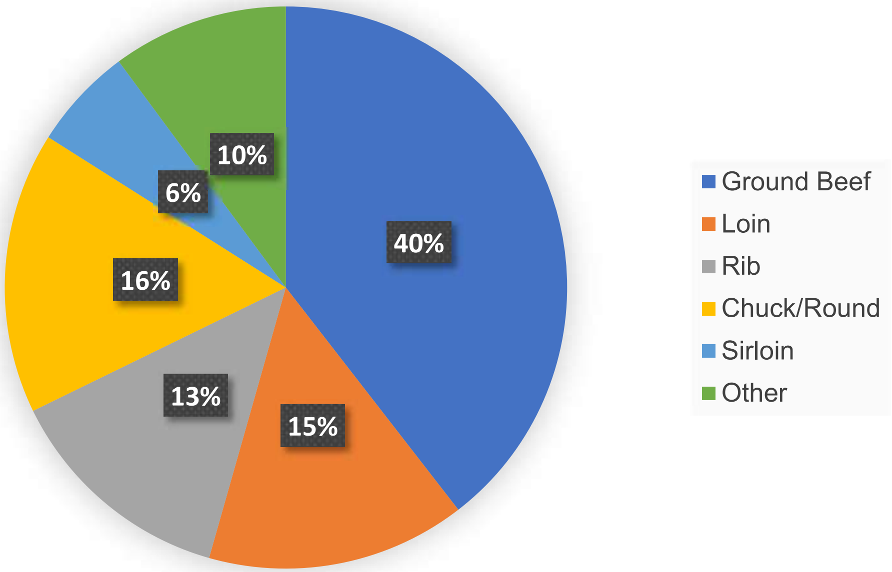
RS3Dprints

Scalable Solution for 3D Printed Alternative Meat

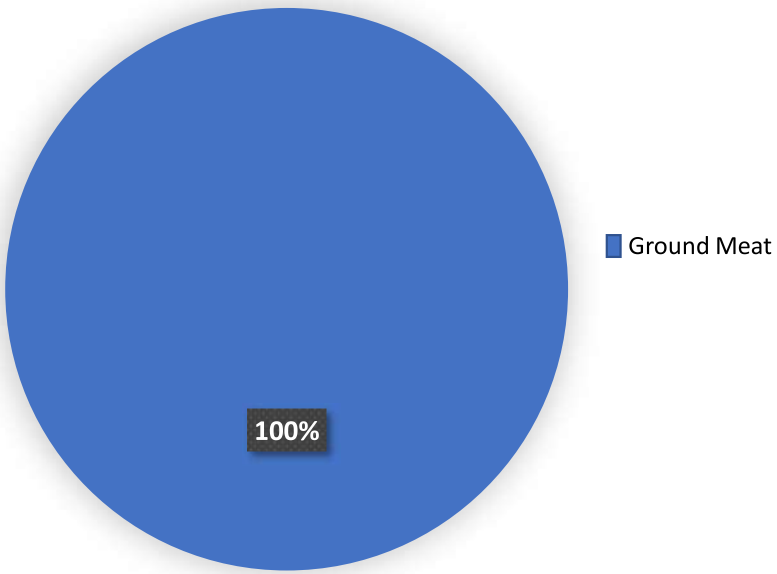
US Beef Sales by Cut*



*statistica 2019

$332.5 Billion (2020)

Alternative Meat Sales by Cut



$4.8 Billion (2019)

The alternative meat industry cannot mass produce alternative meat steaks

Recreating the texture and look of butchered steak on an industrial level has been too challenging so far.

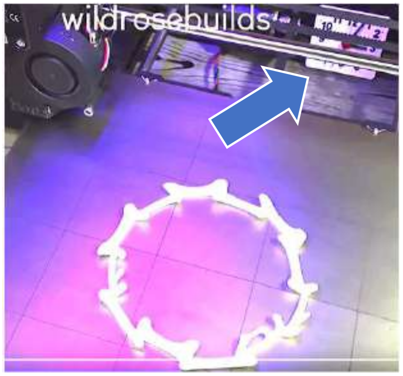
Additive manufacturing, was developed for one off manufacturing not for mass production

3D printing Is very slow.

Biological matter, unlike plastics, **is soft** and has little mechanical strength and is non binding.

No binding properties

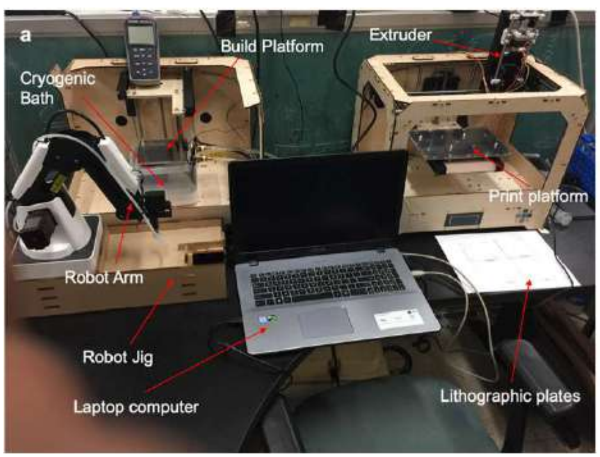
The food industry works on mass quantities: Slow and slimy is not conducive to the food industry.

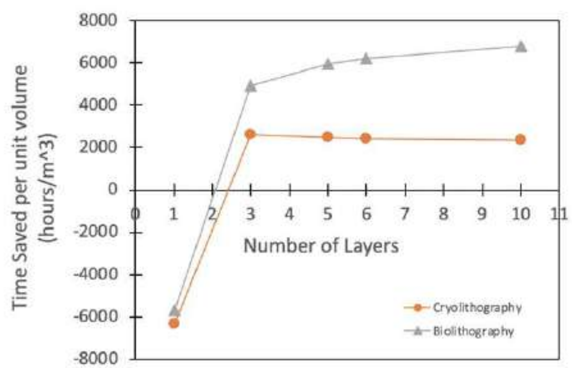


Look at the watch. The printing of this one object began at 3:00 and ended 11h 30' later.

Keys to mass production

- Cryoprinting – foods are frozen voxel by voxel as they are printed.
- Parallel lithography - a parallel technology suitable for large scale mass manufacturing of 3D printed foods
- Anisotropic 3D printing - a food product with complex texture and not only complex composition.



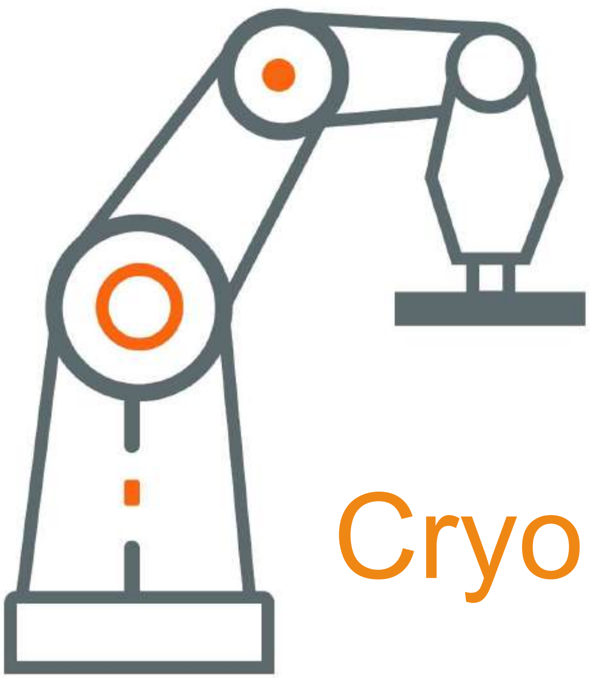


Fried BEYOND MEAT

Fried RS3D MEAT

History of RS3Dprints, Inc.

- RS3Dprints started in 2016 at UC Berkeley.
- The company is based on research focused on the production of biological organs
- Originally seen as a way to create cellular products for medical purposes.
- Base patent focused on 3D printing into freeze inducing liquid and was licensed from UC Berkeley.
- Have since produced multiple additional patents and processes for multiple applications

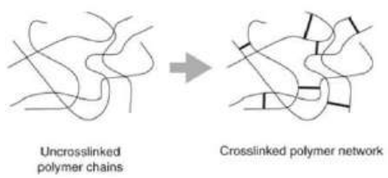


Cryoprinting

Cryoprinting

In cryoprinting the object is frozen as it is printed.

- Increases the stiffness of the object (h - height of object before it collapses on itself)
- Protects the printed material from deterioration and spoilage
- Produces frozen foods directly
- Control the microstructure



Stiffness: O(1) kPa

Yield Stress: O(10) Pa

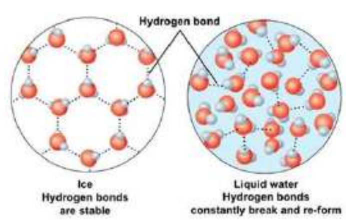
$h \sim 0.1cm$

Freezing opens up more possibilities

Yield Criteria:

$$\frac{\rho g h}{\sqrt{3}} \geq \tau_y$$

$\tau_y = yield\ stress$
$\rho = density$
$g = acceleration\ due\ to\ gravity$
$h = characteristic\ hieght$

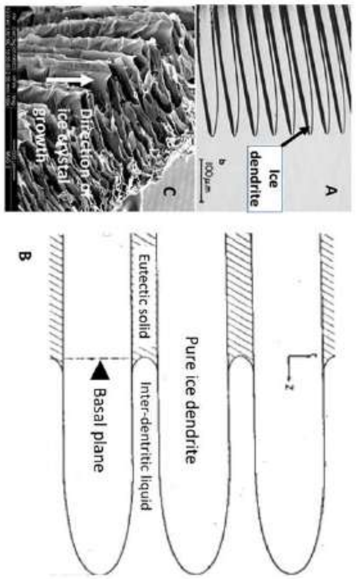


Stiffness: O(1) GPa

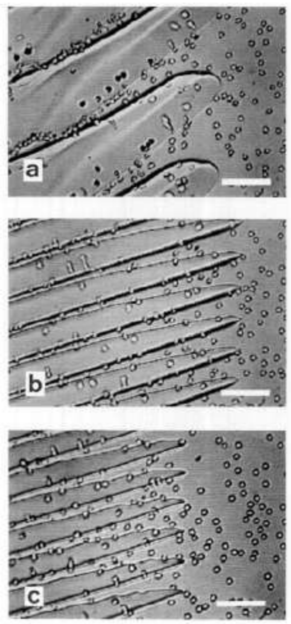
Yield Stress: O(1) MPa

$h \sim 100m$

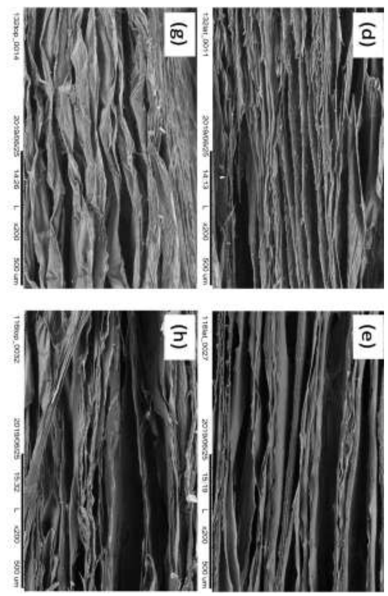
3D cryoprinting with controlled thermal parameters produces a micron scale structure which confers controlled texture to foods and desired mechanical properties. Conventional 3D printing of food is concerned only with the macrostructure - but many foods (meat) are fibrous.



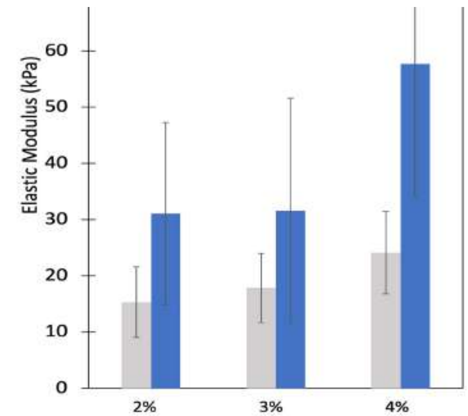
Ice grows in the form of spicules.
Ice has a tight crystallographic structure. Therefore solutes are rejected around the ice forming texture after thawing.



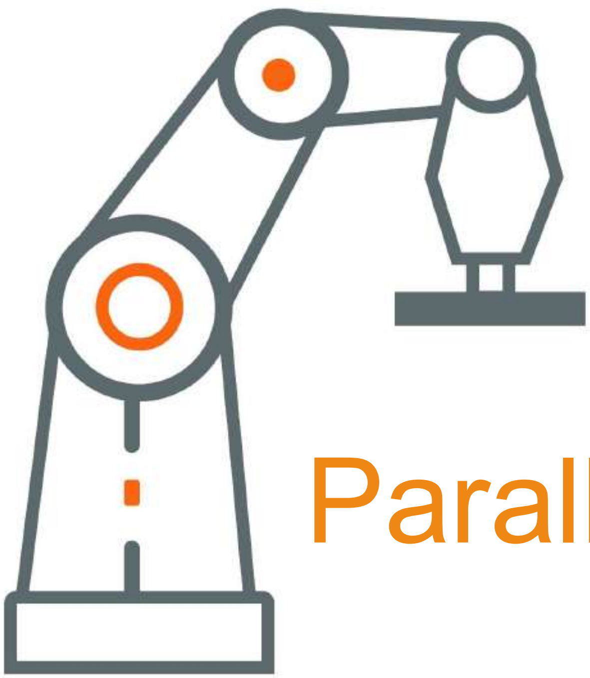
The controllable thermal parameters during 3D cryoprinting control the size and orientation of the ice crystals



This in turn controls the microscale texture

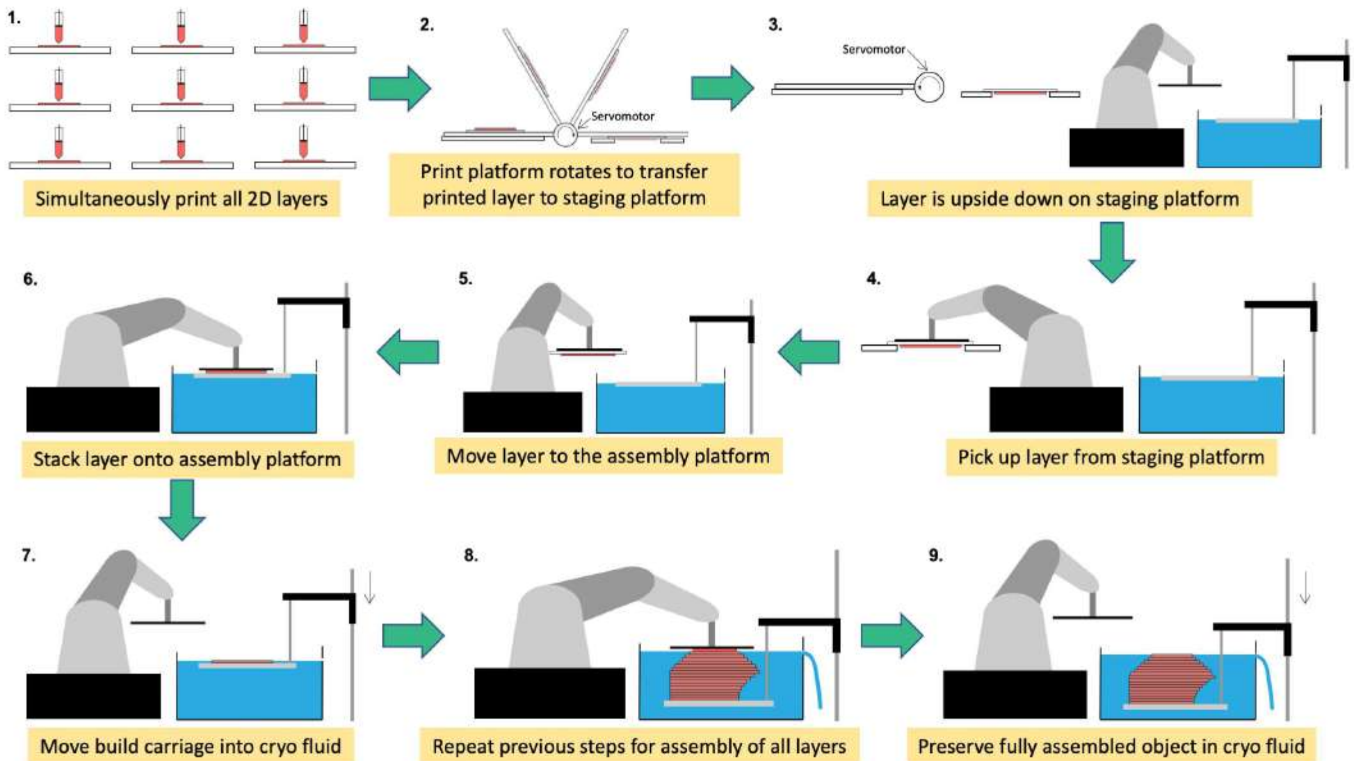


Which in turn controls, the food sensory Experience.

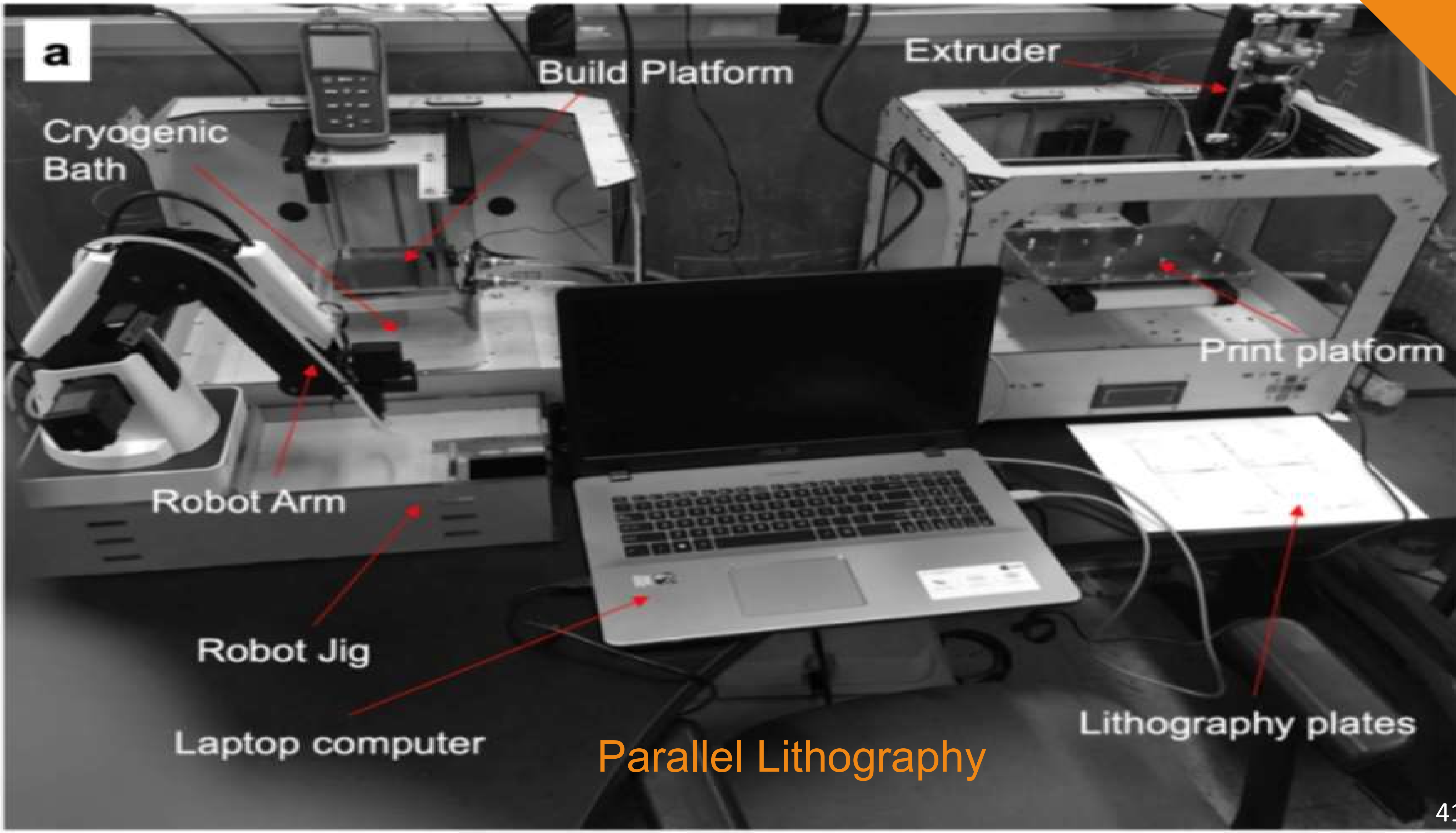


Parallel Lithography

Additive manufacturing is a linear process. Mass manufacturing requires a parallel process. We have parallelized the additive manufacturing process by separating the printing of each 2D layer and the 3D assembly.

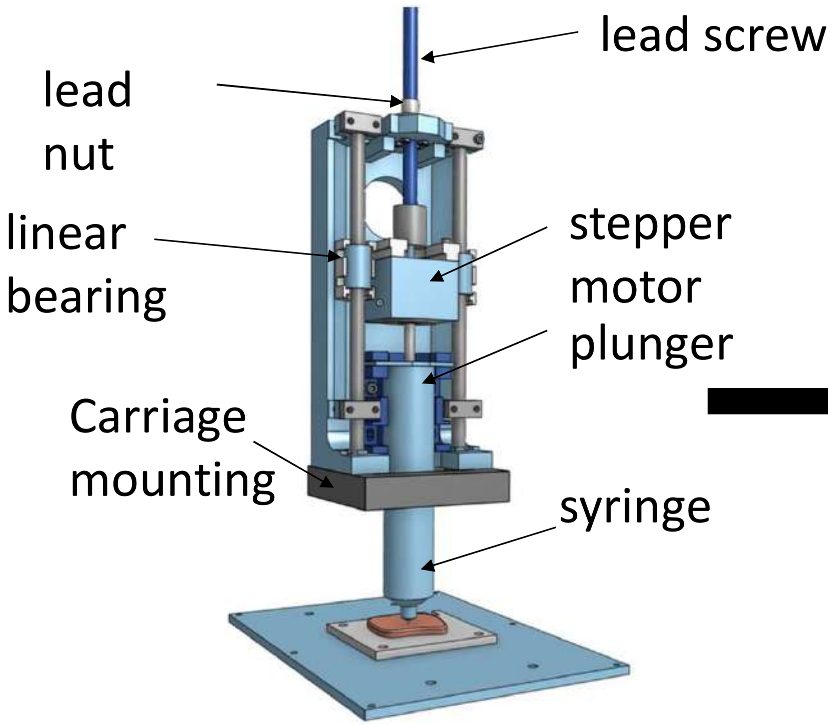


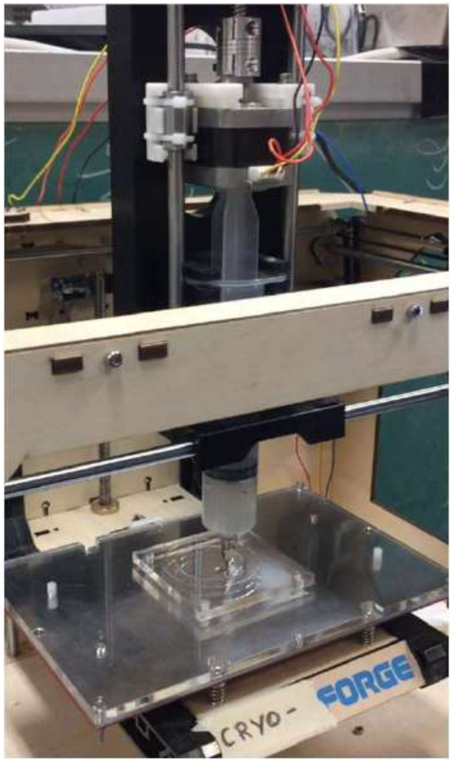
Ukpai et al. J. of Med Devices (2019)



Parallel Lithography

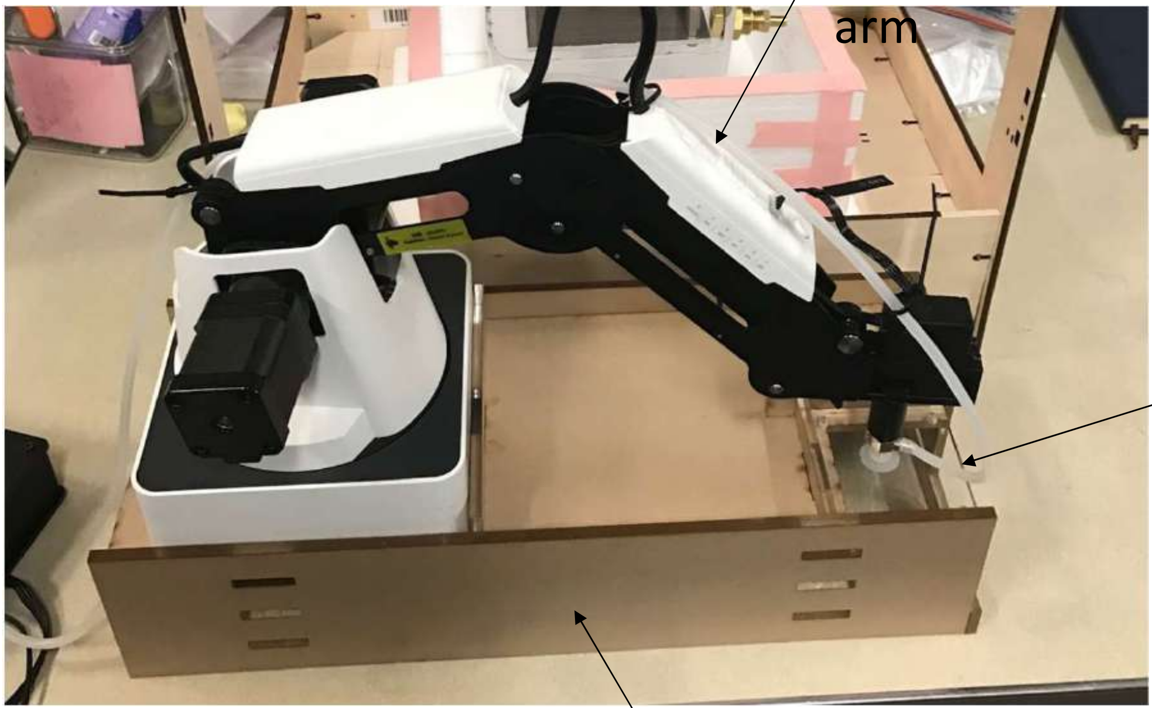
2D Layer Print Mechanism Design





2D print agent and meat layer → Pick up lithography plate → Stack layer onto printing object → Move built carriage in cryo bath

Pickup Process



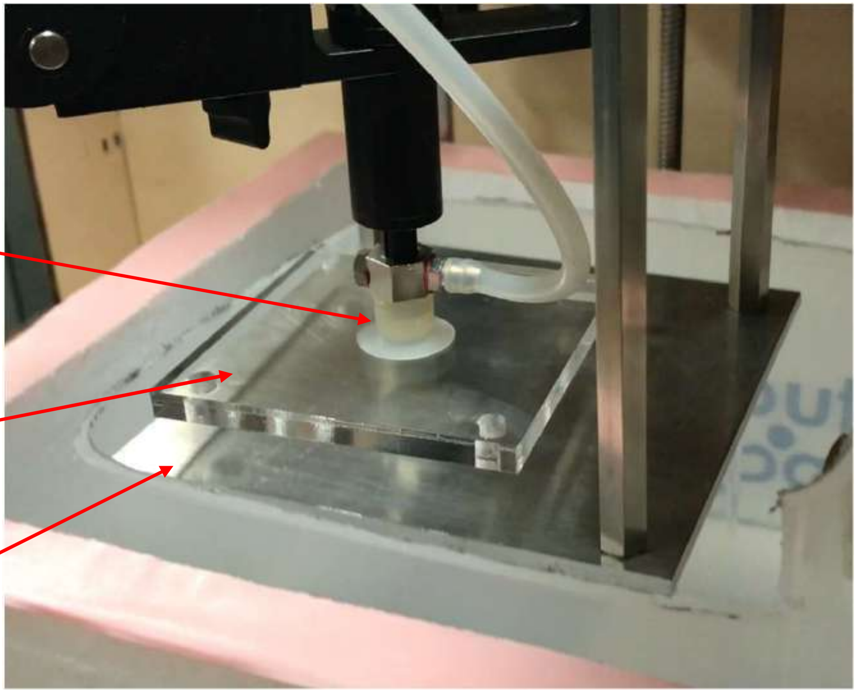
2D print agent and meat layer → **Pick up lithography plate** → Stack layer onto printing object → Move built carriage in cryo bath

Stacking Process

Suction cup

Lithography plate

Stacking plate

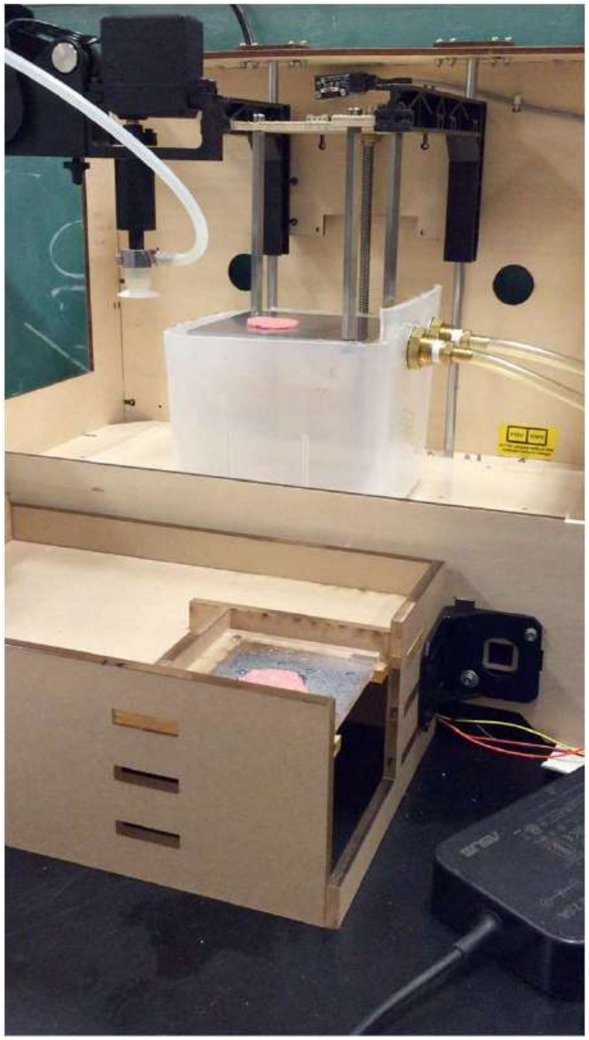


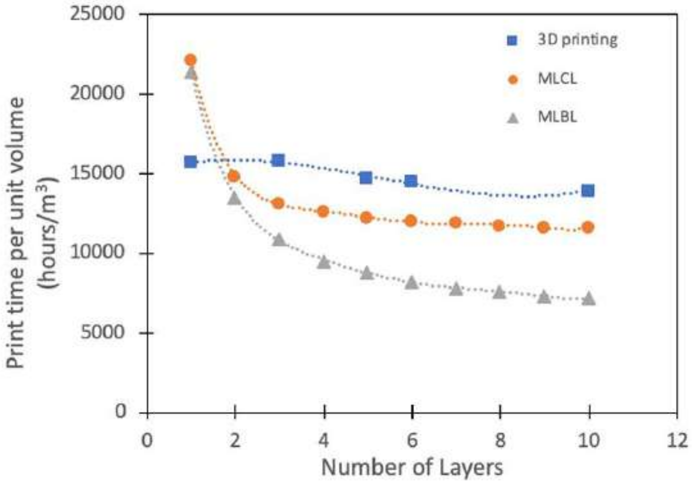
2D print agent and meat layer → Pick up lithography plate → Stack layer onto printing object → Move built carriage in cryo bath

Freezing Process

2D print agent and meat layer → Pick up lithography plate → Stack layer onto printing object → Move built carriage in cryo bath

Time savings from parallel lithography



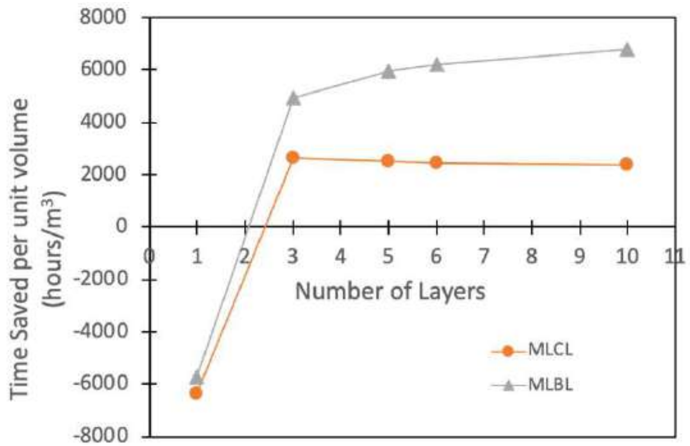


Printing Process:

3D Printing – Traditional

MLCL - Multilayer Cryoprinting

MLBL – Multilayer - no freezing

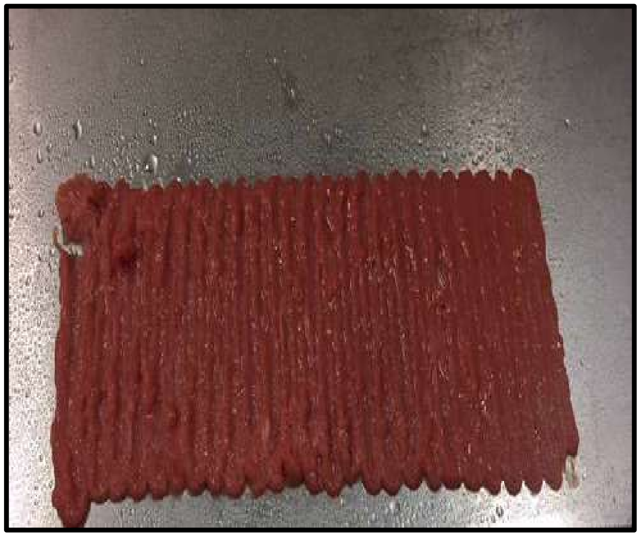
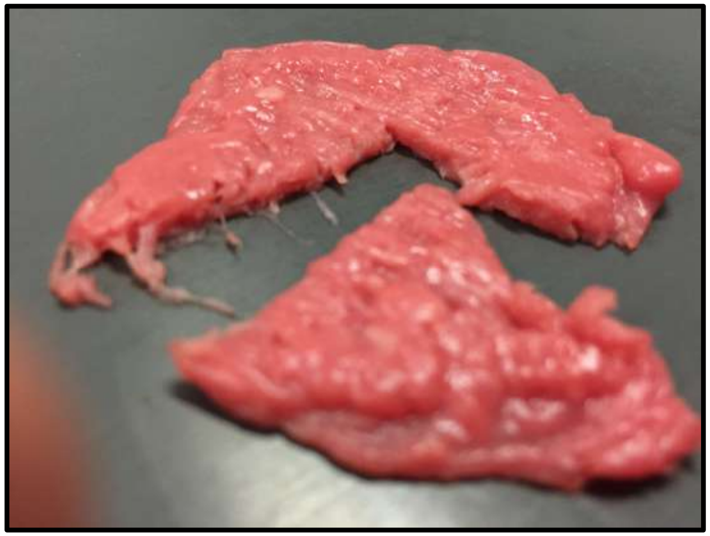
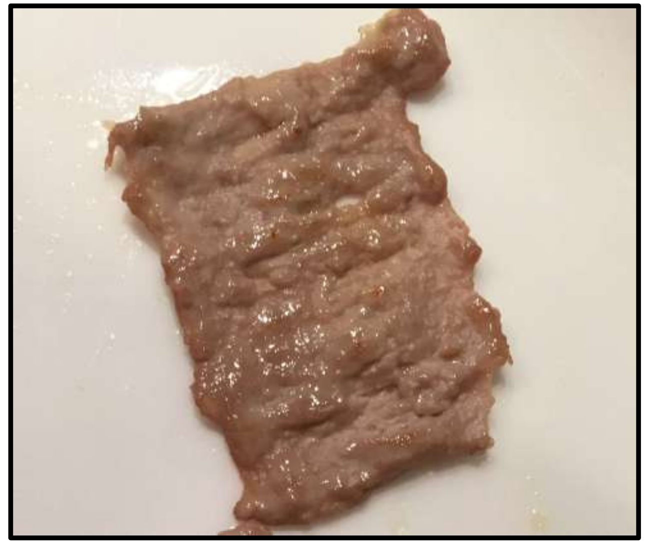


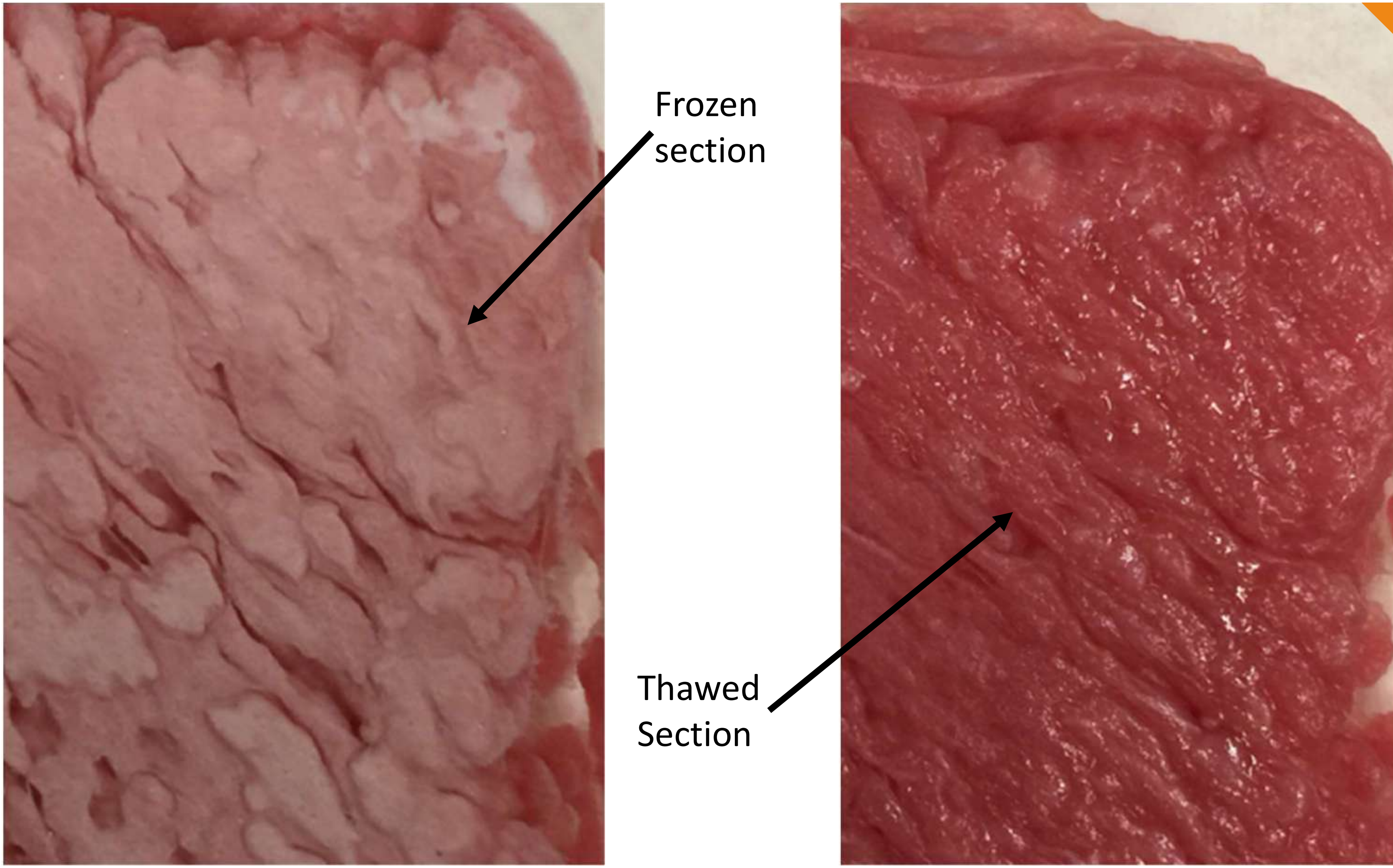
Freezing Process:

MLCL - Multilayer Cryoprinting

MLBL – Multilayer

Anisotropic 3D printing


Frozen section
Thawed Section

Cryolithographic Parallel Printing Advantages

Faster Printing

- Printing ten stacked layers with a traditional 3D printer takes 10X the amount of time as printing ten individual layers in different locations and then stacking them.

Printing Height

- Alternative meat does not bind to itself the way chocolate or dough does; limiting the height of the finished product. Food safe material and freeze inducing liquid binds each layer allowing for unlimited height.

Cheaper Printer

- 3D printers are expensive because they require X, Y, Z movement. By breaking the device into each movement, the overall 3D printer cost is reduced.

Realistic Texture

- Traditional 3D printers cannot make contact with the previously printed layer. Printing one layer at a time allows us to create a texture through intentional contact with the previously printed line.

Freezing

- Stacking directly into a freeze inducing liquid controls the formation of ice crystals reducing the damage done by post printing freezing.

Input Agnostic

Thank You

Contact Us

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