Reliability*: This device must evenly apply a layer of matrix onto the tissue sample. The layer must be fine, and strike the tissue sample wet, but water drops cannot form before hitting the tissue

d. *Life in Service*: This device must be able to endure concentrated periods of intense use of approximately four hours a day and also be able to endure up to two month periods when there is little or no usage. The life of the device should last at least five years.

e. *Shelf Life*: The matrix solution is an organic solvent capable of causing internal damage to device components. All components must therefore be easily disassembled to allow for regular cleaning. The design specifications include a device enclosure that will serve as protection from external conditions during and between uses.

f. *Operating Environment*: The device will operate at standard temperature and pressure, and low humidity will be maintained inside the device enclosure. All components must be able to withstand repeated coating with the organic solvent matrix.

g. *Ergonomics*: The well insert and matrix solution must be easily placed into the device enclosure, and the enclosure must be easily opened and closed between uses. Minimal user interaction is desired during operation.

h. *Size*: The device size is restricted to the working area of a standard laboratory fume hood, and minimizing the overall dimensions is desirable. The device height must allow for sufficient distance between the tissue sample and release of matrix but must not restrict the view of the device user. The device must accommodate a standard 384 well insert (123 by 81 millimeters) and hold 10 to 15 milliliters of matrix solution.

i. *Weight*: The weight limit of the unit may vary based on design proposals, however; a hand-held airbrush system should not exceed the weight of five pounds. On the contrary, a unit mounted on a base needing only to be moved when not under operation could have a weight limit of up to twenty pounds.

j. *Materials*: Any material that comes into contact with the matrix solution can not dissolve in organic compounds like methanol or acetonitrile. Inert materials like stainless steel, polypropylene, and Teflon are applicable.

k. *Aesthetics, Appearance, and Finish*: For this design, function far outweighs appearance. However, we will strive to give our client a professional, well-manufactured design.

II. Production Characteristics

a. *Quantity*: One unit is needed for this project

b. *Target Product Cost*: The target product cost is \$300, the maximum funding allotted Dr. Harms. Significant expenses may include a stepper motor to power a conveyor that moves the plate and also a different spraying mechanism, should we decide to avoid the current air brush design.

III. Miscellaneous

a. *Standards and Specifications*: The device indeed must comply with all FDA standards related to the administration of aerosols and chemicals as well as the use of live tissue test subjects. Specific standards may be found at the Food and Drug Administration website.

b. *Customer*: Ideally, the client desires a chamber to enclose the matrix spray process in which the plate can be placed, a few buttons pushed, and the matrix is sprayed with perfect consistency. Also, the capability to adjust each of the variables in the current airbrush process is desired. However, our client is open to any solution that can be generated and has no prejudice against other design ideas.

c. *Patient-related concerns*: The “patient” of the MALDI-MSI process is a living tissue, let it be a cross-section or an entire animal. Therefore, for the health of any living animal that is scanned, and for the integrity of any results, the plate upon which the tissue rests should be cleaned and sterilized between uses. However, the matrix application device itself does not need to be sterilized after each use, but only cleaned regularly to ensure the purity of the tissue coating.

d. *Competition*: Multiple patent searches using the U.S. Patent and Trademark Office website revealed no patents detailing methods for spraying matrix onto plates for the MALDI-MSI process. Patent 7,095,018 was granted for a sample spot drop method, and patent 6,918,309 involved an invention using electric fields to pull the droplets to the correct area on the plate, but no patent directly related to our spray approach was found.