

# Sandia National Laboratories

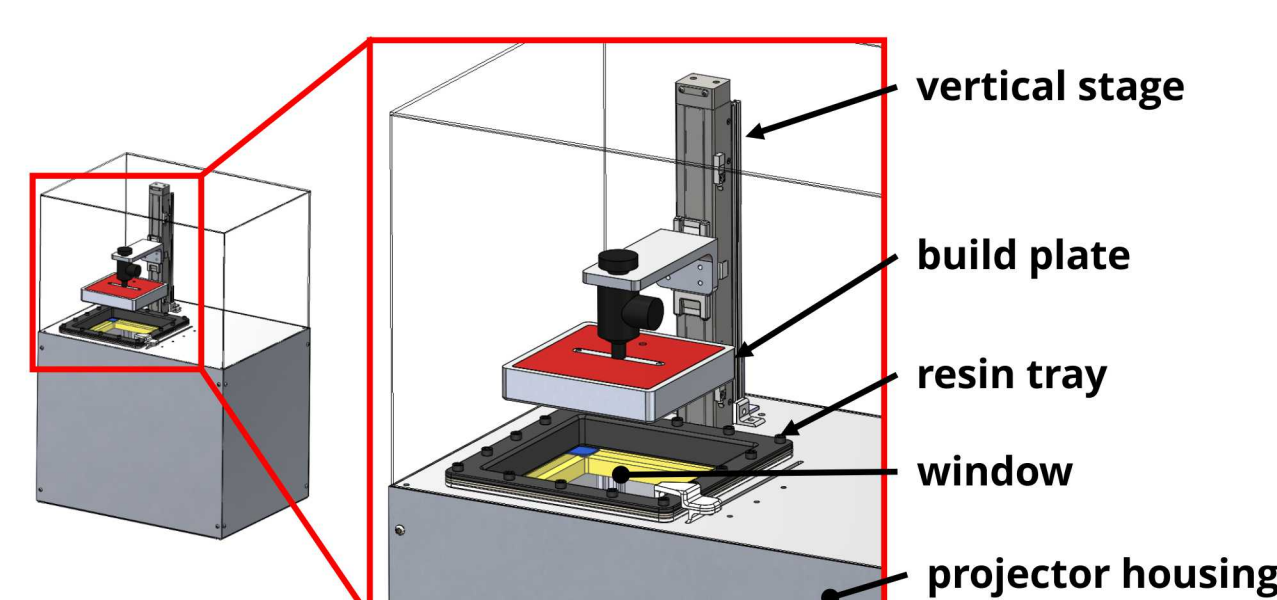
## Mechanical Challenges of 3D Printing Ceramics Using D.L.P.

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### Introduction / Motivation

Digital light processing (DLP) 3D printing can be used for manufacturing complex structures using a variety of materials, which would be nearly impossible using traditional manufacturing methods. Recent work at Sandia National Laboratories uses DLP technology for additive manufacturing of complex alumina structures, using photocurable resins loaded with micron or submicron alumina particles. These resins are printed using a DLP 3D printer to produce a "green part." The work presented here will discuss the mechanical challenges associated with printing alumina using commercially available DLP and stereolithography 3D printers, including the design of a custom DLP 3D printer to address identified mechanical challenges, thereby leading to improved print versatility and quality.

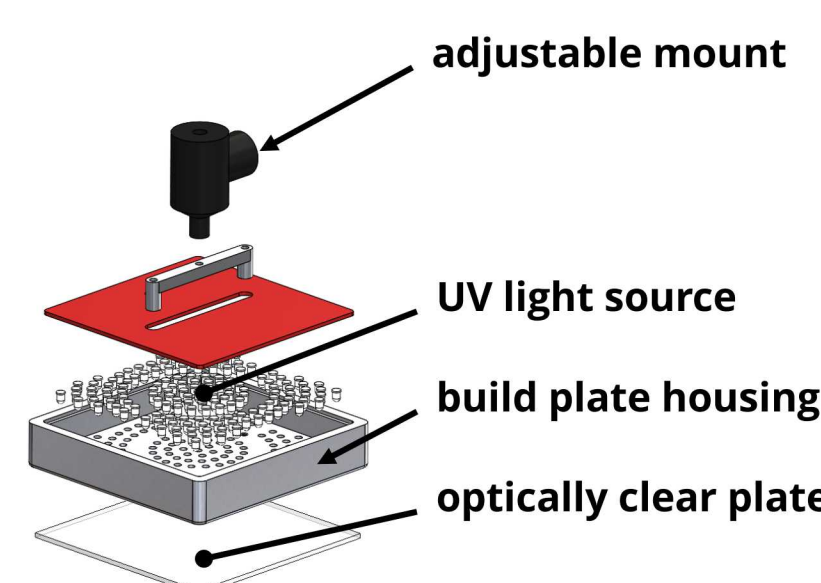


### Custom Printer

#### UV Backlit Build Plate

The UV backlit build plate is intended to:

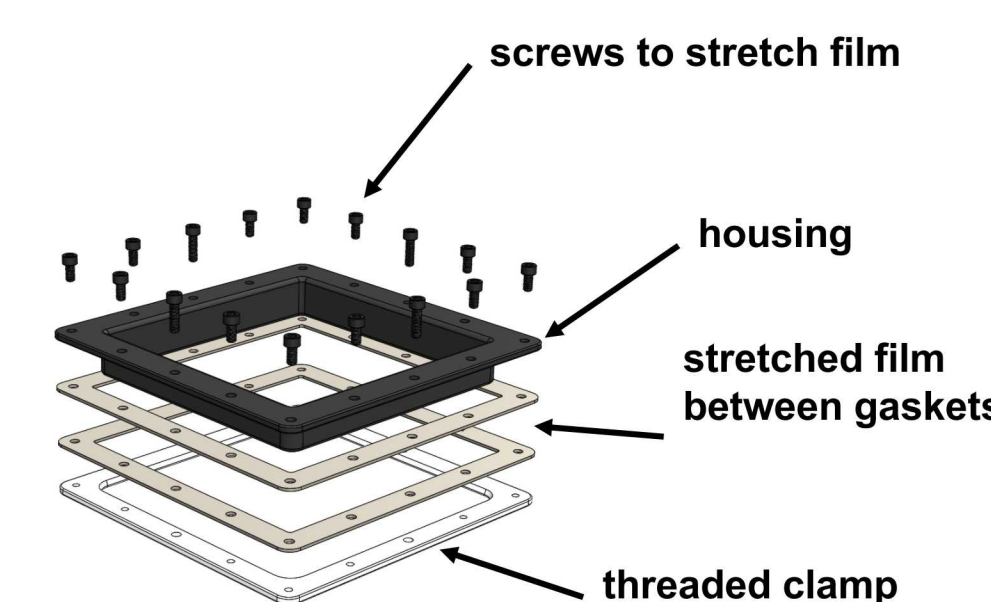
- Ensure strong build adhesion
- Provide a level surface between resin tray and build surface



#### Stretched Film Resin Tray

The stretched film resin tray is intended to:

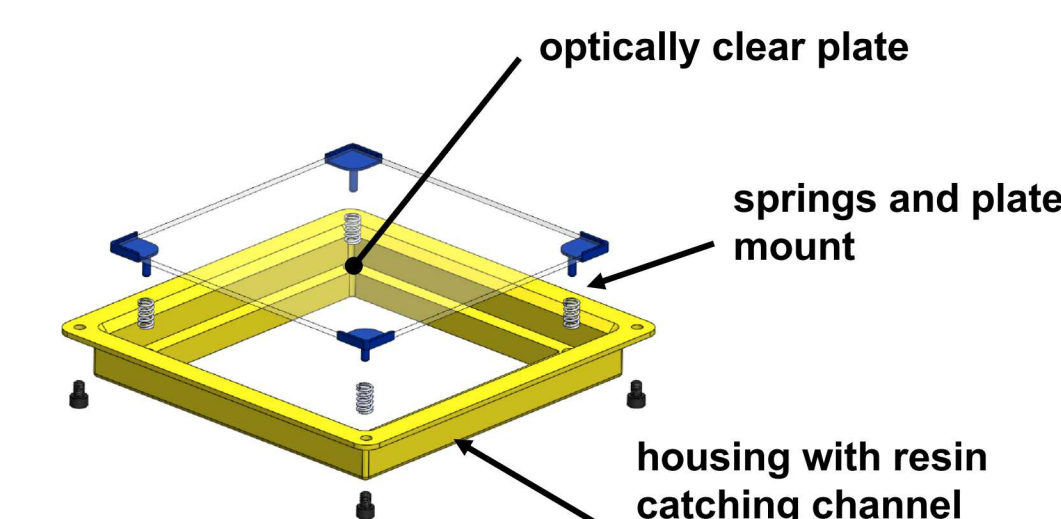
- Allow builds to slowly release from resin tray
- Reduce force on build due to separation
- Provide an optically clear, durable, surface to build from



#### Glass Support Plate

The glass support plate is intended to:

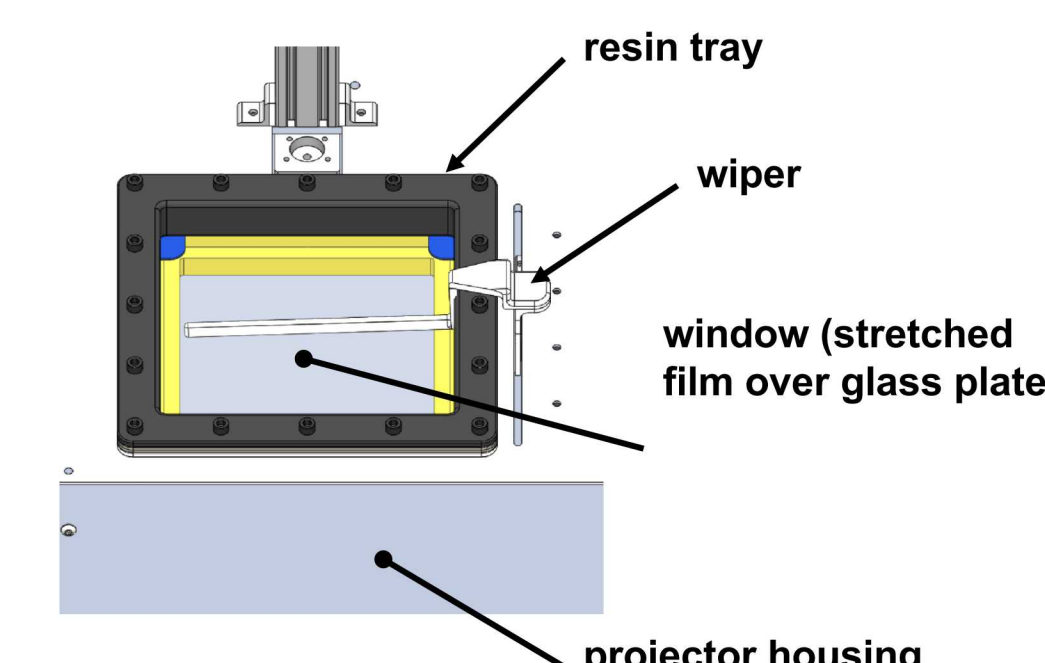
- Provide a level surface for the stretched film to come in contact with
- Provide a level surface for the build plate to allow for uniform layer thickness
- Prevent damage to print surfaces and printer



#### Wiper Bar

The wiper bar is intended to:

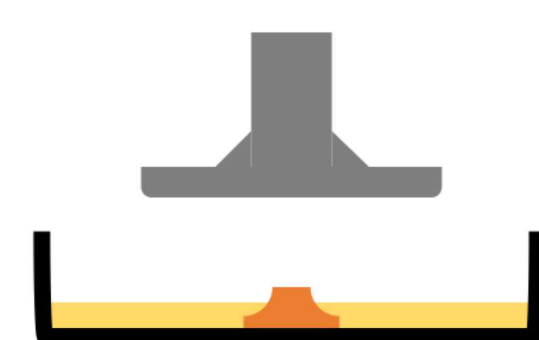
- Remove over cured materials from active print area
- Agitate material to prevent particle settling



### Challenges

#### Dropping

Dropping occurs when the initial layers of the build are not strongly adhered to the build plate.  
**Solution: UV-Backlit build plate**



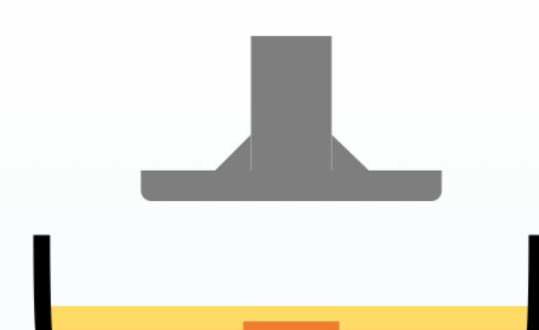
#### Splitting

Splitting occurs when the force of separation on the build is too great, resulting in a build fracture.  
**Solution: Stretched film resin tray**



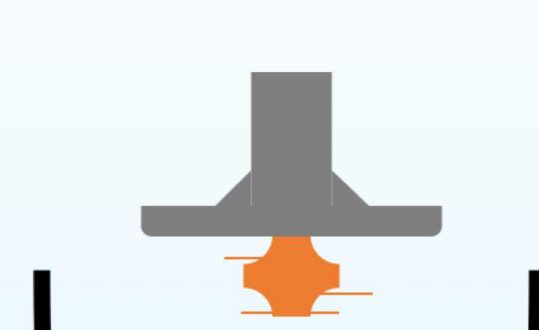
#### Sticking

Sticking occurs when the build plate does not have adequate contact with the resin tray.  
**Solution: Glass support plate**



#### Flaking

Flaking occurs due to the overcurving of resin. This overcurving occurs frequently in advanced materials.  
**Solution: Wiper bar**

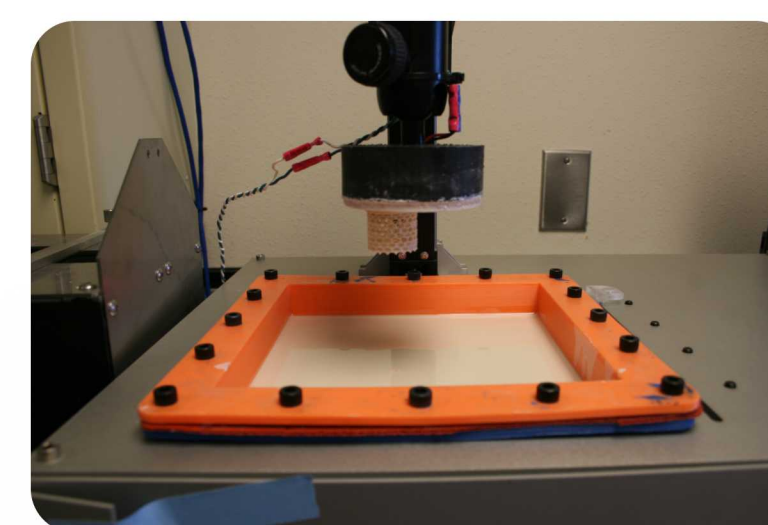


### Results

#### Prototype

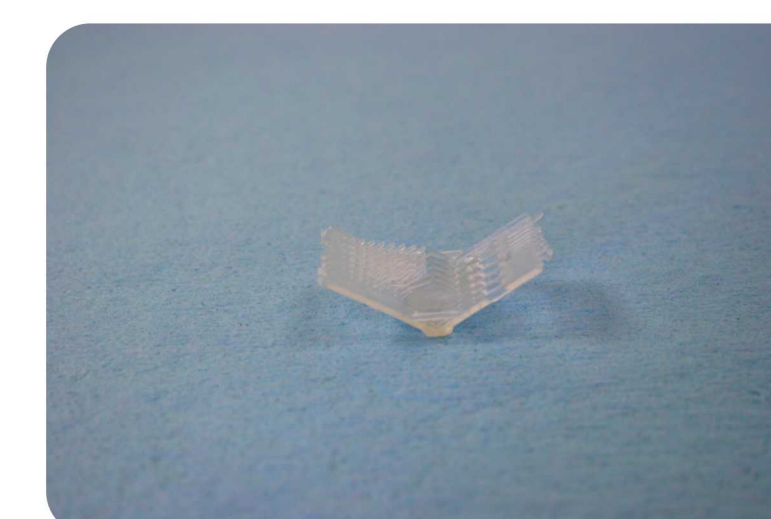
The prototype shown to the right includes:

- UV backlit build plate
- Stretched film resin tray
- Modified support plate made of acrylic.
- High power, high resolution (2560x1600) UV projector



#### Standard Resin

- Genesis (By Tethlon 3D)
- 0.025 mm layer resolution
- Scratched copper build plate
- *Basic functionality proven*



#### Silica Loaded

- Porcelite (By Tethlon 3D)
- 0.025 mm layer resolution
- UV backlit build plate
- *Ability to build using loaded resins proven*



#### Alumina Loaded

- Alumina loaded resin (Custom material)
- 0.025 mm layer resolution
- UV backlit build plate
- *Proven some functionality building with alumina*



### Future Work

- Finalize prototype design and further iterations
- Custom control program
- Larger UV-backlit build plate, for larger production of printed parts without creating longer print times (when using DLP technology)
- Heated build chamber, for finer resolution by exploiting changes in resin curing at different temperatures (Hot Lithography).
- Alternative high-performance materials such as glass and metals

