THE PHOTO-MACHINING PROCESS

A New Technology for Machining Ceramics and Other Advanced Materials

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INDUSTRIAL SOLUTIONS

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WELCOME TO INDUSTRIAL SOLUTIONS PHOTO-MACHINING

Our Photo-Machining Process (PMP) uses abrasive etching to selectively remove a variety of brittle materials and coatings.

Below is a partial listing of the materials and coatings that are photo-machinable:

- Alumina
- Alumina Silicate
- Aluminum Nitride
- Anodized Aluminum
- Boron Carbide
- Boron Nitride
- Carbon Fiber
- Ceramic Composites
- Ferrite
- Glass
- Graphite
- Mullite
- Quartz
- Steatite
- Titanium Nitride
- Variety of Plated/Painted Materials
- Zirconia
- Silicon Nitride
- Silicon Carbide

Applications [See Figure 1]

Detailed Etching: Photo-Machining can be used to create detailed patterns and markings with a resolution up to 0.002" (50 µm).

Deep Etching: Photo-Machining can be used for both deep etch and the removal of large amounts of material.

Hole Drilling: Photo-Machining is well-suited for creating thru-holes and patterns in thin materials. Blind holes are also possible. Fragile workpieces will not experience the potential for chips or breakage associated with other machining methods.

Large Area Removal: Photo-Machining provides the ability to quickly remove significant material on a large workpiece. Work area or workpiece size limitations inherent to CNC and ultrasonic machining are not an issue with Photo-Machining.

Marking/Part Identification: Difficult to mark workpieces can be individually and indelibly identified using Photo-Machining.

Surface Texturing / Finishing: Photo-Machining can be used to abrade most surfaces to create unique surface patterns, prepare the surface for a future coating process and/or produce a variety of surface finishes.

Coating Removal: Photo-Machining offers the ability to selectively remove most coatings generating detailed and complex patterns as required.

THE PHOTO-MACHINING PROCESS (PMP) REPLACES:

Ultrasonic Machining

Ultrasonic Machining/Milling has inherent limitations in pattern size and symmetry. There is also a continued cost in tool design and wear replacement. Ultrasonic Machining/Milling is inherently more difficult to engrave contoured and interior surfaces.

Rotary Tooling/Milling - (Handheld and CNC)

On brittle materials, there is also the potential for uncontrolled chipping or the need for burr removal. Replacement costs for tooling can be expensive.

Laser

Material removal rate can be slow for large areas. It is more difficult to engrave contoured surfaces and there is the potential for laser/raster marks.

Grinding

It is difficult to isolate area of material removal and therefore patterning of surfaces is limited. It is more difficult to grind contoured and interior surfaces and there is the potential for uncontrolled chipping. Typically, this is a slow process.

AN EXPLANATION OF THE PHOTO-MACHINING PROCESS

Our Photoresist technology coupled with abrasive etching is the basis for our Photo-Machining Process (PMP). This process is used to selectively remove material from a variety of hard and brittle surfaces. [See Figure 1]

Because PMP is a photographic process, precision tolerances down to 50 microns (0.002") are easily reproduced. Layered or coated substrate surfaces can be modified, patterned or channeled to achieve the desired end product. A variety of surface finishes are possible. Typical depth uniformities possible are within 50 microns (0.002") across a 30 cm length.

PMP can remove material at a rate much faster than many conventional machining methods, such as milling, ultrasonic machining, etc., and is best suited for symmetrical flat or cylindrical substrates.

FIGURE 1: Detailed Etching, Deep Etching, Hole Drilling, Large Area Removal, Marking/Part Identification, Surface Texturing/Finishing, and Coating Removal


Detailed Etching


Deep Etching


Hole Drilling


Large Area Removal

BENEFITS OF THE PHOTO-MACHINING PROCESS

Brittle materials such as ceramic, glass and certain metal type substrates are notoriously difficult to machine because of their high level of hardness and propensity to chip or crack. Additionally, machining these materials can cause rapid cutting tool wear. The PMP provides several advantages over conventional machining methods when modifying hard/brittle surfaces or when selectively removing coatings from these surfaces.

The major benefits of PMP are:

- Increase pattern design capabilities
- Broader range of material engineering
- Lower process costs
- Quick turn around

More specifics around these benefits include:

- Many substrate surfaces can be modified in seconds, rather than minutes, with very high precision and reproducibility.
- Registration of pattern to be removed is accurate and precise.
- Greater pattern design flexibility allows for many designs which may otherwise be compromised due to machining limitations.
- No need for expensive cutting tools (i.e. carbide, diamond tips). Abrasive media wears slowly compared to cutting tools. Mechanical machining requires cutting tools to be harder than the workpiece.
- Greater substrate stability with less tendency to warp, crack, or break.
- Surface finish can be tailored to end user needs by selecting the right abrasive media size.
- Hole pattern arrays can be etched with PMP as long as substrates are thin (wafer materials) and where slightly tapered edges are acceptable. [See Figure 1]
- Corners or right angles of connecting pattern lines are sharper versus cutting tools.

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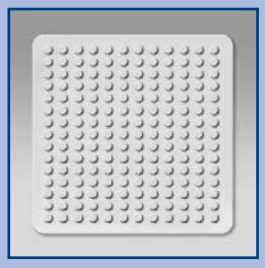
for an online demonstration

COMPARATIVE ANALYSIS
PMP VS. CNC MACHINING, ULTRASONIC MILLING AND OTHER MACHINING METHODS

PATTERN ETCHING

Pattern: Channel
Material: 96% Alumina
Substrate Size: 3.5" x 3.5"
Width of the Channel: 0.070"
Length: 39"
Depth of Etch: 0.020"
Compared Machining Method: CNC



LARGE AREA REMOVAL

These are etched, raised (~25 mil) pads in 96% alumina. The 4.5" square took about 15 minutes to etch. The entire PMP process took about 30 minutes from photoresist application through etching. Multiple parts could have been processed at the same time for greater productivity. The time to CNC mill this pattern is 60-80 minutes.

Parts as large as 2' by 5' have been routinely etched using a standard etching cabinet.

Larger workpieces can be photo-machined using alternative etching equipment.

CYLINDRICAL WORKPIECE

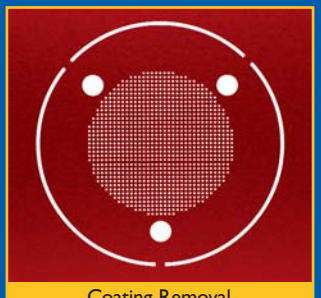
PMP provides the ability to quickly machine contoured shapes such as cylinders. The dot pattern shown was etched into the coated Boron Nitride in less than 5 minutes.

THRU-HOLE DRILLING

PMP allows 0.012" diameter thru-holes to be simultaneously etched into a thin silicone wafer in about 15 minutes.


Marking/Part Identification


Surface Texturing/Finishing


Coating Removal

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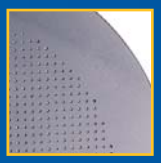

IKONICS has served as an international leader in the development of imaging technologies for over 50 years. IKONICS proudly introduces products and process solutions for a diverse array of imaging markets.

At the core of IKONICS' success is the ability to quickly adapt its fundamental, commercial and technological competencies to the needs of image consumers everywhere.

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