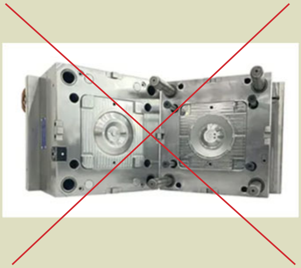

Stop That Mold!
3D Printed Fine Pitch Sockets

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Jason Bassi – Boston Micro Fabrication (BMF)

TestConX™

Mesa, Arizona • March 2–5, 2025

RATCHET & PAWL LLC

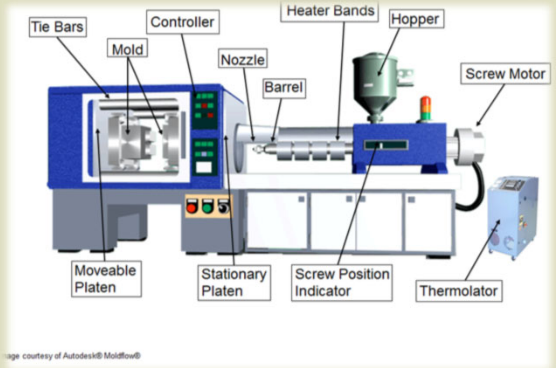
BMF® BOSTON MICRO FABRICATION

Contents

- Existing Socket Housing Manufacturing Methods
- Current Challenges with Socket Housing Manufacturing Methods
- Advantages of 3D Printed Socket Housings
- 3D Printers and Materials
- Simulations Results
- Embedded Thermal Cooling and Electrical Capabilities
- Cost and Lead Time Analysis

Existing Socket Housing Manufacturing Methods

- CNC (Computer Numerical Control) Machining
- Injection Molding
- Precision Drilled Holes for Pins

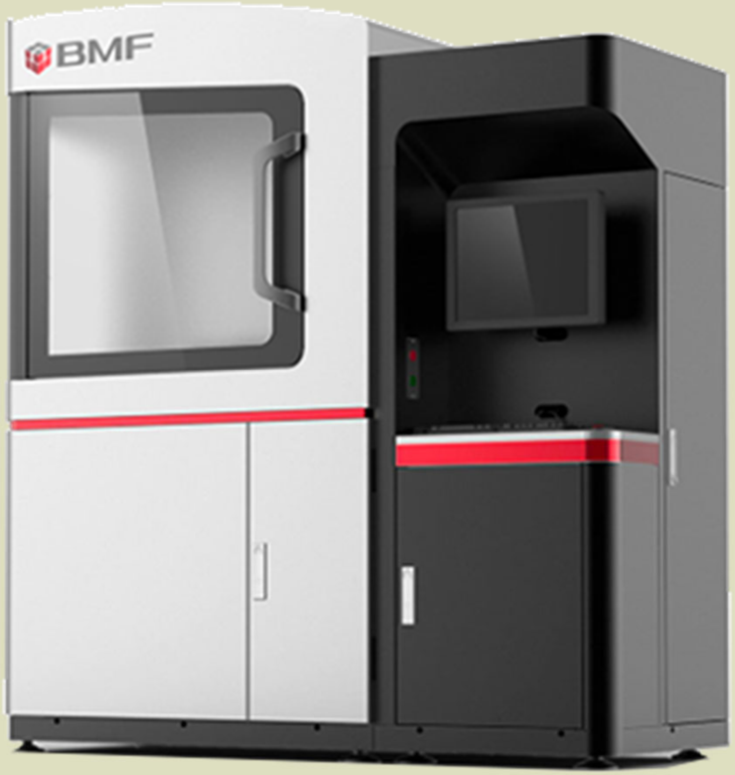


Challenges with Existing Socket Housing Manufacturing Methods

- High cost of machining and molding
- High upfront mold costs
- Molding holes to required tolerances is very difficult
- Long lead times
- Highly skilled workers required at factories to operate equipment

Advantages of 3D Printing Socket Housings

- Single manufacturing process
  - Housing and holes are made simultaneously
- Can be produced on site
- Great for high mix / low volume sockets
- No molds and CNC programming required
- Can be produced from part file
- Quick turnaround
- Economical process



Past Challenges with 3D Printing Socket Housings

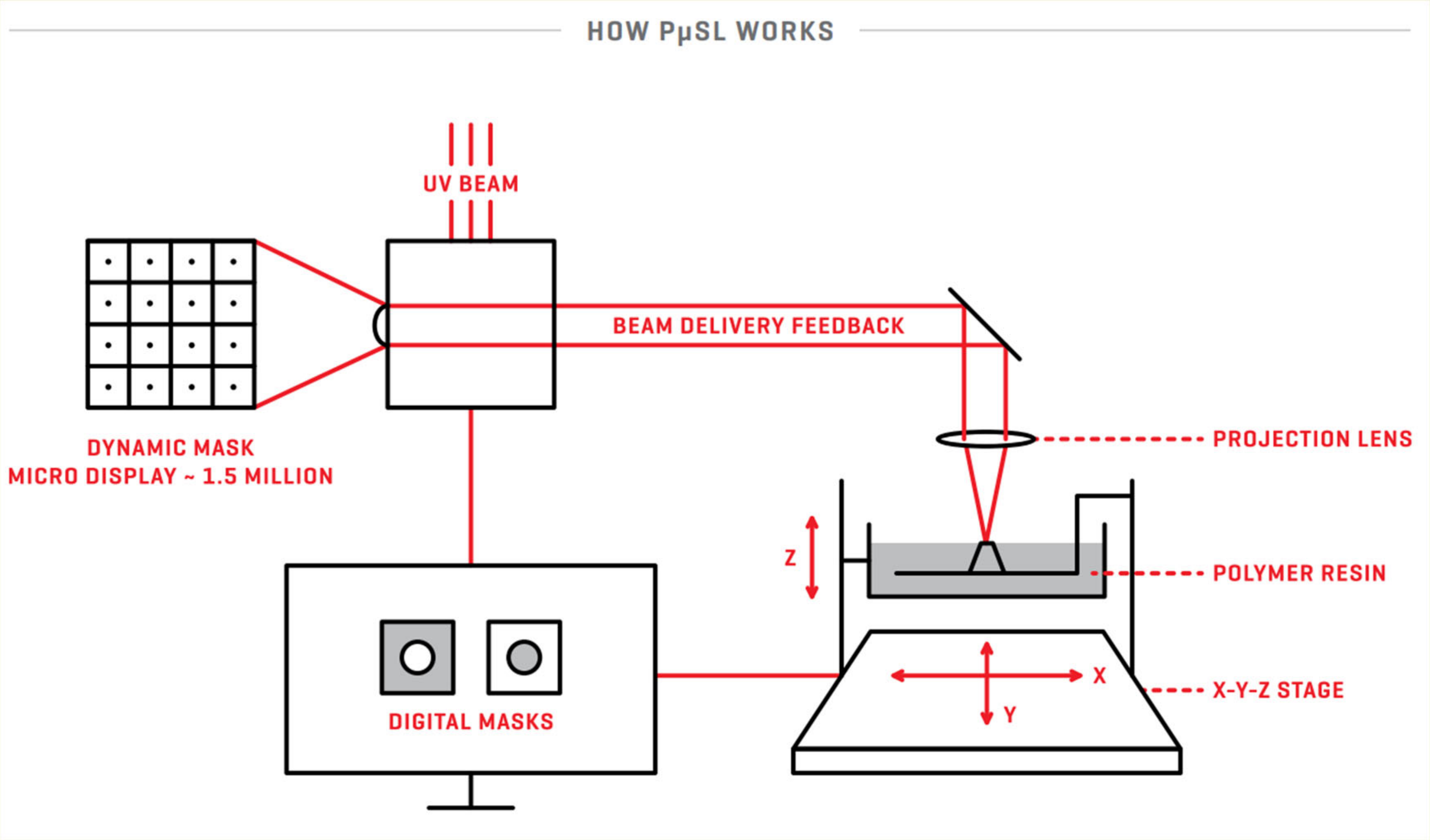
- Traditionally 3D printing did not have the required precision
- 3D printers have not been able to print small precise holes
- Tolerances have been too loose for precision pin holes and package alignment

Solution to the 3D Printing Challenges

- Projection Micro Stereolithography (PµSL) from BMF
  - Projection Micro Stereolithography (PµSL) is a polymerization process separating themselves from other 3D printing techniques by utilizing the benefits of both DLP (Digital Light Processing) and SLA (Stereolithography) technologies.
  - PµSL involves printing in the top-down direction of, like SLA. However rather than curing material with a small spot laser by tracing a vector path, a raster method of image projection is used for curing as done in DLP.
  - Pixel size (2µm, 10µm, and 25um)
  - Multiple projections per layer

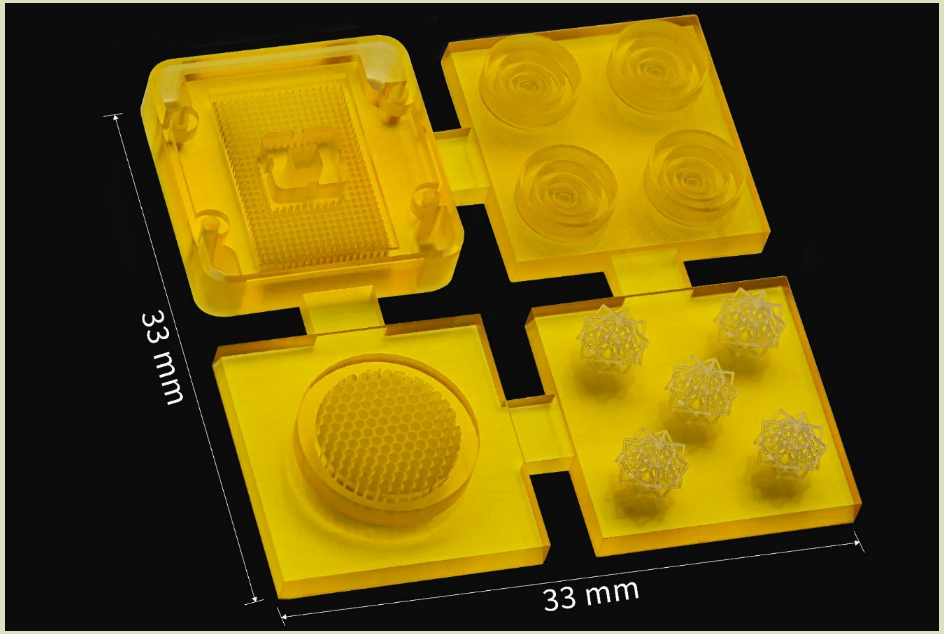
TestConX 2025

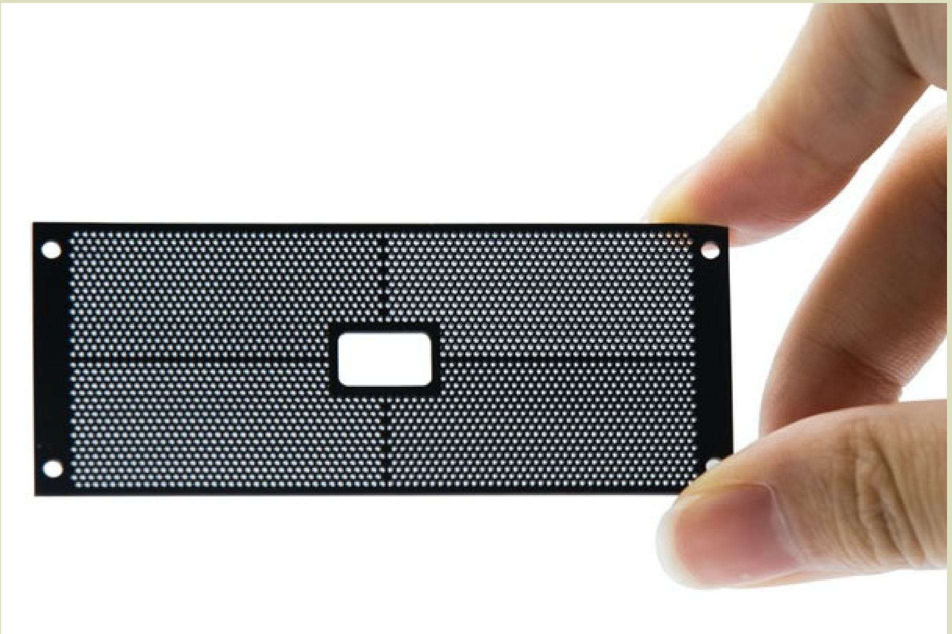
Projection Micro Stereolithography (PμSL)



PµSL used for Extreme Micro Devices

PµSL is capable of making thin walls and dense holes that are difficult to make using traditional injection molding and CNC machining.





Micro-Precision 3D Printed Electronics Parts

Large parts with fine detailed features

Micro Chip Socket

- +/- 25µm tolerance
- 1500 holes diameter=0.35mm / spacing of 50 µm
- Print time: 11 hours - 3 pcs (S140)

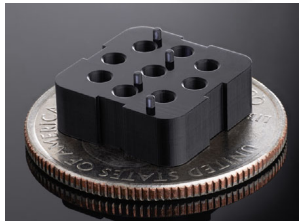
Micro Bulkhead Connector

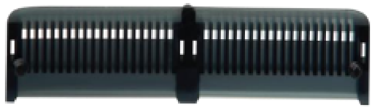
DIMENSIONS 6mm x 3mm x 3mm
RESOLUTION 10µm
TOLERANCE ±0.025mm
FEATURES 250µm hole array with 500µm spacing

Connector Base

HIGHLIGHTS

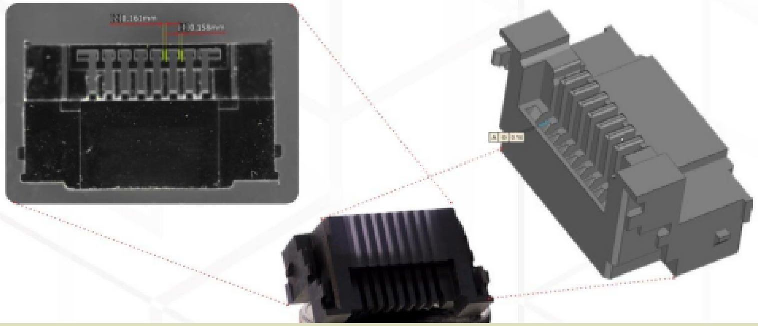
- Tolerance: ±0.025mm





Electrical Connector

DIMENSIONS 9.8mm x 9.8mm x 13.8mm
RESOLUTION 10µm
TOLERANCE ±0.025mm
FEATURES 150µm wall thickness

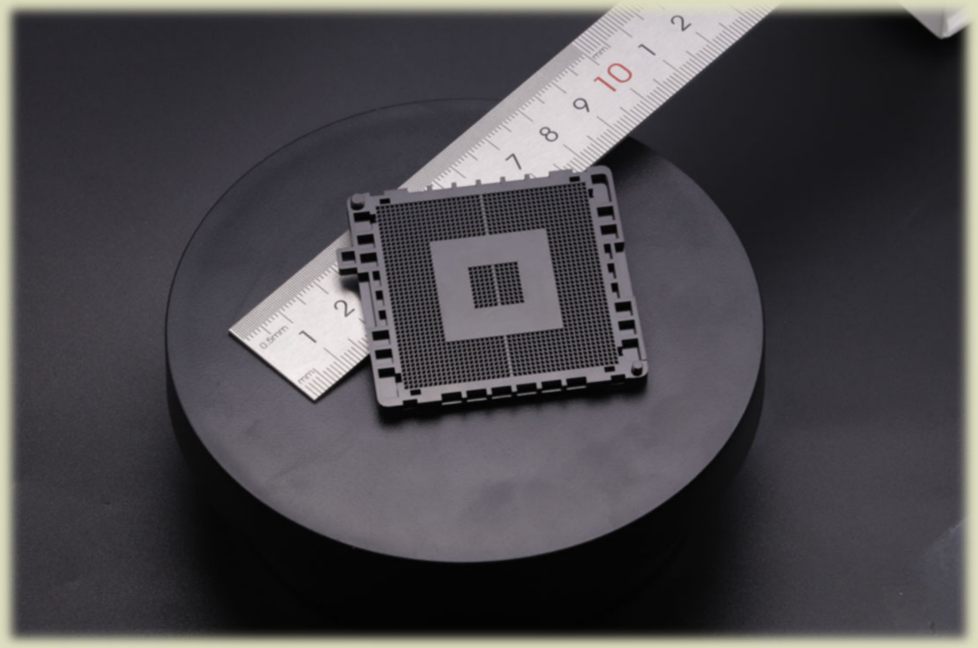


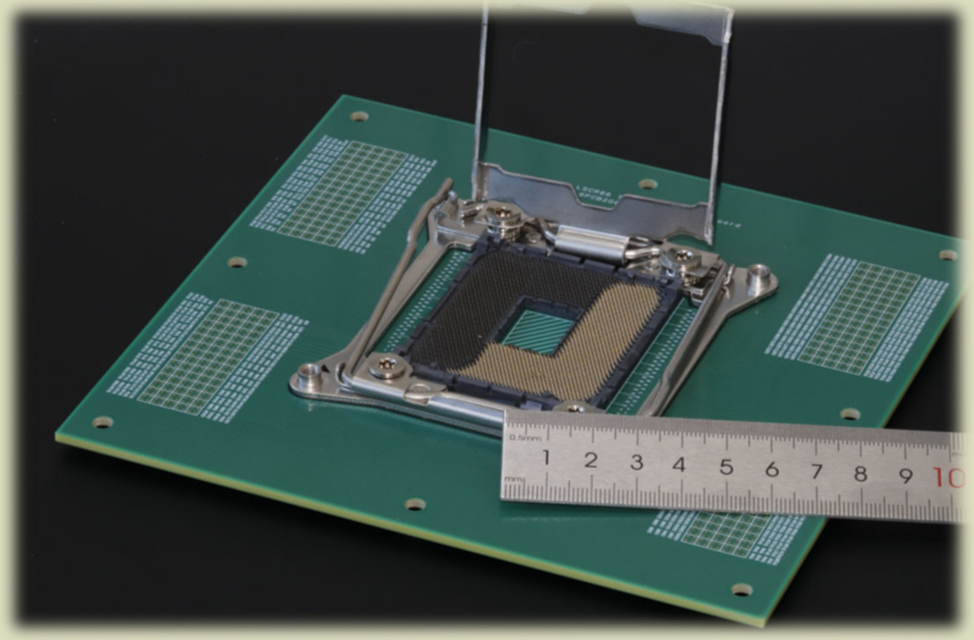
Connector Base

DIMENSIONS 18mm x 2.7mm x 4.8mm
RESOLUTION 10µm
TOLERANCE ±0.025mm
FEATURES 280µm spacing between connector teeth

No Limitations to Shapes

3D Printing is not limited to shapes. Any hole shapes can be printed at any angle, even that cannot be drilled.





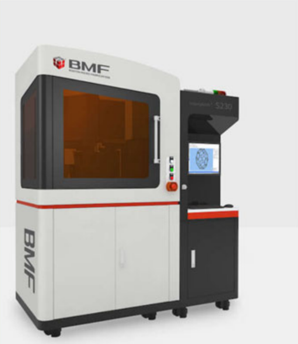
BMF 3D Printing Equipment

Ultra-High Resolution 3D Printers - microArch® D1025, S230, S350

microArch® is the first commercialized high resolution, 3D micro-fabrication equipment based on PμSL (Projection Micro Stereolithography) technology, which is designed for production of high resolution, highly precise parts for prototyping and short run production.

LIGHT SOURCE	UV-LED (405nm)
PRINTING MATERIAL	Photosensitive Resin
EXPOSURE RESOLUTION	10μm and 25μm
XY PRINTING RESOLUTION	10μm and 25μm
LAYER THICKNESS	10μm~50μm
SURFACE ROUGHNESS	0.4-0.8μm Ra (top) 1.5-2.5μm Ra (side)
PRINTING AREA	100 × 100 × 50mm
INPUT DATA FILE FORMAT	STL
POWER SUPPLY	2000w
EXTERNAL DIMENSIONS	1350(L) × 900(W) × 1950mm(H)
TOTAL WEIGHT	500kg

LIGHT SOURCE	UV-LED (405nm)
PRINTING MATERIAL	Photosensitive Resin
EXPOSURE RESOLUTION	25μm
XY PRINTING RESOLUTION	25μm
LAYER THICKNESS	10μm~50μm
SURFACE ROUGHNESS	0.4-0.8μm Ra (top) 1.5-2.5μm Ra (side)
PRINTING AREA	100 × 100 × 50mm
INPUT DATA FILE FORMAT	STL
POWER SUPPLY	2000w



LIGHT SOURCE	UV-LED (405nm)
PRINTING MATERIAL	Photosensitive Resin
EXPOSURE RESOLUTION	2μm
XY PRINTING RESOLUTION	2μm
LAYER THICKNESS	5μm~20μm
SURFACE ROUGHNESS	0.4-0.8μm Ra (top) 1.5-2.5μm Ra (side)
PRINTING AREA	50 x 50 x 50mm
INPUT DATA FILE FORMAT	STL
POWER SUPPLY	3000w

Socket Capabilities

- Housings can be made for Pogo Pins or Elastomers
- Maximum Socket Size: 100 mm x100 mm
- Maximum Pin Length: 50 mm
- Minimum Pin Hole Pitch: 0.1 mm
- Tolerance for Hole Diameters and Package Guides: +- 0.01 mm
- Any ball / pin pattern, including “Balls Anywhere”
- Pins can be placed at an angle

Materials

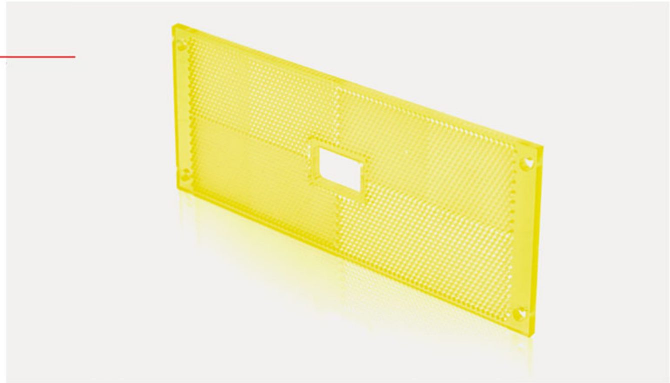
- Many materials are available, both made by BMF and 3rd parties.
- Recommended material for test sockets is: **BMF HT 200**
- High Young's Modulus (3 GPa)
  - Measure of a material's stiffness
  - Resistance to elastic deformation under load
- Low Poisson's Ratio (0.23)
  - Ratio of lateral to axial strain during deformation
  - How much a material gets thinner when you stretch it (or fatter when you squeeze it)

The higher the Young's Modulus and the lower the Poisson's Ratio for a material are, the less it deforms under various loads.

HT 200

HT 200 is a high temperature material that can withstand temperatures up to 200°C with high strength and durability, perfect for end use applications.

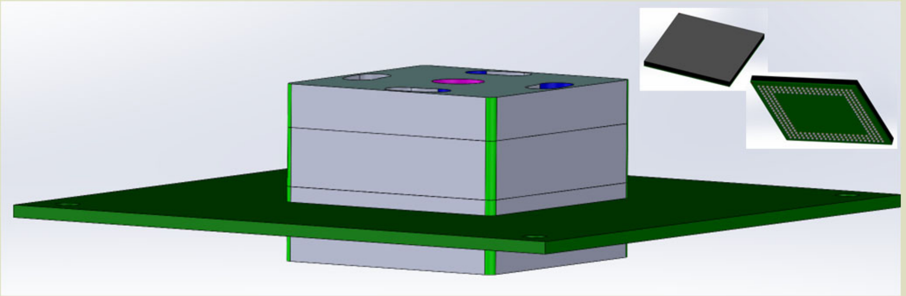
DOWNLOAD A DIGITAL COPY



		Cured Parts	Standard
Tensile Properties	TENSILE STRENGTH	87.8 MPa	ASTM D638
	ELASTIC MODULUS	3074 MPa	ASTM D638
	ELONGATION AT BREAK	4.6%	ASTM D638
Flexural Properties	FLEXURAL STRENGTH	153.6 MPa	ASTM D790
	FLEXURAL MODULUS	3.8 GPa	ASTM D790
Impact Properties	IMPACT STRENGTH	14.5 J/m	ASTM D256
Thermal Properties	CTE @ 60C	102.0 μm/m/°C	-
	HDT @ 0.45 MPa	217.8 °C	ASTM D648 - 07
General Properties	CONTACT ANGLE	30-60°	ASTM D7334
	WATER ABSORPTION [24h]	2.70%	ASTM D570
	HARDNESS	78.6 Shore D	ASTM D785
	VISCOSITY	285 cP	-
	STANDARD COLOR	Yellow Translucent	-
	COMPATIBLE BMF SYSTEMS	S130, S140, S230, S240, S350	-

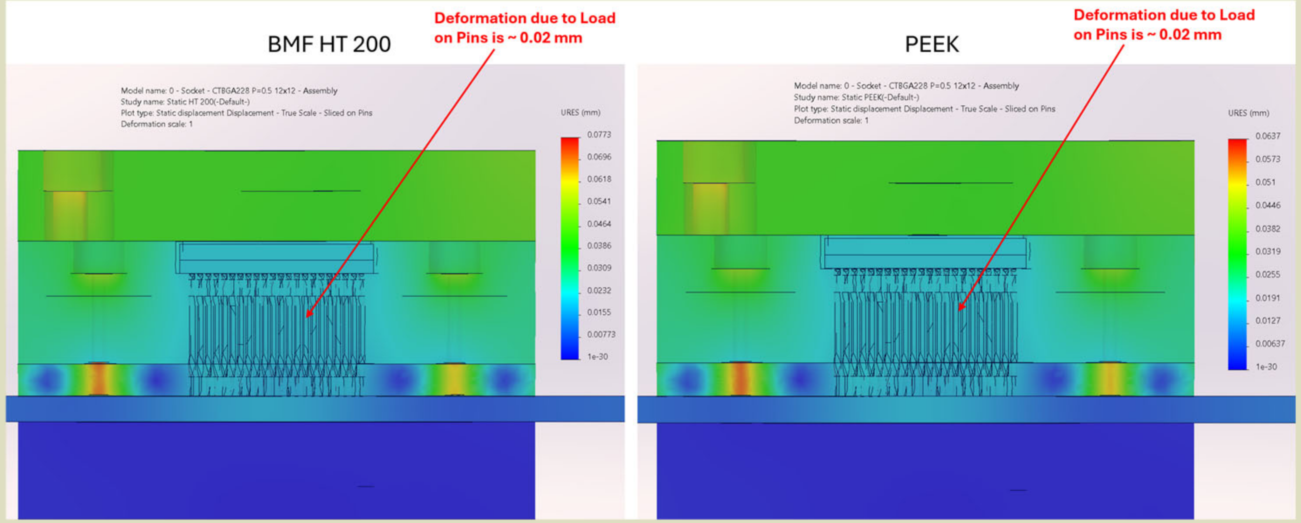
Mechanical Simulations

12 x 12 CTBGA Package
0.5 mm Pitch, 228 Pins
Force: ~ 30 grams / pin
Total Force: ~ 7 kg



All 5 Socket Housing Components are made out of the same material

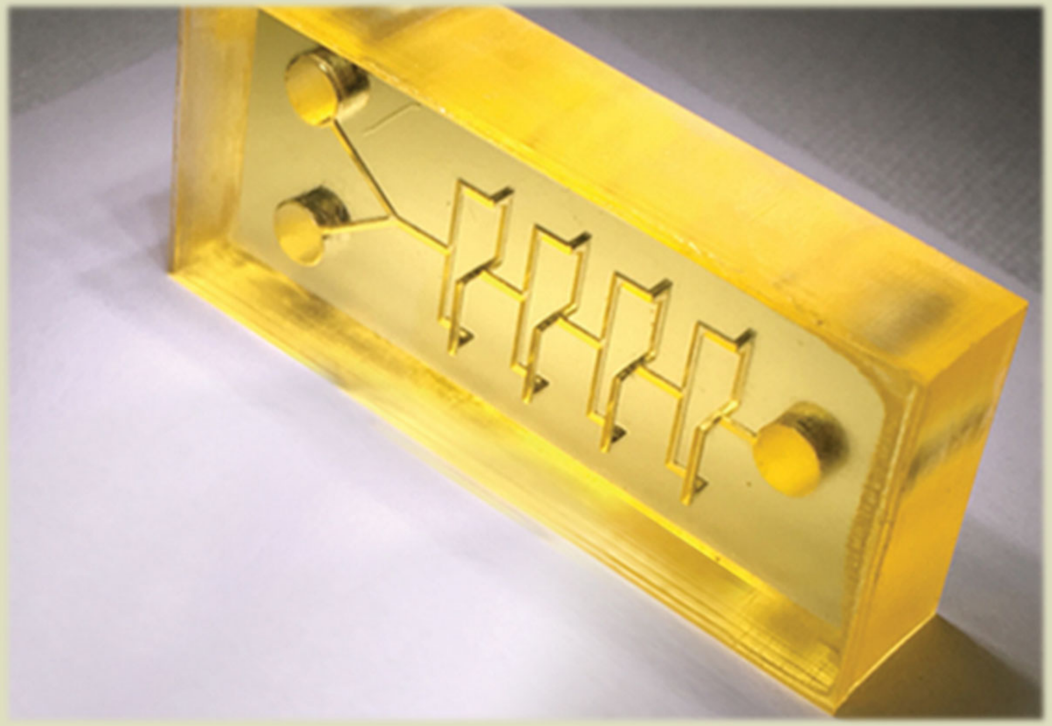
1. Lid
2. Top Pin Block
3. Compression Plate
4. Bottom Pin Block
5. Bottom Support Plate



Static Simulation using Solidworks Simulation Premium

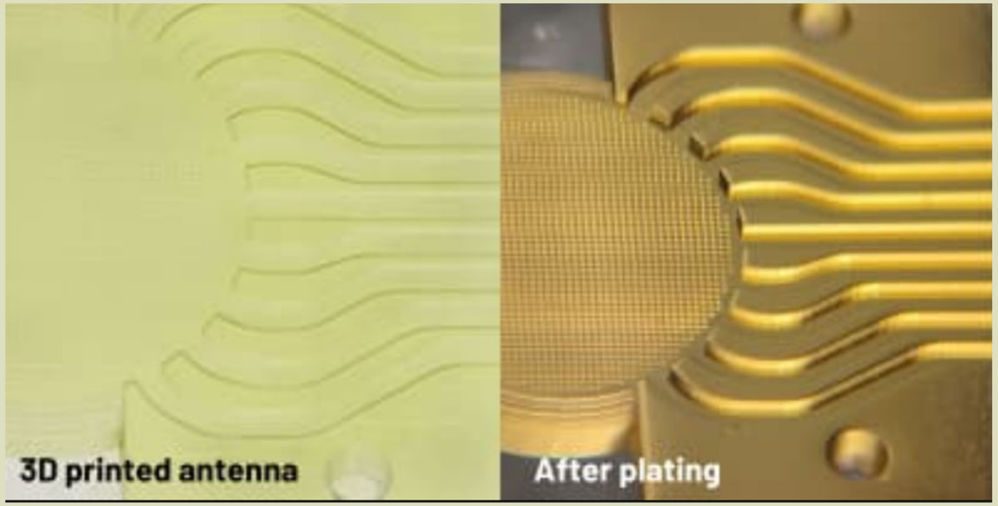
Embedded Thermal Cooling Capabilities

Microfluidic capillaries can be 3D printed in the housing that can be injected with a liquid or a phase change material allowing capillary cooling directly in the housing.



Embedded Electrical Capabilities

- 3D printed photopolymers can be metal plated after 3D printing.
- Antennas, inductors, power and ground planes, shields, and other electrical features can be designed directly into the socket housing and metalized by plating the housing after 3D printing.



Customers, Data, and Future Developments

- Reliability data is currently being generated and is still under development.
  - Cycling
  - Assembly / Disassembly of pins
  - Collection of manufacturing data
- Development of new materials
- Testing at customer sites
- 2 types of customers:
  - IC Manufacturers (OEMs) and Testing Facilities making sockets on site
  - Socket manufacturers make socket housings using our 3D printing technologies

Conclusion

3D printed socket housings can be:

- Made with the same precision as traditional CNC machined and injection molded sockets.
- Faster and cheaper than traditional manufacturing methods.
- Metal plated and have embedded passive components created directly using the 3D printing process.
- Embedded with thermal cooling solutions that can be created directly using the 3D printing process.

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