THIRD-PARTY SUBMISSION UNDER 37 CFR 1.290

(Do **not** submit this form electronically via EFS-Web)

Application Number (required): 13/503,217

U.S. PATENTS AND U.S. PATENT APPLICATION PUBLICATIONS

Cite No.	Document Number Number-Kind Code[1]	Issue Date or Publication Date MM/DD/YYYY	First Named Inventor
1	US- 5870663A	02/09/1999	Stucker
	US-		
	US-		
	US-		
	US-		
	US-		
	US-		
	US-		
	US-		

FOREIGN PATENTS AND PUBLISHED FOREIGN PATENT APPLICATIONS

Cite No.	Country or Patent Office and Document Number Country Code[2]-Number[3]-Kind Code[4]	Publication Date MM/DD/YYYY	Applicant, Patentee or First Named Inventor	Translation Attached
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1. If known, enter kind of document by the appropriate symbols indicated on the document under WIPO Standard ST.16. See MPEP 901.04(a). 2. Enter the country or patent office that issued the document by two-letter country code under WIPO Standard ST.3. See MPEP 1851. 3. For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 4. If known, enter kind of document by the appropriate symbols indicated on the document under WIPO Standard ST.16. See MPEP 901.04(a).

THIRD-PARTY SUBMISSION UNDER 37 CFR 1.290

Application Number (required): 13/503,217

NON-PATENT PUBLICATIONS (e.g., journal article, Office action)

Cite No.	Author (if any), title of the publication, page(s) being submitted, publication date, publisher (where available), and place of publication (where available)	Translation Attached	Evidence of Publication Attached
2	Paul Forderhase et al: 'Reducing or Eliminating Curl on Wax Parts Produced in the Sinterstation TM 2000 System', Solid Free Form Fabrication Proceedings, Sept. 1993, S. 94-101	☐	☒
	(available at http://utwired.engr.utexas.edu/lff/symposium/proceedingsArchive/pubs/Manuscripts/1993/1993-11-Forderhase.pdf)	☐	☐
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STATEMENTS

The party making the submission is not an individual who has a duty to disclose information with respect to the above-identified application under 37 CFR 1.56.

This submission complies with the requirements of 35 U.S.C. 122(e) and 37 CFR 1.290.

☐ The fee set forth in 37 CFR 1.290(f) is submitted herewith.

■ The fee set forth in 37 CFR 1.290(f) is not required because this submission lists three or fewer total items and, to the knowledge of the person signing the statement after making reasonable inquiry, this submission is the first and only submission under 35 U.S.C. 122(e) filed in the above-identified application by the party making the submission or by a party in privity with the party.

Signature	s/Kit Walsh/	**Date**	4/4/2013
Name (Printed/Typed)	Kit Walsh	**Reg. No., if applicable**	

Examiner Signature*		**Date Considered**	

*EXAMINER: Signature indicates all items listed have been considered, except for citations through which a line is drawn. Draw line through citation if not considered. Include a copy of this form with next communication to applicant.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
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5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No:	13/503,217	Confirmation No.: 8748
Inventor(s):	Satoshi Abe, Isao Fuwa, Yoshikazu Higashi, and Norio Yoshida	
Filed:	June 21, 2012	
Art Unit:	1733	
Examiner:		
For:	Method and Apparatus for Manufacturing Three-Dimensional Shaped Object	
Petitioners:	Electronic Frontier Foundation	

NOTIFICATION REQUEST OF NON-COMPLIANT THIRD-PARTY PREISSUANCE SUBMISSION

The undersigned requests notification via e-mail to the following address in the event the third-party submission is determined to be non-compliant.

E-mail Address: cwalsh@cyber.law.harvard.edu

Respectfully submitted,

ELECTRONIC FRONTIER FOUNDATION

By its counsel,

s/Kit Walsh/

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Date: April 4, 2013

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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Inventor(s):	Satoshi Abe, Isao Fuwa, Yoshikazu Higashi, and Norio Yoshida	
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THIRD-PARTY PREISSUANCE SUBMISSION UNDER 37 C.F.R. § 1.290 CONCISE DESCRIPTION OF RELEVANCE

Cite No. 1 – U.S. Patent No. 5,870,663 to Stucker et al.

Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

Dear Examiner:

Listed on accompanying Form PTO/SB/429 are documents that may be considered material to the patentability of this application pursuant to 37 C.F.R. § 1.290. Copies of the patents or publications cited are enclosed, except as waived by 37 C.F.R. § 1.290(d)(3).

In accordance with 37 C.F.R. § 1.290(d)(2), Petitioners' undersigned representative submits the following concise description of relevance for the Stucker reference, Cite No. 1 on Form PTO/SB/429:

Stucker discloses, among other things, a method for rapid prototyping using selective laser sintering, wherein a "three dimensional solid is built up by the addition of material layers." Stucker at col. 4, line 39 to col. 5, line 33. This method is similar to the laser sintering systems disclosed in ¶¶ 0002-0034 of the Specification and recited by Claims 14-27 of the instant Application. Specifically, Stucker discloses an atmospheric control unit that "regulates the temperature and amount of N_2 flowing through the air in the chamber. It also filters the air that flows through the process chamber." Stucker at col. 4, lines 52-55. This control of the airflow using nitrogen gas is similar to the airflow control recited by claims 14-27 of the instant Application.

Should Examiner or the Office find that the above statement of relevance, or any portion thereof, is non-compliant with some requirement of 37 C.F.R. § 1.290, Petitioners respectfully request the third-party submission be entered if the error is of such minor character that it does not raise an ambiguity as to the content of the submission. *See* 70 Fed. Reg. 42,150, 42,168 (July 17, 2012).

Respectfully submitted,

ELECTRONIC FRONTIER FOUNDATION

By its counsel,

s/Kit Walsh/

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Date: April 4, 2013

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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THIRD-PARTY PREISSUANCE SUBMISSION UNDER 37 C.F.R. § 1.290 CONCISE DESCRIPTION OF RELEVANCE

Cite No. 2 – Forderhase/Corden Article

Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

Dear Examiner:

Listed on accompanying Form PTO/SB/429 are documents that may be considered material to the patentability of this application pursuant to 37 C.F.R. § 1.290. Copies of the patents or publications cited are enclosed, except as waived by 37 C.F.R. § 1.290(d)(3).

In accordance with 37 C.F.R. § 1.290(d)(2), Petitioners' undersigned representative submits the following concise description of relevance for the Forderhase reference, Cite No. 2 on Form PTO/SB/429:

The Forderhase reference discloses, among other things, a method for building wax parts in layers using selective laser sintering. Forderhase at 94-97. This method is similar to the laser sintering systems disclosed in ¶¶ 0002-0034 of the Specification and recited by Claims 14-27 of the instant Application. In particular, the Forderhase reference notes on page 96 that “the build chamber had been significantly optimized in terms of gas flow;” in Table 2 on page 97 that there was an adjustment in fan setting; and on page 94 that “the process gas in the beta and production platforms must first flow across the part bed before it can be used to cool the feed areas . . . [t]he gas flow over the part bed causes each sintered layer to cool rapidly." Further, specific gas flow patterns are discloses in figures 2 and 4 on pages 95 and 96, respectively. These gas flow patterns are similar to the localized gas flow recited by Claims 14-27 of the instant Application.

Additionally, the Forderhase reference discloses "flow bypass boxes" which "were used to re-direct the process gas flow across the feed beds while avoiding flow across the part bed." Forderhase at 95. The disclosed gas flow is similar to the localized gas flow recited by Claims 14-27 of the instant Application.

Should Examiner or the Office find that the above statement of relevance, or any portion thereof, is non-compliant with some requirement of 37 C.F.R. § 1.290, Petitioners respectfully request the third-party submission be entered if the error is of such minor character that it does not raise an ambiguity as to the content of the submission. *See* 70 Fed. Reg. 42,150, 42,168 (July 17, 2012).

Respectfully submitted,

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Date: April 4, 2013

Reducing or Eliminating Curl on Wax Parts Produced in the Sinterstation™ 2000 System

by

Paul Forderhase and Richard Corden

Abstract

An experimental program was performed on the beta and production platforms of the Sinterstation 2000 System with the objective of building wax parts without anchors. Changes in operating strategy are described. Following a machine characterization, improvements in part build technique and thermal environment were evaluated to facilitate the processing of wax with reduced or absent anchors. Experimental data is presented showing the effects of the machine and build technique improvements made to date.

Acknowledgments

The authors wish to acknowledge the guidance and support during this project of Dr. Kevin McAlea, Rick Yeager and Mark Henton of DTM Corporation.

Introduction

In the past, wax parts have been built on a "superbase", a 13mm thick piece of beeswax, which is placed on the part cylinder prior to the wax build. Anchors connect the downward facing surfaces of the part to the superbase (figure 1).

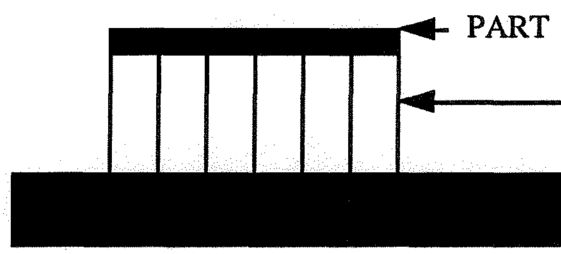

figure 1

This method for producing parts, when executed with sufficient anchors, is capable of eliminating or reducing curl to an acceptable value. The superbase, while serving well as a means to produce flat parts, places constraints on part placement within the build.

If one examines what actually transpires during a wax build, the necessity for anchored supports comes into question. In reviewing the process, however, one must keep in mind that this method for building wax parts was developed on the SLS model 125; an older platform with a different hardware configuration than the Sinterstation 2000 System. When using this procedure on either platform, the process gas is normally kept at a temperature between -5° and 5°C since the wax must cool sufficiently to allow adequate feeding. This need for refrigeration was first identified in work done at the University of Texas and subsequently became a requirement for wax parts built using the selective laser sintering process. Unlike the SLS model 125 platform, however, the process gas in the beta and production platforms must first flow across the part bed before it can be used to cool the feed areas (figure 2). The gas flow over the part bed causes each sintered layer to cool rapidly. This rapid cooling may contribute to curl by differential contraction of the hot layer on top of the cool part inducing a shear force in the plane of the part.[1] The loss of volume in each layer during solidification may also contribute to curl.

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1. Beaman, J.J. Mechanism for Thermal Distortion in Selective Laser Sintering, unpublished DTM memorandum 7/8/92.

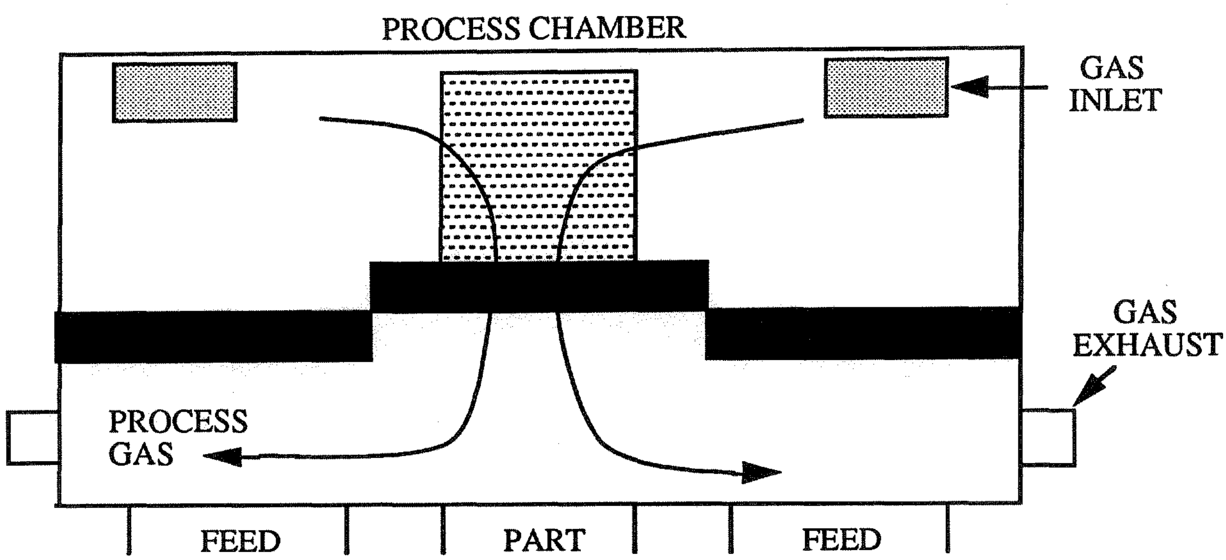


figure 2

Machine Baseline

Using the test platform, a series of SPC (Statistical Process Control) coupons were built without anchors. These builds were not intended to be representative of all parts that can be run on a Sinterstation 2000 System, but they were intended to identify the prominent failure modes encountered when running wax without anchors. Infrared imaging of the part bed under build conditions indicated that a temperature variation of 2°C was maintained over a build area of approximately ten inches. Gas velocity measurements were also taken under build conditions using a hot wire anemometer. Gas velocity over the part bed ranged from 0-20 fpm and could be characterized as being erratic. Flow over the feed cartridges was not detectable under these conditions.

Part Bed Isolation

Part bed isolation, or isolating the part bed from the flow of process gas, was developed to reduce the cooling rate of the part in order to reduce curl. It was discovered however, that when the part build area was completely isolated from the flow of the process gas, the feed material was not cooled sufficiently to allow feeding. To circumvent this problem, "flow bypass boxes" were used to re-direct the process gas flow across the feed beds while avoiding flow across the part bed. The bypass box is a sheet metal box designed to fit in the same space as the feed heater on the beta system and is equipped with a channel to direct the refrigerated process gas over the feed areas without cooling the part build area (figure 4).

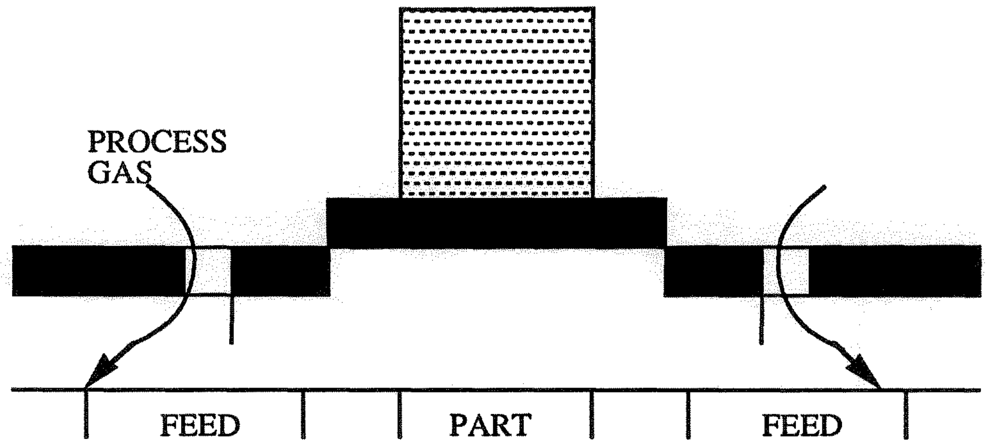


figure 4

Use of the feed bypass boxes had a significant, positive effect on the curvature of the parts. The feed bypass boxes also allowed sufficient refrigerated process gas to pass over the feed areas to facilitate feeding of the wax powder at higher temperatures; the data labelled "std" in table 1 were gleaned from a run which suffered a feed failure. The comparison of baseline runs performed with and without bypass boxes is shown in table 1.

t-Test: Two-Sample Assuming Equal Variances				
Measurement	top dia std	top dia bypass	bot dia std	bot dia bypass
Mean	20.76	36.99	4.38	7.63
Variance	85.48	208.20	1.01	3.77
Observations	8	8	8	8
Pooled Variance	146.84		2.39	
Hypothesized Mean Difference	0		0	
df	14		14	
t	-2.68		-4.20	
P(T<=t) one-tail	0.01		0.00	
t Critical one-tail (90% c.i.)	1.35		1.35	
P(T<=t) two-tail	0.02		0.00	
t Critical two-tail (90% c.i.)	1.76		1.76	

Table 1: feed bypass box comparison

Steady State Optimization

Once the build chamber had been optimized in terms of gas flow and chamber temperature with respect to feed flow quality, it was possible to begin attempts to counter the most significant failure modes present in wax parts built without anchored supports. These failure modes involved part curl and part growth, essentially the opposite extremes of the same process. To map the parameter space between these two failure modes, designed experiments were run on the beta and production platforms.

The Designed Experiments

The variables under study and their high and low values are listed in table 2. Note that the numbers listed for laser power and fan setting are percents of their maximum; the unit for the part temperature is degrees C and the unit for the layer delay is seconds.

For the designed set run on the beta platform.

	Laser Power	Part Temp.	Fan Setting	Layer Delay
Hi	30	38	50	0
Low	20	32	20	10

For the designed set run on the production platform

	Laser Power	Part Temp	Fan Setting	Layer Delay
Hi	16	38	4	0
Low	22	34	12	10

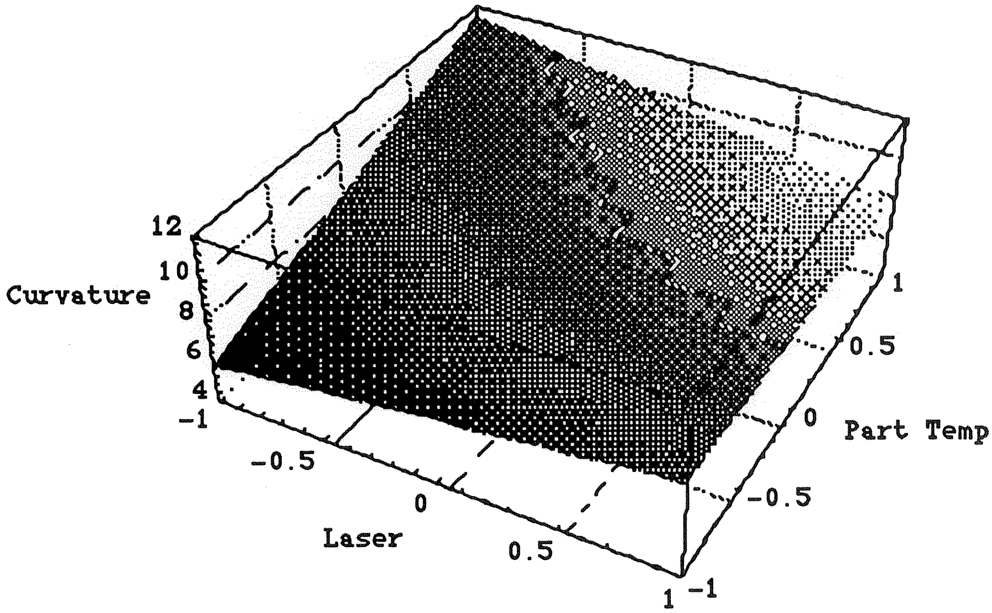
Table 2: designed experiment variable values

The values for laser power and part temperature were established by performing preliminary test runs. The control set points at which catastrophic failures were seen for high and low combinations of variables were used to define the designed set variable window. The values for fan setting were derived by correlating the absolute flow at the build surface on the beta platform to the control flow set points already established as the extremes for build success. This correlation was then applied to the production platform in order to achieve an equivalent absolute flow. These methods were employed for this designed experiment in order to accomplish two things: first, it was necessary to bracket as much of the operating envelope as possible in order to obtain significant results, and second, it was felt that by using part build failure runs and measurements of machine variables, we could compensate for differences in the two platforms. A set of SPC coupons was used as the test build due to its sensitivity to both curl and growth. An eight run resolution IV fractional factorial was used to avoid the aliasing of main effects with each other or with two way interactions.

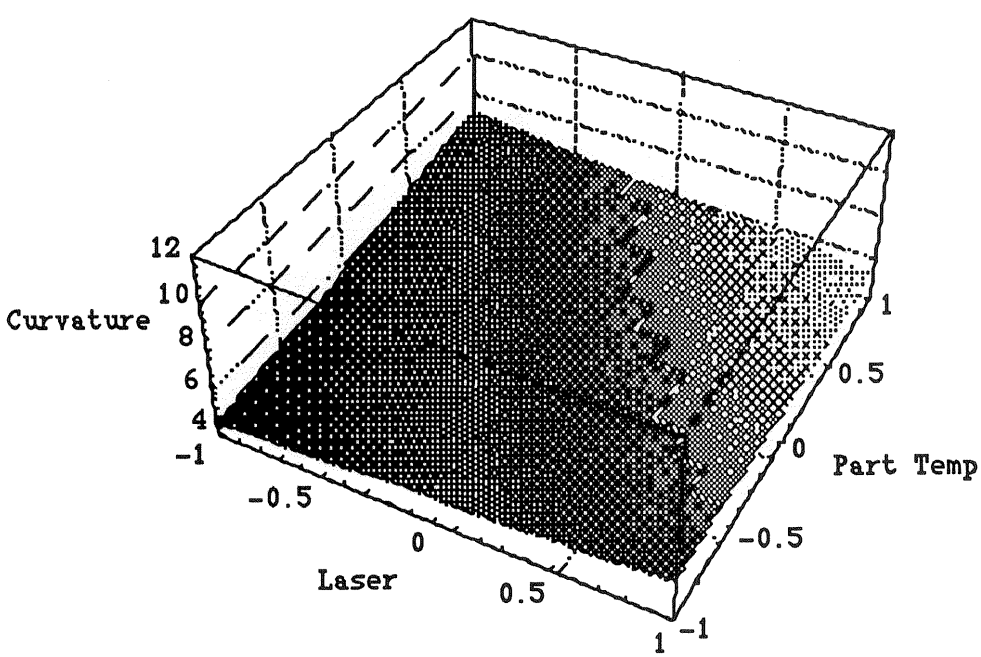
Designed Experiment Results

The response surfaces shown below are a graphical representation of the influence of laser power, part temperature, and their interaction. The height of the response surface represents the curvature diameter of the coupon's lower plane, while the gray scale represents the growth of the part as measured by the mass of the coupon (the white region indicates maximum growth). The response surfaces indicate a high degree of consistency for both platforms, and the equations used to generate the surfaces posses coefficients that are approximately equal with regard to size, sign, and statistical significance. The results indicate that in controlling part curvature, laser power was not significant on either platform; however, there is an indication that part temperature was significant in this respect. Also, in controlling growth, laser power and part temperature had equivalent amounts of influence. The experimental equations along with the probability of the observed difference in the mean being due to chance are shown in tables 3 and 4. None of the variables tested had a significant effect on sample standard deviation.

BETA PLATFORM STEADY STATE RUN OPTIMIZATION



PRODUCTION PLATFORM STEADY STATE RUN OPTIMIZATION



Model	Bottom Curvature			Mass	
Effect	Coefficient	P(2 tail)		Coefficient	P(2 tail)
Constant	8.406	0.000		8.731	0.000
Laser Power	-.210	0.774		1.006	0.000
Part Temperature	1.356	0.072		1.006	0.000
Air Flow	-0.644	0.383		0.218	0.101
Layer Delay	-0.0187	0.979		-0.344	0.019
Laser*Part	-1.594	0.037		0.394	0.010
Laser*Flow	0.848	0.253		-0.047	0.720
Part*Flow	-2.077	0.007		-0.456	0.005

Table 3: Beta Platform Results

Model	Bottom Curvature			Mass	
Effect	Coefficient	P(2 tail)		Coefficient	P(2 tail)
Constant	5.64	0.000		6.290	0.000
Laser Power	-0.181	0.391		0.593	0.000
Part Temperature	0.620	0.006		0.390	0.000
Air Flow	0.144	0.494		-0.318	0.000
Layer Delay	0.325	0.129		-0.256	0.000
Laser*Part	-0.787	0.001		0.157	0.003
Laser*Flow	0.698	0.002		-0.244	0.000
Part*Flow	0.053	0.801		-0.180	0.001

Table 4: Production Platform Results

Note that although the models exhibit acceptable values of significance, the means of the data fall into the range of what is referred to as "poor parts"; i. e. regardless of what was tried, the parts were subject to unacceptable amounts of either curl or growth. The results from the designed experiments led us to conclude that there is no region within the operating envelope in which a unique combination of process variables exist that will allow the manufacture of flat wax parts without anchors. This led to the further conclusion that other methods of suppressing curl or growth must be applied in order to achieve flat anchorless parts.

Laser Power per Unit Area

A simple formula was derived to calculate the amount of power per unit area (P/A) delivered by the laser using the laser power (LP), scan spacing (ScSp.) and step size(SS).

$$P/A = \frac{LP}{(ScSp)(SS)}$$

Preliminary tests indicate that there exists some variation in the results of delivery at constant P/A; i.e. P/A may be maintained by varying both laser power and scan spacing, but a part built with a high laser power and a larger scan spacing will not exhibit the same growth patterns as a part built with a lower laser power and a smaller scan spacing, even though P/A remains constant for both parts. The speed at which the laser power was delivered also had an effect on the amount of curl and growth present.

Table 4 represents a collection of data for test parts built on the beta platform. Note that success, in this case minimizing both curl and growth, is achieved when the correct "balance" is found between the significant parameters in conjunction with part re-orientation. Note also that curvature decreases as the value increases and that the growth value is derived from an arbitrary comparison scale:

Part #	Curvature	Pt. Temp.	Sc. Sp.	LP	SS	Growth	P/A
1	139.91	25	0.012	20	35	7	47.62
2	388.00	27	0.012	20	35	10	47.62
3	540.30	27	0.010	20	45	1	44.44
4	545.31	30	0.012	20	35	9	47.62
5	620.44	31	0.010	20	45	6	44.44
6	647.64	31	0.010	20	53	5	37.74
7	697.45	30	0.010	20	53	4	37.74
8	753.99	30	0.010	22	45	1	48.89
9	825.57	31	0.012	18	53	0	28.30
10	1343.65	30	0.010	20	53	5	37.74
11	1352.14	31	0.012	20	35	3	47.62
12	1780.15	32	0.010	20	53	6	37.74

Table 4: P/A test results

Angled Parts

Part orientation is perhaps the most significant factor in diminishing the curl experienced by wax parts built without support structures. Rotating the part within its three dimensional build region allows the reduction of the cross sectional surface area of all surfaces that would normally be parallel to the plane of the part bed. The part is subject to less stress, and therefore less likely to curl, when the cross sectional area of these surfaces, referred to as downward facing, is reduced to a minimum since the relative beam strength of that cross section is also reduced. Minimizing cross-sectional area, however, also diminishes the part's stability during the initial stages of the build. With such a small area being scanned at the build's outset, less than 1\8th of an inch for parts tested, it was necessary to raise part temperature to cause partial agglomeration of the surrounding wax bed thus creating a stable base. This "base" allowed the roller to pass across the bed during powder addition without disturbing the part itself.

The partial agglomeration of the surrounding wax may have provided the support needed to establish the part bed, but it also promoted growth and made for a more vigorous breakout. A re-evaluation of the part and its orientation suggested that its geometry could be generalized as being in the form of a cup. If during re-orientation, this "cup" was downward facing, then increasing the part temperature during the build would cause heat to be trapped beneath the part proliferating growth. If, however, the part was oriented so that the "cup" was upward facing, then excess heat could diffuse upward through the bed decreasing growth.

Since growth is affected by the energy introduced into the system during sintering, growth reduction can also be accomplished through laser parameter manipulation. Using information derived from a preliminary portion of this test, laser power, step size and scan spacing were adjusted to minimize growth. Though density, and subsequently strength, suffered as a result of this manipulation; parts built in this fashion had the least amounts of both curl and growth.

Anchor Design or "Surround Support"

Though this test did not follow the "unsupported wax" precept, it does improve upon current methods for building wax parts. The part is "encased" in a box which actually serves as a support structure. The interior of this box is cross-hatched, as opposed to being filled, so that it may be removed from the part after the build has completed. Since it is not required that this box be attached to the bees-wax superbase, parts may be initiated at any point in the cylinder. The initial work indicates that parts which are built without re-orientation still tend to be subject to curl which suggests the need to redesign the box structure.

Conclusion

The ability to build sintered, wax parts without anchored supports to the standards of quality demanded by post build applications is one that can significantly improve the viability and economics of the process. Once the restriction of "superbase attachment" has been removed, the potential for increased productivity becomes obvious. It also appears obvious from the results of various testing included in this paper that simply removing all supports and balancing build parameters accordingly is not sufficient to produce quality parts. Various amendments to the build procedure including: optimized laser parameters, angled builds and "surround support" offer the most promising potential in reducing the constraints currently associated with wax builds.

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Application No:	13/503,217	Confirmation No.: 8748
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Art Unit:	1733	
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Petitioners:	Electronic Frontier Foundation	

THIRD-PARTY PREISSUANCE SUBMISSION UNDER 37 C.F.R. § 1.290
AFFIDAVIT CONCERNING EVIDENCE OF PUBLICATION

Cite No. 2 – Forderhase/Corden Article

Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

Dear Examiner:

Listed on accompanying Form PTO/SB/429 are documents that may be considered material to the patentability of this application pursuant to 37 C.F.R. § 1.290. Copies of the patents or publications cited are enclosed, except as waived by 37 C.F.R. § 1.290(d)(3).

Petitioners' undersigned representative submits the two attached documents as evidence of publication for the Forderhase reference, Cite No. 2 on Form PTO/SB/429.

The first document, the Web page http://utwired.engr.utexas.edu/lff/symposium/proceedingsArchive/pubs/Table%20of%20Contents/1993_TOC.cfm, is a Web site listing 1993 as the date of publication of the Foderhase article and providing a downloadable copy of the article. The copy of the Forderhase article submitted by Petitioners' undersigned representative is a true and correct copy of the document Petitioners' undersigned representative downloaded from the second document's link.

The second document, the Google Books entry for the Solid Freeform Fabrication Symposium proceedings, shows a scan of the heading of the Forderhase article on the first page and shows on the third page that this article was available from the University of Michigan's library on December 17, 2007.

I hereby declare under penalty of perjury that the foregoing is true and correct.

Respectfully submitted,

ELECTRONIC FRONTIER FOUNDATION

By its counsel,

s/Kit Walsh/

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Date: April 4, 2013

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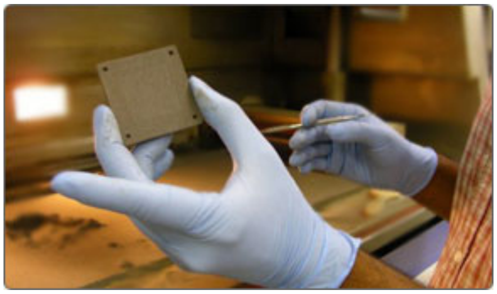

Freeform Fabrication is a collection of manufacturing technologies with which parts can be created without the need for part-specific tooling. A computerized model of the part is designed. It is sliced computationally, and layer information is sent to a fabricator that reproduces the layer in a real material.

SFF Symposium > Proceedings Archive > 1993

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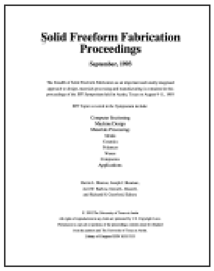

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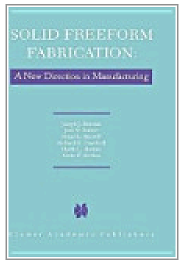

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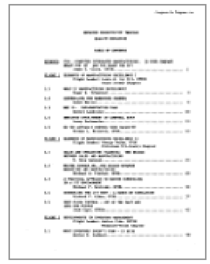

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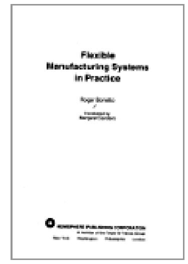

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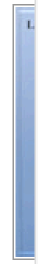

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Common terms and phrases

3D Printing accuracy algorithm alumina approximation Austin TX binder build carbon ceramic component composite composite material contour creep distortion CreepBar cross-sectional cure depth curl curve deposition diameter DIGIBOT dimensional droplet effect epoxy resin equation error experimental fibers fraction Freeform Fabrication Symposium function geometry green hatch spacing heat increase infiltration interface investment casting laser beam laser power layer thickness manufacturing material measured melting metal method mils mold nanocomposite parameters particle pattern photolithography photopolymer PMMA polymer powder bed power density produce QuickCast rapid prototyping residual stresses samples scan speed Selective Laser Sintering shape shown in Figure shrinkage silicon carbide simulation slicing SLS process Solid Freeform Fabrication solidification spray dried stereolithography Stratasys strength structure substrate surface techniques temperature Texas at Austin thermal conductivity tool topology triangles University of Texas UserPart vertical

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