

Machining of Piezo Ceramics and PCBs

Intro

Direct Machining Control enabled the customer to use their laser system for etching, drilling and cutting of PCBs and piezo ceramics. Customer tried several CAM software packages, but they either didn't support galvo scanner machining or crashed due to large and complex files with dense hatching. Before contacting Direct Machining Control, user settled to use 4 different software packages to control different parts of the system: galvo scanners, positioning stages, camera, and height sensor.

DMC was installed to replace those four different software packages. Process was simplified from complex multiple steps to a single recipe with minimal operator input. Creation of new processes became easy, visual and user intuitive.

The Challenge

Customer had a laser machining setup designed for internal prototyping and small-scale production purposes. The intention was to etch, drill and cut PCBs and piezo ceramic wafers.

- **Gerber file import. All the parts are designed in Gerber format. Currently, user had to export them to DXF and hatch in CAD software. Then import files to laser marking software.**
- **Combining galvo scanners and positioning stages. Processing requires high resolution and accuracy. However, only using positioning stages is not an option, since dense hatching is used, machining with stages would take several days. So, customer had small field ScanLAB galvo scanners with tele centric lens mounted over Aerotech positioning stages.**
- **Thick wafer drilling / cutting. Wafers are thicker than beam spot waist. At the beginning customer used to focus beam at the bottom and kept scanning with laser marking software at the same height. As alternative laser marking software was used to make a layer, then switching to Aerotech Motion Composer to make Z adjustment and run drilling recipe in marking software again. Both alternatives required unnecessarily long processing times and regular operator input.**



- **Wafer flatness correction.** Large wafers are not completely flat. This means, that laser focus position doesn't change linearly throughout the wafer. This results either in non-repeatable machining process or in an overkill while etching and cutting to make sure wafer is cut all the way through.
- **Double sided machining.** Wafers had to be machined from both sides. Machining trajectories must match existing patterns on both sides within 2 μm .
- **Operators had no experience with CNC or other machining processes.** Thus, programming machining workflows was time-consuming and inconvenient.



Solution

We analyzed the situation with the customer and made several online sessions to work together on the setup to fully understand their needs. The following solutions were implemented with DMC software:

- **Customer is able to import Gerber and NC Drill files, so there are no longer any intermediate steps. A Gerber and NC Drill file support was developed and added to DMC free of charge. Now customer can import the same files that are used for parts creation. Moreover, their coordinates are being preserved when importing, so different layers imported with different files match automatically. For example, holes on PCB are matching etching pattern perfectly. So, there is no need for position adjustment which saves time and helps to avoid errors.**
- **Galvo scanner and positioning stages are combined using Stitching tool in DMC. No need to use additional software for galvo scanners and positioning stages. All motion is divided between galvo scanners and positioning stages automatically (Figure 2).**
- **Etching, drilling and cutting processes are combined in the same recipe to save time and maintain accuracy. Single recipe uses several types of Gerber files and NC drill files. Gerber file is hatched and used for etching and cutting, while NC drill file is used for layer-by-layer drilling. Different laser and speed parameters are set for different parts of the recipe to perform them efficiently. For example, PCB is drilled with two sets of parameters, one for the copper top and bottom and one for polymer middle layer (Figure 2).**
- **User is using coaxial camera positioned by galvo scanners. Camera and laser focus height matches almost perfectly. So, DMC camera Autofocus tool is used to find laser focus position (Figure 3). A special tool was developed to create height maps by measuring focus position on the wafer in various positions. After that, fabrication recipe is automatically transformed to match the height differences on the sample. Alternatively, a Keyence height sensor might be used for better measurement accuracy.**
- **DMC integrated Machine Vision is used for visual alignment to compensate for the wafer displacement before the start of processing and after flipping the wafer for machining of the other side.**
- **The entire design of the recipe and control of the processing is made in a single software window using visual tools and no G-Code programming. This saves great amount of time and nerve for the user.**
- **Keyence height sensor is used to measure and display etching results. Operator can see and log machining results like depth of ablated areas accurately without taking the wafer away.**



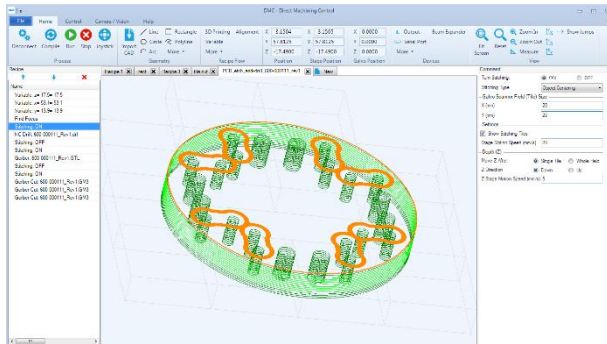


Figure 1. Several Gerber and NC Drill files imported to DMC software and different settings are selected for different processes.

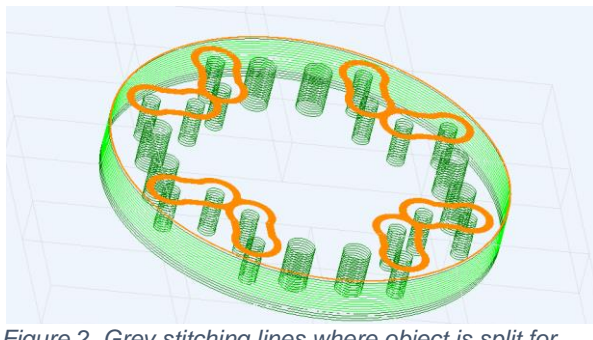


Figure 2. Grey stitching lines where object is split for galvo and stages machining are visible. Different object colors represent different laser and speed parameters.

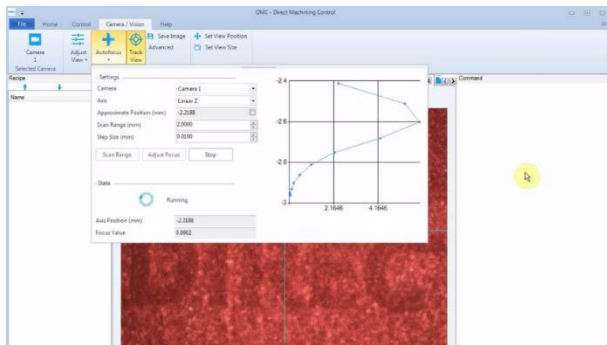


Figure 3. Camera view is used to find camera and laser focus position automatically.

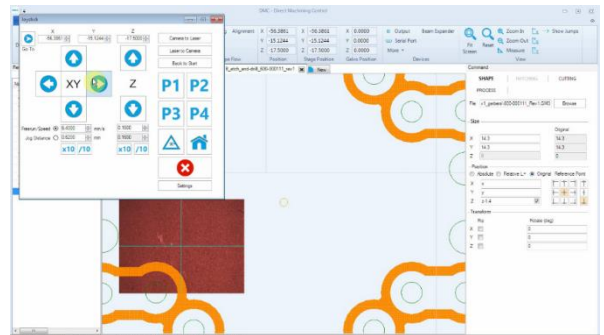


Figure 4. Camera is used for alignment on the PCB.

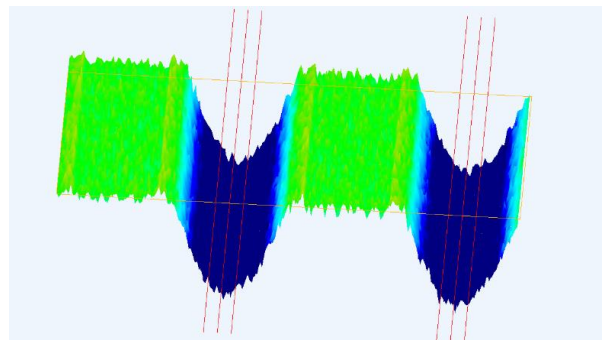


Figure 5. Height map acquired with Keyence sensor and matched with machining trajectories. Customer uses this feature for quality inspection and result logging.

Results

Using DMC laser machining software, customer is finally able to use their setup for intended purposes: etching, drilling and cutting of PCB and piezo ceramics wafers. All processing is achieved by a single recipe. Double sided wafer processing is enabled using automatic visual alignment.

Accuracy, speed and process repeatability is achieved by combining galvo scanners and stages and by measuring and compensating wafer flatness variations.

All of it is done in a single software window in a visual and intuitive way, without any kind of programming.



Your quick path from idea to implementation.

About Direct Machining Control

DMC is a control software for laser machines. It's an all-in-one solution where the user creates or imports CAD objects, sets process parameters and clicks Run. DMC takes care of all the hardware control according to the recipe.

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LASER ADDITIVE MANUFACTURING	PCB LASER PROCESSING	LASER ENGRAVING	LASER DRILLING
DMC software is a great tool to prepare and control laser additive manufacturing / 3D printing processes like Selective Laser Sintering SLS, stereolithography and others.	Gerber and NC Drill files can be imported to DMC laser machining software and prepared for machining. The whole process for both sides of PCB is controlled at single window.	Laser engraving processes can be easily prepared and controlled with DMC laser machining software. Import DXF, STL files or design picture with inbuilt tools.	DMC laser machining software allows easy preparation and control of laser drilling processes. Use NC Drill, DXF files or add holes yourself.

DMC is hardware-independent and looks the same for any combination of the hardware. Visit directmachining.com and fill the form to receive a link to the **FREE TRIAL version of DMC.**

