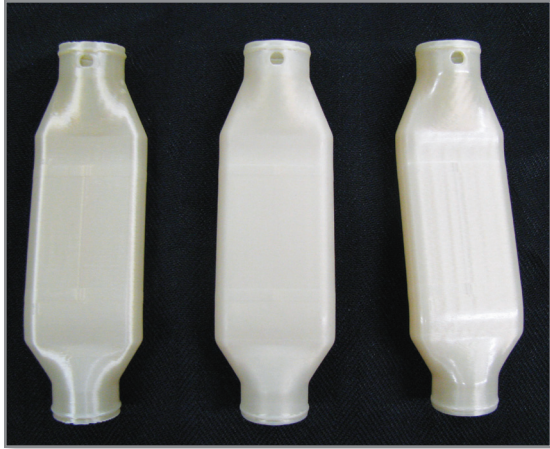


MASS FINISHING FOR FDM PARTS

OVERVIEW

Mass finishing is being used to improve the surface finish of Fused Deposition Modeling (FDM) parts. Mass finishing can abrade away layer marks in a sanding action (called “cutting”), or polish an FDM surface to a glossy luster. To achieve cutting and polishing, employ a two-step process.



From left to right: a part straight from the FDM machine; a part after being smoothed with cutting media; a part cut and polished.

Typical parts that may benefit from mass finishing include: parts to be painted, models representing injection-molded parts, housings, vents and duct work, and master patterns.

Examining an FDM part up close, you’ll see that the outer toolpaths have a slight bulge of about 0.002 inches from the layer deposition process (Image 1). Mass finishing works by smoothing material from the outside surface of the part, removing 0.0015 to 0.003 inches from the surface.

SYSTEM TYPES

Stratasys has tested two types of systems to enable mass finishing: vibratory and centrifugal barrel. Tests were successful on machines from the two manufacturers listed below. Results cannot be predicted on machines from other manufacturers.

Vibratory machines are available in tub or bowl shapes, each in various sizes (Images 2 and 3). Both tubs and bowls are suitable for all FDM materials. Standard tubs process parts aggressively, so we’ve added damage-control rods to the tub, which protect the part from damage that can result from media getting trapped between the part and the wall (Image 4). These rods are required when finishing FDM parts in a tub system. Cycle times are longer for bowl systems because of less aggressive processing, but parts are better protected from damage. Additionally, this method is preferred for its uniform smoothing action.

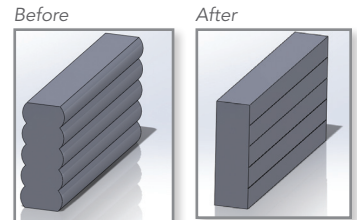


Image 1: Close-up of finishing effect on surface



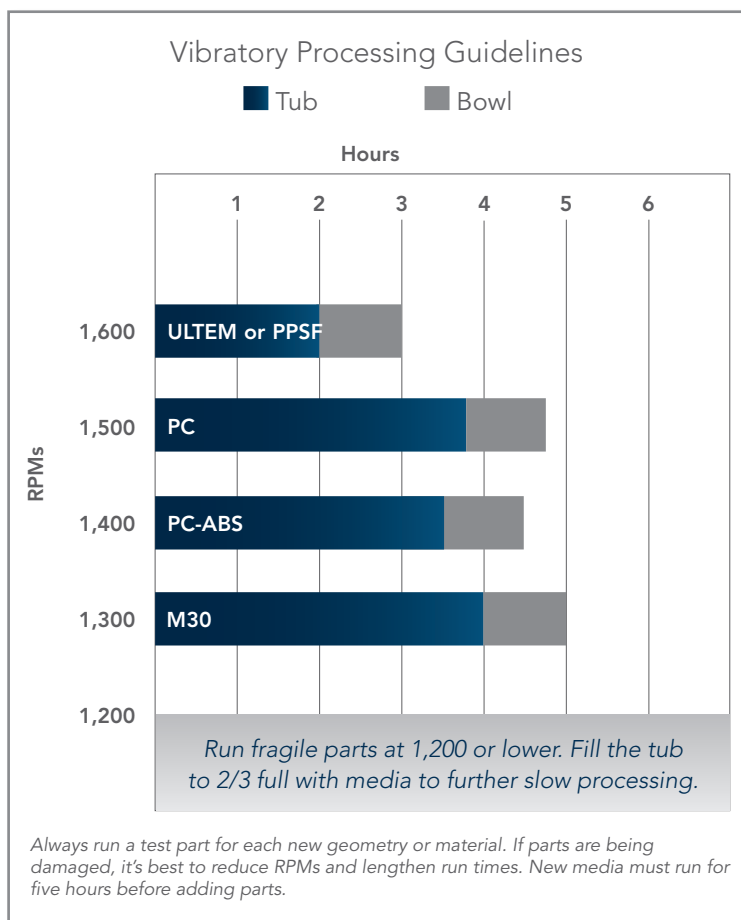
Image 2: Vibratory tubs like this one process parts aggressively.



Image 3: Vibratory machines are also available in a bowl shape.



Image 4: Damage-control rods protect parts in a vibratory tub.



Stratasys has tested and recommends the V13 end-discharge vibratory tub from Almco Inc. (www.almco.com; 507 West Front St., Albert Lea, MN 56007; 1-800-521-2740). The tub measures 51 in. by 20 in. by 24 in. For ample media room and flow, the maximum part size is about 45 in. by 12 in. by 16 in. Some large parts may benefit from being mounted in a roll fixture (Image 5), which prevents processing torque from distorting long parts. The tub may be divided for use with multiple types of media. The approximate cost is \$40,000 for the



Image 5: Roll fixtures can protect long parts from torque during processing.



Image 6: Centrifugal barrel machines are suitable for fragile, detailed parts.



Image 7: Ceramic stars and plastic cones are two examples of finishing media.

machine plus \$5,000 for the media. For bowl systems, Stratasys also recommends Almco. Work with the vendor to choose the right size system for your typical part.

Centrifugal barrel machines come in one model and one size (Image 6). This machine is suitable for all FDM materials, but part size is limited to about 5 in. on all sides. The centrifugal barrel finishing process is suitable for fragile or finely detailed parts.

Stratasys has tested and recommends the C-4-806 finishing machine from Grav Co (www.gravcollc.com; 400 Norwood Ave., Sturgis, MI 49091; 1-800-521-5793) because it features a variable-speed drive. The machine's four barrels may use a total of two different types of media. (Too many types of media may cause imbalance as the barrels spin.) The approximate cost is \$30,000 for the machine plus \$2,000 for four varieties of media.

MEDIA CHOICES

Many mass finishing media are available (Image 7). Stratasys has tested ceramic, synthetic, plastic and corn cob. With the exception of corn cob, media comes in many sizes and shapes. Consider the size and geometry of your most-used parts when choosing media. Small parts require small media, and highly detailed or featured parts require complex media shapes such as star. Be aware that manufacturer descriptions of desired finish, such as “brushed” or “satin,” describe results for metal parts. Here are our findings from experiments with FDM parts:

Ceramic is the heaviest and most aggressive media and best suited for the most robust FDM materials: PC, ULTEM and PPSF. Ceramic media is available in many shapes and sizes for cutting and/or polishing, depending on your desired finish. Ceramic polishing media can achieve a glossy surface on all FDM materials.

Synthetic media, mainly used for cutting, works well with M-30 and PC-ABS. Because it’s lighter than plastic or ceramic, cycle times may increase. The lighter the media, the lower the risk of damaging the part. If the weight of a ceramic or plastic media alone in a tub or bowl might break thin part walls or fine features as the part flows through the media, synthetic may be a good alternative.

Plastic is best suited for M-30 and PC-ABS, but in most cases will work for PC as well. This media is less aggressive because it weighs less than ceramic and is softer. Mainly used for cutting, plastic comes in many shapes and sizes.

Corn cob, mainly used for polishing, can also be combined with compounds for cutting and improved polishing. Stratasys testing on this media is still preliminary; M-30 may be the only material for which corn cob is a suitable cutting media. Corn cob should be used as a final polish after a wet polish is complete. Corn cob may cause some discoloration, which is easily washed away. A WaterWorks tank filled with clean water works well for this.

Regardless of media, to prevent sediment from collecting on parts, remove parts from the system at the end of the finishing process; don’t allow parts to dwell in stationary media. Rinse parts in clean water to remove any residue.

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