APPLICATION GUIDE:

PPSF Finishing Techniques

TIME REQUIRED ■□□ COST ■□□ SKILL LEVEL ■□□

By Jesse Hanssen, Stratasys Inc.

OVERVIEW

PPSF (polyphenylsulfone) is a high-temperature, high-strength and chemically resistant FDM material. While ideal for demanding applications, the durability and chemical resistance make it difficult, and time consuming, to finish PPSF parts with sandpaper or solvents.

When smooth surfaces are needed, the two options most often used have been hand sanding or milling. Resistant to abrasion, PPSF makes hand sanding a laborious task that can consume hours of time. While a finishing pass with a CNC mill can make short work of surface smoothing, it negates many of the advantages of the FDM process. To prepare for machining, time is needed for CAM programming and machine set-ups. Machining also requires that an operator oversees the process.

If PPSF is used to make tools or molds, there is a new and faster alternative for surface smoothing, thermoforming. A thin sheet of plastic is drawn onto the surface of the PPSF part. While it conforms to the part's shape, the plastic sheet does not transfer the layer lines to the outer surface. To preserve the mechanical, thermal and chemical advantages of PPSF, the thermoforming process uses sheets of plastic made from PEEK resin. Versus hand sanding, PEEK thermoforming can reduce lead time by 75 percent and cost by 90 percent (table 1).

Co-developers:
Milwaukee School of Engineering, Rapid Prototyping Center

Applies to Materials:
- PPSF

Supplies:
- Victrex APTIV PEEK film
- Typical thermoforming materials

Tools & Equipment:
- Thermoforming machine
- Typical thermoforming too

How does FDM compare to traditional methods?

PROCESS	LEAD TIME	LABOR COST	MATERIAL COST
Hand Sanding	4 hours	$160	$5
Peek Film	1 hour	$10	$6
Savings	3 hours (75%)	$149 (90%)	

PROCESS DESCRIPTION

Smoothing a PPSF part with an outer skin of PEEK is a relatively simple process that requires few modifications to a standard thermoforming operation. The key differences are that PEEK is the thermoformed material and the FDM part serves as the thermoforming mold.

Following are highlights of the process. For a detailed, comprehensive description of thermoforming with FDM, see Stratasys' "Thermoforming for Prototype and Short-Run Applications" guide.

PPSF FINISHING TECHNIQUES

1. PART CONSTRUCTION:

Select the desired thickness of the PEEK sheet that will be thermoformed. The recommended thickness range is 0.003 to 0.005 inch (0.08 to 0.13 mm), but sheets as thick as 0.010 inch (0.25 mm) may be used. Note that thicker sheets of PEEK will require more vacuum pressure during thermoforming and may resist drawing into small features.

To compensate for the thermoformed sheet's thickness, adjust the CAD model of the PPSF part by offsetting all external surfaces. Optionally, the CAD model may be modified to include a 0.050-inch (1.27 mm) deep ring around the perimeter of the mold. This ring will aid in bonding the PEEK film to the part.

To simplify and expedite the thermoforming process, modify the FDM build parameters to make the PPSF part more porous. This allows the vacuum in the thermoforming machine to be pulled through the part without having to manually drill vent holes around its periphery. Do this in Insight by adjusting the raster air gaps of the two outermost surfaces to 0.001 inch (0.03 mm). Also, change the model's body raster air gaps to 0.010 inch (0.25 mm) to promote air flow through the part.

Next, build the PPSF part an Fortus system. After the build is complete, remove the supports in preparation for thermoforming.

2. THERMOFORMING:

Mount the PPSF part on a base plate cut to a size that fits on the thermoforming machine's platen. The base plate can be made from any rigid material that will withstand the heat of the thermoforming process.

Load the PPSF part in the vacuum forming machine and insert a sheet of PEEK material (figure 1). To ensure that there is a strong mechanical bond between the PPSF part and PEEK film, adhesive-backed materials are suggested. Testing has shown that Victrex P500S, an APTIV PEEK film backed with silicone adhesive, works well for this application.

Heat the sheet to 284-320 °F (140-160 °C) and draw it onto the PPSF part as soon as it reaches its forming point. Typically, this cycle should be completed in less than 20 seconds. Extended cycle times will cause the PEEK film to crystallize, which causes it to become stiff and opaque. To avoid crystallization, observe the PEEK sheet. As heat is applied, it will relax and then become taut. Once the PEEK sheet draws tight, quickly apply the vacuum (figure 2) and hold it until the PEEK film cools.

Following the vacuum forming operation, trim the PEEK sheet to the size of the PPSF part. The PPSF/PEEK part (figure 3) is now ready to be put into service.

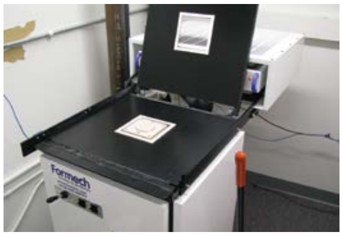

Figure 1: Place the PPSF part (center) and load a PEEK sheet (top; clear pane) in the vacuum forming machine.

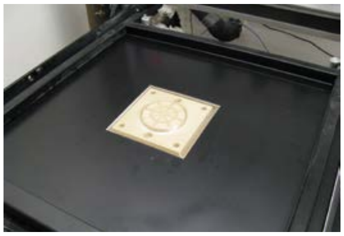

Figure 2: After the heated PEEK sheet becomes taut, apply the vacuum and hold until cooled.

Figure 3: The PEEK sheet conforms to the part's shape while smoothing its surfac

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.

stratasys

E info@stratasys.com / STRATASYS.COM

ISO 9001:2008 Certified

HEADQUARTERS

7665 Commerce Way,
Eden Prairie, MN 55344
+1 888 480-3548 (US Toll Free)
+1 952 937-3000 (Intl)
+1 952 937-0070 (Fax)

2 Holtzman St., Science Park,
PO Box 2496
Rehovot 76124, Israel
+972 74 745-4000
+972 74 745-5000 (Fax)