Micromolding and 3D-Printing: Process Review

New photos show crisp, well defined features from micromolding

Background

The advantages of 3D-Printing as a model and prototype-making process have excited the overall product development community. This is because of quick lead times and new design freedoms that offer flexibilities not found in previous tooling-based prototyping and modeling technologies. In fact, for some very low quantity applications, such as personalized medical implants, 3D Printing has reportedly been used as a "limited run" production technology. Therefore, it is natural that the successes experienced by those using 3D-Printing in the "Macro-world" would inspire similar experimentation in the "Micro-world", too.

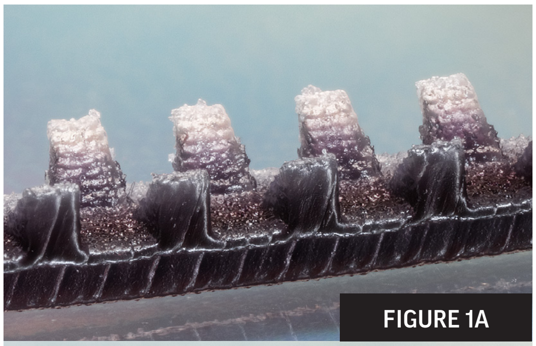
Identifying the Problem: Choosing Processes

3D-Printing is "100% Process", meaning the process converts engineering data directly into three-dimensional products, using a projectile printing technology like inkjet printing, the technology used in document printers. No form tool is used to create the shape of the finished part, so all locational and tolerance-based requirements are dependent on the accuracy and repeatability of the process delivering the projectiles to the correct locations. This is a tall order in the "Macro-world", but it is a tremendous challenge in the "Micro-world", as the photos show in Figures 1a and 1b.

Micromolding, on the other hand, is a combination of several "processes" (injection molding plus tooling plus material science, and so forth; see MTD's "6 Sciences of Micromolding" in MTD's Micro-Tech Bulletin No. 1401, available on the MTD website: www.mtdmicromolding.com/microseries).

Engineering Dilemma

So the dilemma for most development engineers is in determining whether the short delivery time and low sample cost of a 3D-Printed part outweigh the disadvantages of loss of micro-feature definition, reduced material choices, and possibly the loss of the ability to dynamic test.



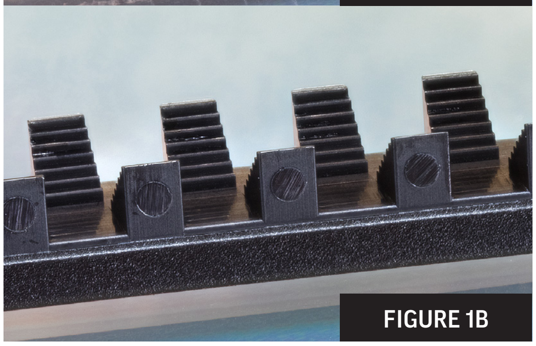


FIG. 1A, 1B: Photo 1a shows a customer design, with the plastic part being created using 3D-Printing technology. Photo 1b shows a Micromolded version of the same part exhibiting sharp, well-defined corners on repeating sets of stair-step features.

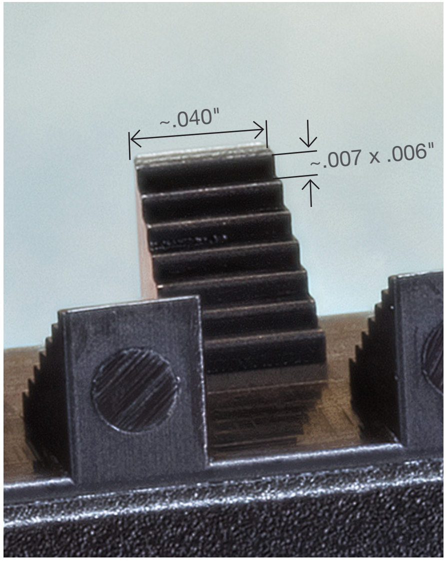


FIG. 2: Enlarged view of Micromolded part. Note the crisp and clean edges and corners. These features are remarkably focused, especially since each "stair-step" is only about the width of one (1) human hair wide and equally high.

To clarify the dilemma in terms of the loss of feature definition, a quick visual comparison of the two parts shown in Figures 1a and 1b illustrates the problem. A considerable difference exists between the clarity of the features created using 3-D Printing and Micromolding. In this case, the 3-D Printed parts were formed using a new high-precision printer operating at only a 16μ thick deposition layer and 25μ off-set. The expectation was that this new process would provide very close parity with the Micromolded features.

The Solution:

Critical and Functional for Testing vs. Desirable and Needed Only for Constructing a Model

The answer to whether 3D-Printing will be sufficient or whether a part must be hard-tooled in Micromolding might become clear once the need for micro-sized features is determined. Are they "desirable" or "critical to function"? The same is true for the number of parts required: is the need limited to a handful of parts, or will thousands of pieces be needed? The suitability of materials is also crucial, especially if dynamic, dielectric, biocompatibility, or rate of absorption testing, are required.

Benefits Summary

Fine, micro-sized features not only can be produced and exist on the surface of miniature and micro-sized parts. They can be produced in abundance using Micromolding. This micromolding technology exists and is capable of handling this task. It is effective, repeatable, durable, and cost effective for production applications due to mass production and high volume capability.

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