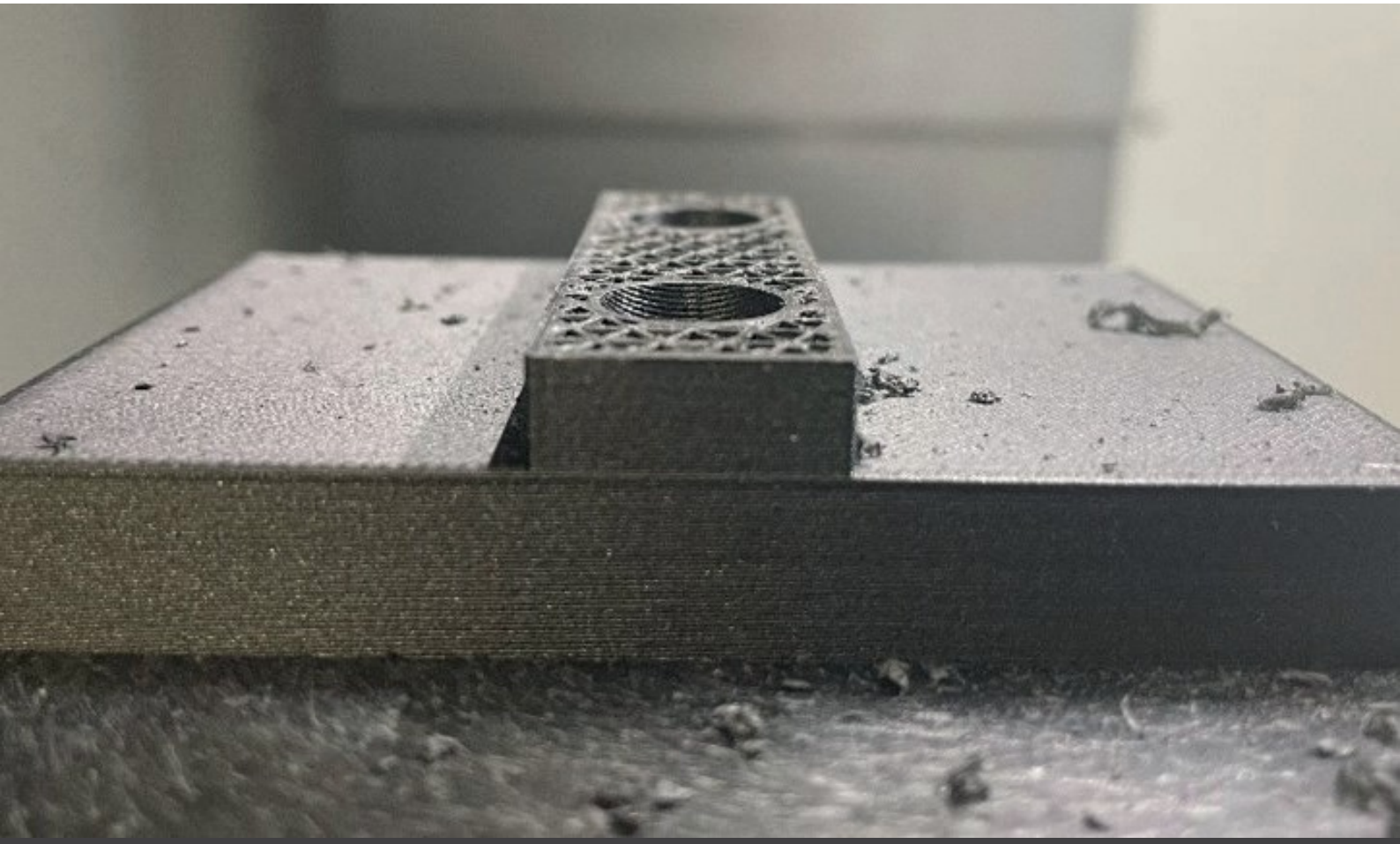
Mark3D
Print Stronger

GUHRING
The Tool Company



Machining additively manufactured components

We are constantly being asked whether our base material Onyx can be reworked and what the results look like. That's why we took up this question with Guhring UK, one of the world's leading manufacturers of high-quality cutting tools.

"Why would you want to rework onyx?" - After all, 3D printers can be used to create all the complex geometries you need. Markforged 3D printers are accurate and produce reproducible parts. However, there are cases where even more precise tools are required.

Markforged

Tip 1: Low cutting depths with low feed rates and speeds produce the best surface quality (and keep heat to a minimum).

Tip 2: You can simply mill into the closed honeycomb structure. However, you can also make this setting in Eiger.

Tip 3: Pocket milling works well for printed components with thicker walls. Make the last pass carefully to remove the slight burr or rem thumbnail.

Speed ...

... is not always the best solution

Ian Weston from Mark3D UK caught up with Steve Smith from Guhring UK to find out which tools and milling programs are suitable for machining Markforged's popular Onyx material.

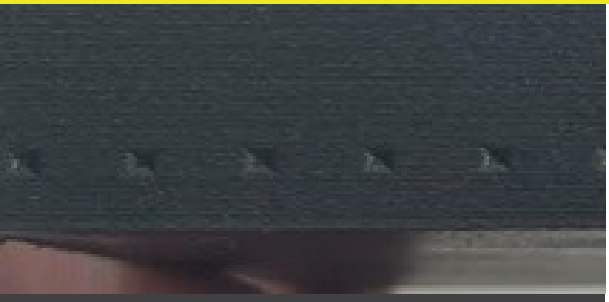
Onyx is a really pleasant material to work with, which can be printed reliably and with which you can produce precise, reproducible and robust components. It is one of the many polymers developed by Markforged specifically for 3D printing and is a blend of nylon with approximately 15% carbon short fibers.

The carbon fiber content ensures good wear properties. This must be taken into account during machining, as the tools wear out quickly if the settings are incorrect. It was therefore a real advantage that Steve Smith, an expert in machining all types of materials, was available at Guhring. Steve chose a tool from the standard range to start the trials. In this case, it was a three-edged end mill (product code RF100AL) with a special "Carbo" coating. The standard milling data for thermoplastics can be found in the main catalog for milling, so the team decided to use this as a starting point.

The first test was carried out with a cutting speed of 200 Vc, a feed rate of 0.05 mm Fz and a cutting depth of 0.1 mm. The results were promising and the team concluded that the settings from the manual were a good start! A cross-reference to a special Guhring catalog for composite cutting tools revealed that slightly lower speeds and feeds were required when machining carbon fibers. The machine was therefore slowed down by 20% for the next pass, again improving the results.

The cutting depth was increased from 0.1 mm to 0.5 mm and again the results were acceptable. The final 1 mm depth of cut produced some burrs, which could be removed with a thumbnail, but generated heat! To complete this test, a final pass of 0.1 mm was made across the top.

"If you work onyx at full speed, you tear the material apart, so you get better results by slowing it down." - Steve Smith



Tip 4: Use a support bar to prevent the machine tool from damaging the printed component (if necessary).

Tip 5: Delivery according to your 3D printed layer height.

Which tool is the best?

Solid carbide

For occasional users, a coated standard milling cutter of good quality is sufficient and the results were very good. A coated 10 mm tool was used for these tests.

PCD tools

The milling tests were carried out with a PCD tool that even had a 3D printed tool body made from the market research Metal X. This end mill was used to test milling at high speed and high depth of cut. This led to mixed results as heat developed and softened the surface of the material.

Special composite tools

There are tools that have been specially developed for machining composite materials and are made of both solid carbide and polycrystalline diamond. These tools are specifically designed to prevent delamination and cracks in the components and they also remove any fraying or burrs caused by the process. They are specifically designed for applications where the geometry is not really there (these tests were mainly reworking existing shapes) and are used to mill pockets, slots and other features from 'solid' parts. So in this case it is very likely that they would work and possibly provide some additional benefits, but they were not part of this test.

Many thanks to Steve Smith and Guhring UK for taking the time to carry out these tests.

	Carbide	PCD
Costs	✓	
Delivery	✓	
Pre-processing	✓	
Finishing		✓
Cycle times		✓
Tool life		✓

Mark3D GmbH

Rodenbacher Street 15
35708 Haiger

Phone 07361 63396-00
E-mail markforged@mark3d.de
Internet www.mark3d.com