



PCB And Piezo Ceramic Laser Etching, Drilling and Cutting

Direct Machining Control enabled customer to use their laser machine for PCB and piezo ceramics etching, drilling and cutting processes. 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 change those four different software packages. Process was simplified from complex multiple steps to a single recipe with minimal operator interference. Creation of new processes became easy, visual and user intuitive

Direct Machining Control creates software to control laser machines – DMC.

DMC is used for various laser machining applications including additive laser manufacturing, PCB laser processing, laser engraving, drilling and others.

DMC provides a simple and user intuitive way to prepare and control complex laser machining processes.





The Challenge

Customer had a laser system assembled for internal prototyping and small scale production purposes. Intention of the system was to etch, drill and cut PCB and piezo ceramic wafers.

The challenges that customer faced:

1. 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.
2. Combining galvo scanners and positioning stages. Process requires high resolution and accuracy. However, using positioning stages only 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 telecentric lens mounted over Aerotech positioning stages.
3. 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 were consuming unnecessary large amounts of time and required regular operator interference.
4. Wafer flatness correction. Large wafers are not completely flat. This means, that laser focus position changes not linearly through the wafer. This results in either unrepeatability or an overkill in etching and cutting to make sure wafer is cut through.
5. Double side machining. Wafers had to be machined from both sides. Machining trajectories must match existing patterns on both sides within 2 μm .
6. Operators at customer side had no experience with CNC or other machining processes. So using machining code was time-consuming and inconvenient.

Solution

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

1. 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 part creation. Moreover, their coordinates are being preserved when importing, so different layers imported with different files match automatically. E.g. holes on PCB are matching etching pattern perfectly. So there is no need for position adjustment which saves time and helps to avoid errors.

2. Galvo scanner and positioning stages are combined using Stitching tool in DMC. No need to use separate software for galvo scanners and positioning stages. All motions are divided between galvo scanners and positioning stages automatically (Figure 2).

3. Etching, drilling and cutting processes are combined in the same recipe to save time and keep accuracy. Single recipe uses several types of Gerber files and NC drill files. Gerber file is

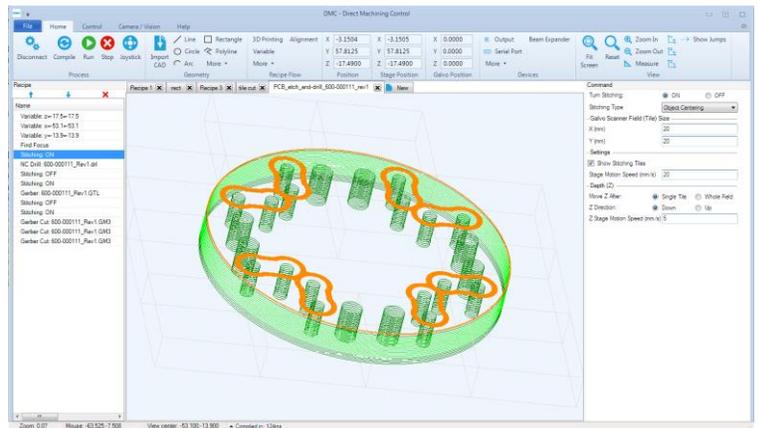


Figure 1. Several Gerber and NC Drill files imported to DMC software and different settings are selected for different processes.

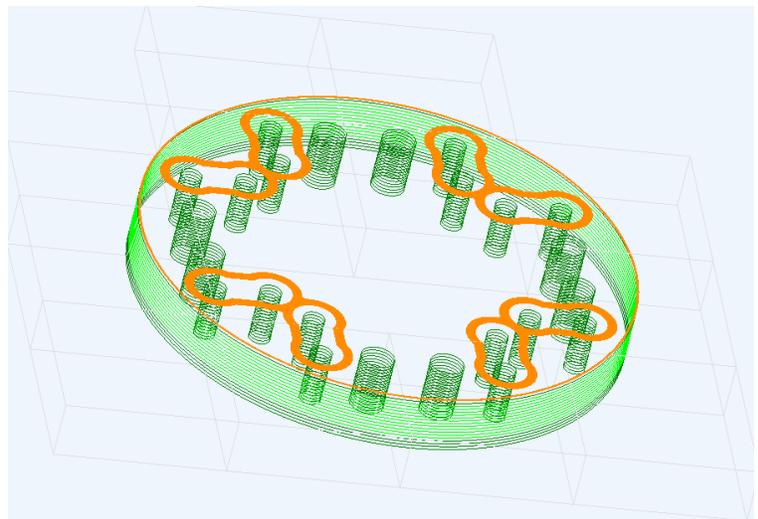


Figure 2. Grey stitching lines where object is split for galvo and stages machining are visible. Different object colors represent different laser and speed parameters.

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. I.e. PCB is drilled with two sets of parameters, one for the copper top and bottom and one for polymer middle layer (Figure 2).

4. User is using coaxial camera through 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.

5. DMC integrated Machine Vision is used for visual alignment to compensate wafer displacement before process start and after flipping the wafer for back side machining.

6. All the designing of the recipe and control of the process is made in a single software window using visual tools and no G-Code programming.

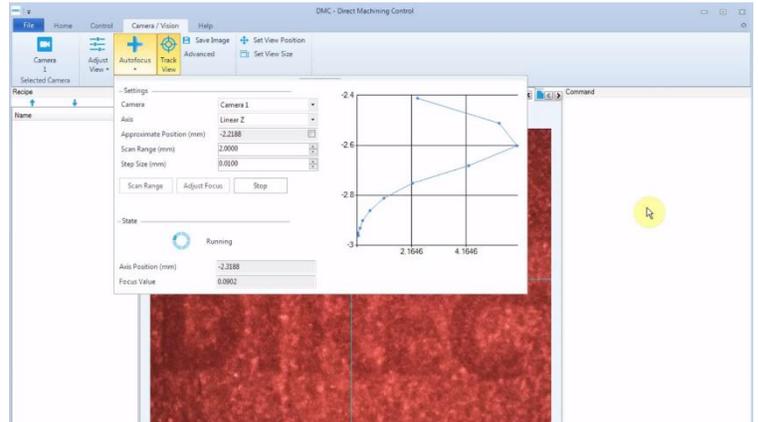


Figure 3. Camera view is used to find camera and laser focus position automatically.

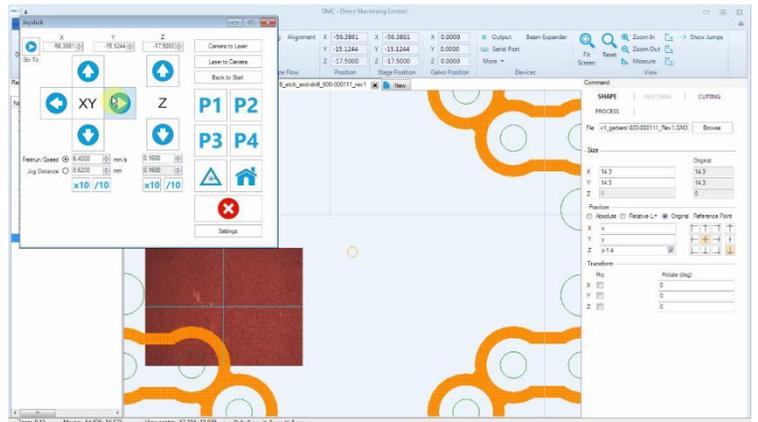


Figure 2. Camera is used for alignment on the PCB.

This saves great amount of time and nerve for the user.

7. In addition to that, Keyence height sensor is used to measure and display etching results. So operator can see and log machining results like depth of ablated areas accurately without taking wafer away.

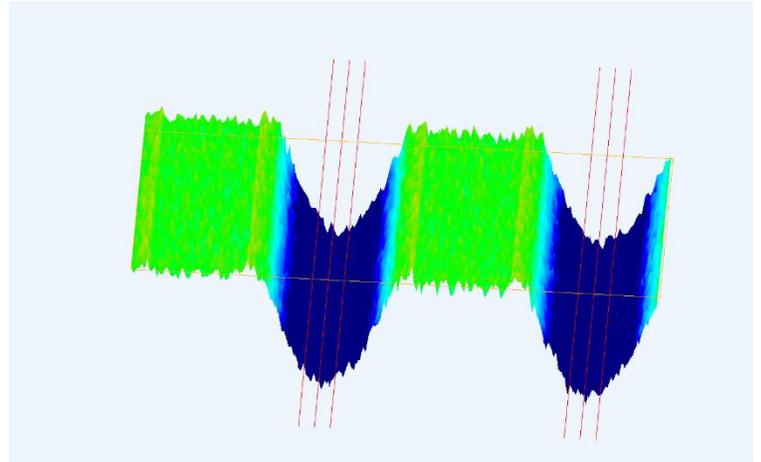


Figure 4. Height map acquired with Keyence sensor and matched with machining trajectories. Customer uses this feature for quality inspection and result logging.

Results

Using DMC laser machining software, customer is finally able to use machine for intended purposes: etching, drilling and cutting of PCB and piezo ceramics wafers. All processes are integrated to a single recipe. Double side 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.