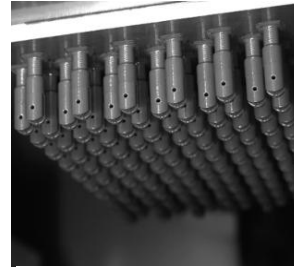


PureForm™ Printing Design Guidelines



Introduction to Pureform

Greene Group Industries' PureForm additive manufacturing platform uses Digital Light Processing to produce intricate metal parts at production scale. The H200 industrial printer grows a batch of parts layer-by-layer by curing a slurry that mixes metal particles with a highly reactive photopolymer. (see Picture 1) The high resolution of the DLP light engine combines with proprietary PureForm material, software, and precision equipment to make fine features in parts sized from a softball to a grain of rice. (see Picture 2)

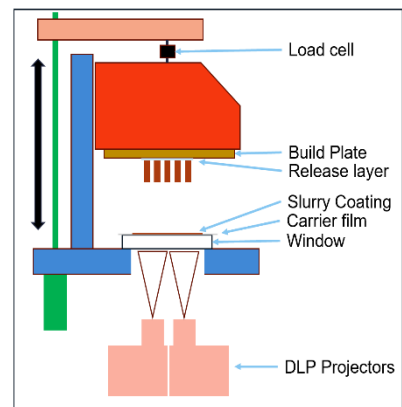


Picture 1: In process parts



Picture 2: Finished parts

The printer operates in a bottom-up configuration. The parts hang from a build plate that moves down to immerse the parts in a thin layer of slurry. (see Graphic 1) Once the parts reach the correct layer thickness, the desired pixel pattern is projected through a window, curing that layer of the part. The parts then move up; a fresh film of slurry is brought into position and the sequence repeats. After printing, the parts are cleaned, de-bound and sintered to their pure metal, final dimensions. The process is designed for highly repeatable positioning of parts in both the Z direction and the X-Y image plane, simple post-print cleaning and low feedstock usage. As with any additive process, however, it is most successful when certain specific part design guidelines are followed.



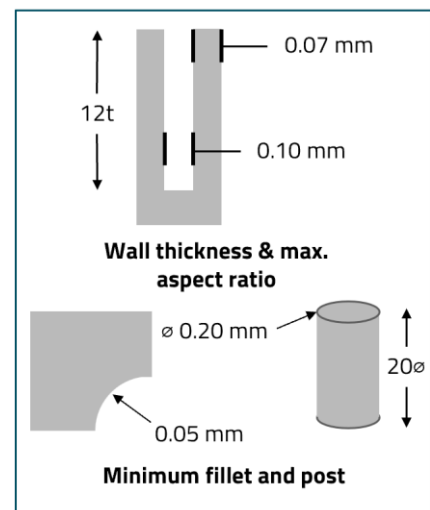
Graphic 1: Printing Module

Feature sizes

The pixel size of the projected light, the size of the metal particles and other process parameters for printing, cleaning and sintering drive size, accuracy and surface quality limitations for producible parts. These guidelines are listed below.

- As-printed surface finish: .8-1.6um Ra*
- Tolerance: +/- .025mm up to 12mm; +/- .2% above
- Minimum wall thickness: 0.07 mm
- Minimum gap between walls: 0.10 mm @ 12:1 aspect ratio
- Maximum wall thickness: 3.5 mm
- Minimum hole diameter: 0.20 mm
- Minimum post diameter: 0.20 mm
- Maximum post and hole aspect ratio: 20:1
- Minimum fillet size: 0.05 mm
- Minimum feature size at base layer: 0.125 mm in shortest direction

*Lower roughness finishes available with post-processing

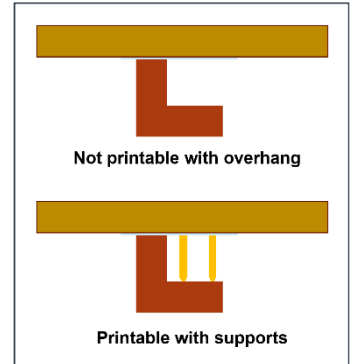


Graphic 2: Feature Size Limits

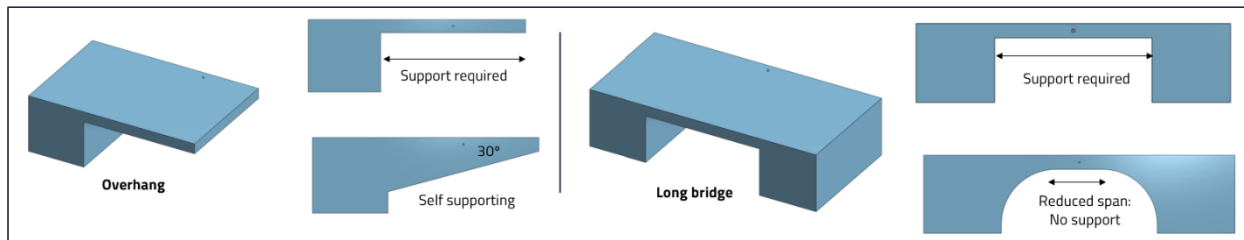
Supports

Because the PureForm printer does not rely on a vat of slurry or a bed of powder to support parts during printing, curing areas of a layer must be in close physical contact with the cured areas from the prior layer. If that is not possible by orienting the part, support structures must be added to the print.

Two common features that require support are bridges and overhangs. Bridges that span more than .50 mm must be supported. Overhangs greater than .125mm also must be supported. In general, avoiding supports is preferred. Supports can be eliminated in some cases by adding arches at bridges and overhangs or converting right-angle overhangs to ramps. Any ramp angled at more than 30° in the X-Z or Y-Z plane will be self-supporting.



Graphic 3: Supports



Graphic 4: Bridges and Overhangs



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