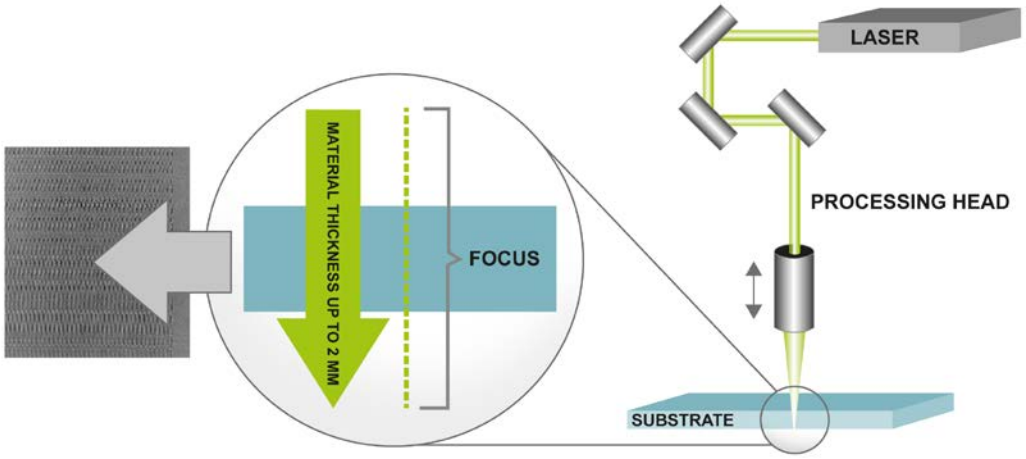
LASER MODIFIES GLASS FOR A CLEAN CUT

By Dr. Dmitrij Walter, Head of development for laser and optical devices, Manz AG

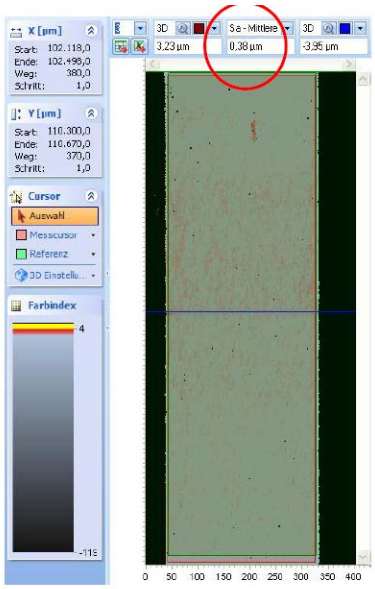
"M-Cut", a newly developed process from Manz, modifies a glass substrate with a laser along a line to divide it into variable geometries – for higher edge quality and break resistance, as well as faster throughput in the production process.

With a diameter of only two micrometers, it is all cut and dried. Proverbially speaking, of course, because the new *M-Cut* laser cutting process uses a hair-thin modification with an ultra-short pulsed picosecond laser – similar to a perforation – to cut super-hard, scratch-resistant glass to a thickness of up to 2 millimeters. The next stage of evolution in laser process technology is suitable for all brittle materials currently processed in the electronics industry. This especially applies to chemically and thermally strengthened glass, and increasingly to sapphire for displays or camera cover glasses, as required in tablets, Smartphones and wearables.



Picture 1: With the M-Cut laser cutting process, the material is "perforated" linearly – with a diameter of just 2 micrometers.

M-Cut stands for *modification cut* and describes the underlying process for a clean cut: the material is modified similarly to a perforation. The moderate energy input makes the process extremely gentle on the processed substrate. This is made possible by a modified beam source different from previous ultra-short pulse lasers. It has specially adapted optics that modify the material along a line (Image 1). The resulting edge cut has a roughness of less than 0.5 micrometers (Image 2). This eliminates the costly polishing of this edge.



Pictrue 2: Edge cut in sapphire with roughness of an impressive 0.38 μm.

M-Cut is therefore a superior alternative to "thermal" laser beam cutting with short-pulse lasers in the microsecond range, in which the glass substrate is melted at the edge cut. The new process also displays better quality than the division of substrates in "cold" ablation. This is also done with an ultra-short pulse laser in the picosecond range, during which the material vaporizes locally. This can lead to slight color distortions in the material, or chipping.

Glass as a high-tech material in the electronics industry

As a material for electronics applications, glass must not only be hard and scratch resistant, but increasingly also flexible or pliable and almost always touch-sensitive – think of touch displays. Innovations in laser processing were a prerequisite for producing such displays cost effectively in high quality and getting the technology to the mass market. Particularly because in the case of mobile end devices, the mechanical requirements for the material are very high.

The displays' substrates are therefore chemically strengthened, but often only after being cut out of a large glass substrate up to 2.2 by 2.5 meters. Mechanical cutting of displays with outer and inner contours or camera cover glasses for Smartphones, for example, were always a challenge after strengthening: Tool wear was enormous, and the cut edges had to be expensively polished. Moreover, the cutting process could cause micro-cracks that affected the glass substrate's break resistance. Therefore the glass was cut first and then strengthened in a chemical bath – a very inefficient process.

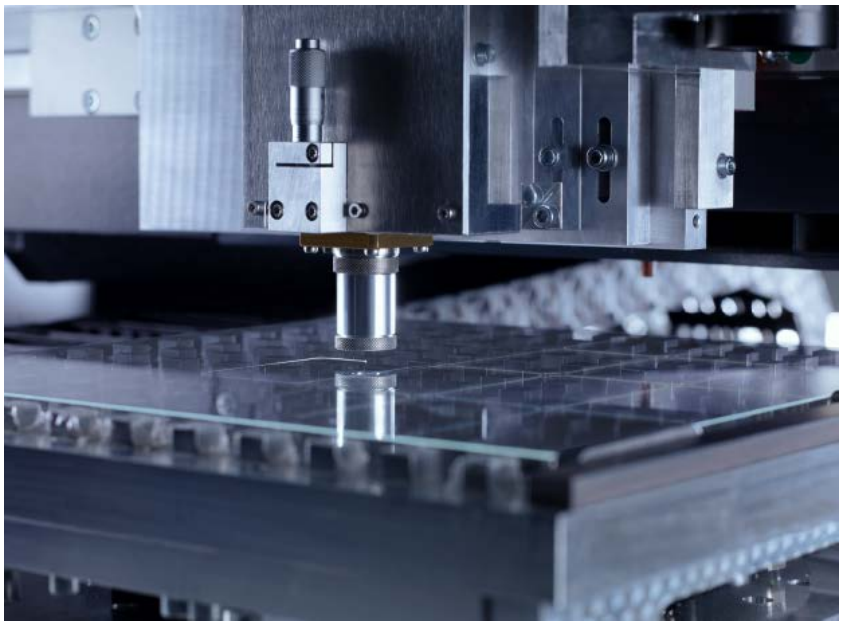
This process was retained even with first-generation laser cutting processes, because even they were not yet suitable for cutting material that was already strengthened. On the other hand, M-Cut makes it possible to harden large glass substrates first and then cut them with

high quality. This makes the material very stable, and it cannot break during cutting. Because chemically strengthened glass has a certain internal stress of its own, perforation is all that is needed for a perfect cut – the individual glass cut-outs can be easily separated after that. With sapphire, which has no such internal stress, display manufacturers need a second step to separate the cut contours from the material.

Picture 3: Cover glasses, lenses and displays: The M-Cut laser cutting process knows no limits when it comes to workpiece geometry.

M-Cut as a flexible laser pocket knife

Many different geometries are possible with the new laser cutting process (Image 3). These even include "cutting around the corner" at a 90-degree angle. The system is based on XY axes and not scanners, which means that no scan field limits the size of the contours to be cut out. Material utilization is very high: only 0.5 millimeter of space between the two geometries to be cut out is sufficient. In the future, even one cut could be enough to cut out an edge of two geometries at the same time. Not only cover glasses for cameras can be cut out with the four-head M-Cut system, but also camera lenses themselves in tiny diameters of one millimeter – even ovals and rectangles. Since no material is removed, no extraction system is needed in production. The diversity of materials to be processed is very wide. Users can flexibly shift their production from one day to another – just by changing the parameters of the laser.



Picture 4: Setting standards for electronics manufacturers: M-Cut laser cutting system from Manz

Overview of the M-Cut laser cutting process:

- Cutting speed of up to 1 meter per second for e.g. 0.5 mm thick glass; very high edge quality with roughness values below 0.5 µm; no polishing needed
- No glass chips, no micro-cracks
- No cutting tool wear
- Up to four times the break resistance for cut-out glass, especially beneficial for users of mobile end devices
- Higher throughput in production
- Greater variety of materials and geometries