ELECTROPLATING WITH FDM MASTERS

FORTUS 3D PRODUCTION SYSTEMS

Time Required Cost Skill Level

By Rob Winker, Stratasys, Inc.

SUPPLIES:

- Sandpaper: 220-500 grit
- Weld-on #3 by IPS Corporation
- Wet Sandpaper: 500-1200 grit
- Primer Paint

OVERVIEW

Electroplating deposits a thin layer of metal on the surface of a part built on a Fortus 3D Production System using the FDM process. This metal coating can be both decorative and functional. The coating gives the appearance of production metal or plated parts and provides a hard, wear-resistant surface with reflective properties. The electroplated part also has improved mechanical properties.

With simple finishing techniques, FDM parts are ready for electroplating with alloys such as chromium, nickel, copper, silver and gold. Combining the properties of Fortus materials with those of a metal coating, the part has strength, durability and heat resistance that is ideal for functional applications.

ELECTROPLATING FOR INCREASED DURABILITY

Electroplating not only enhances the look of a part but it also produces a hard, durable surface and dramatically increases the strength of an FDM part.

Electroplating causes a dramatic increases in strength (figure 1, 2 and 3). The FDM test bars were built both flat and on edge. The plating thickness was tested at both 0.005 inch (0.127 mm) as well as 0.010 inch (0.254 mm). The thickness of plating typically ranges from 0.0001 inch to 0.020 inch (0.0025 mm 0.508 mm). The FDM test bars were plated with a combination of nickel and copper, although typical metals used in plating also include chrome, brass, palladium, silver and gold.

Testing conducted by Aspen Research Corporation in St. Paul, MN, showed impressive increases in both the tensile and flexural strengths of FDM test bars (figure 1, 2 and 3). Depending on the coating thickness and test bar orientation the tensile strength increased 10 - 12 times that of a

An electroplated FDM part.

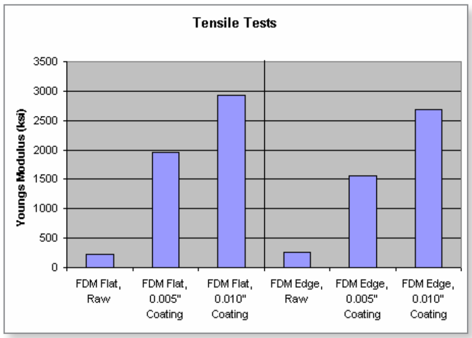

Figure 1: Tensile test results of FDM raw part flat vs edge - 0.005" and 0.010" coatings.

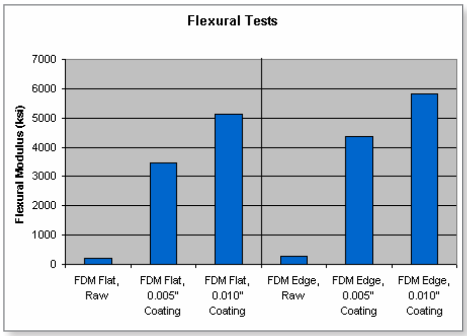

Figure 2: Flexural test results of FDM raw part: flat vs. edge - 0.005" and 0.010" coatings.

	Tensile Tests			Flexural Tests		
	Stress (ksi)	Elongation at Break (%)	Young's Modulus (ksi)	Maximum Stress (ksi)	Flexural Strain at Max Load (%+D1)	Flexural Modulus (ksi)
FDM Flat, Raw	2.8	13.3	228.8	4.9	4.6	206.7
FDM Flat, 0.005" Coating	15.7	2.3	1956.4	43.9	2.3	3449.6
FDM Flat, 0.010" Coating	24.4	3.3	2931.1	66.8	2.5	5124.9
FDM Edge, Raw	3.3	25.6	258.4	6.3	4.7	267
FDM Edge, 0.005" Coating	14.7	3.2	1564	43.6	1.9	4366.2
FDM Edge, 0.010" Coating	26.1	3.5	2682	64.3	2.1	5828.3

Figure 3: Raw numbers for Tensile and Flexural tests.

raw FDM test bar. The results of the flexural tests were even more substantial. They showed an increase of 21 - 24 times that of a raw FDM test bar.

To achieve the optimal strength of electroplated prototypes, the parts need to be sealed as described in step #4. The plating process also requires prototypes to be able to withstand temperatures of 100°F (37.7°C), which is well within the thermal range for Fortus materials.

Figure 4: Sand surfaces.

PROCESS

Consult with vendor on process specifics, estimate coating thickness, temperature exposed and other variables. Choose the right Fortus material and adjust the part according to vendor specifications.

1. Adjust CAD File:
Offset surfaces in the CAD model to allow for the thickness of the electroplated material. If there are any critical dimensions, such as hole or boss diameters, they should be communicated to the electroplater so that these dimensions can be maintained throughout the electroplating process.

2. Build FDM Part:
Materials that have been tested include; ABS-M30, ABS, ABSplus. While all other Fortus materials may be suitable for electroplating, they have not been tested at the time of publishing this document. *NOTE: Parts can be built in either solid or sparse fill.

3. Sand Surfaces:
After removing support structures, sand the part to remove build layer lines and stepped areas. At this point, a coarse sanding is sufficient (figure 4). The smooth surfaces needed for electroplating will be addressed in the next few steps.

4. Seal Surfaces:
The part must be sealed to prevent it from absorbing any of the electroplating solutions. There are three options for sealing the FDM part; smoothing the surface with the Finishing Touch™ Smoothing Station, solvent dipping, and painting (table 1). *NOTE: These methods will also smooth the surface of the part.

Material	Surface Smoothing	Solvent Dip	Painting
ABS, ABSi, ABSplus, ABS-M30, ABS-M30i	✓	✓	✓
PC, PC-ABS, PC-ISO		✓	✓

Table 1: Recommended sealant method per Fortus Material.

Option 1: Finishing Touch Smoothing Station
The first technique, smoothing the surface of the FDM part using the Finishing Touch Smoothing Station, seals the surface by exposing the FDM part to a vaporized solvent for 15 to 30 seconds. Smoothing has been tested on ABS, ABSplus ABS-M30, and ABSi.

Option 2: Solvent Dipping
The second technique, solvent dipping (figure 5), seals the surface by submerging the FDM part in a chemical bath for approximately 15 seconds. The recommended solvent is a methylene chloride solution, sold commercially as Weld-on #3 from the IPS Corporation. If this is not available, methyl ethyl ketone (MEK), sold commercially as Weld-on #2354, may be substituted.

Figure 5: Sealing. Seal the part's surfaces by dipping in solvent.

Option 3: Painting
The third technique, painting, will seal the part as well as fill in the layer lines. Spray the part with sandable primer and allow it to dry. Then, sand the part to the desired finish. Repeat as necessary.

*NOTE: Before applying primer, seek the advice of the electroplater. Primers can cause adverse reactions and contaminate the tanks of electroplating solutions. Also, If FDM master is painted the electroplater will need to apply a "spray" conductive coating instead of using the traditional electro-less nickel bath. Putting a painted part into a bath may ruin the bath.

Skip to step 7 if using Option 3.

5. Dry Part:
There will be solvent trapped in the part after the sealing process. If electroplating is attempted before the solvent has completely evaporated, the plating material will bubble and peel off of the part. Allowing the part to dry for a minimum of 18 hours will ensure that no solvent

remains. However, the drying time may take longer since it is dependent on the part's geometry. To accelerate the process, the part can be heated overnight in an oven set to a maximum temperature of 110°F (43°C).

6. Re-sand Surfaces:
Sand away any remaining layer lines or stepped surfaces with a wet sand paper (500-1200 grit) and repeat steps four and five. Repeat the sealing and sanding steps until the part is free of defects (figure 4). Minor flaws must be buffed out of the copper coating before the nickel coating is applied.

7. Electroplating:
Send part to the approved vendor for electroplating. Verify coating thickness specifications with vendor.

Copper layer thickness guideline:
0.005 - 0.010 inches (0.127 - 0.254 mm) thick.

Nickel layer thickness guideline:
0.001 inch (.0254 mm) thick.

Chromium (Optional) layer thickness guideline:
0.001 inch (.0254 mm) thick.

Electroplated Part: Finished part with functional and decorative copper-nickel-chromium plating.

SUPPLIERS

Supplies are readily available at hardware stores, hobby shops and industrial supply companies.

FDM PROCESS DESCRIPTION

Fortus 3D Production Systems are based on patented Stratasys FDM (Fused Deposition Modeling) technology. FDM is the industry's leading Additive Fabrication technology, and the only one that uses production grade thermoplastic materials to build the most durable parts direct from 3D data. Fortus systems use the widest range of advanced materials and mechanical properties so your parts can endure high heat, caustic chemicals, sterilization, high impact applications.

The FDM process dispenses two materials—one material to build the part and another material for a disposable support structure. The material is supplied from a roll of plastic filament on a spool. To produce a part, the filament is fed into an extrusion head and heated to a semi-liquid state. The head then extrudes the material and deposits it in layers as fine as 0.005 inch (0.127 mm) thick.

Unlike some Additive Fabrication processes, Fortus systems with FDM technology require no special facilities or ventilation and involve no harmful chemicals and by-products.

For more information about Fortus systems, materials and applications, call **888.480.3548** or visit **www.fortus.com**

Fortus 3D Production Systems
Stratasys Incorporated
7665 Commerce Way
Eden Prairie, MN 55344
+1 888 480 3548 (US Toll Free)
+1 952 937 3000
+1 952 937 0070 (Fax)
www.stratasys.com
info@stratasys.com

Fortus 3D Production Systems
Stratasys GmbH
Weismüllerstrasse 27
60314 Frankfurt am Main
Germany
+49 69 420 9943 0 (Tel)
+49 69 420 9943 33 (Fax)
www.stratasys.com
europe@stratasys.com

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3D PRODUCTION SYSTEMS