

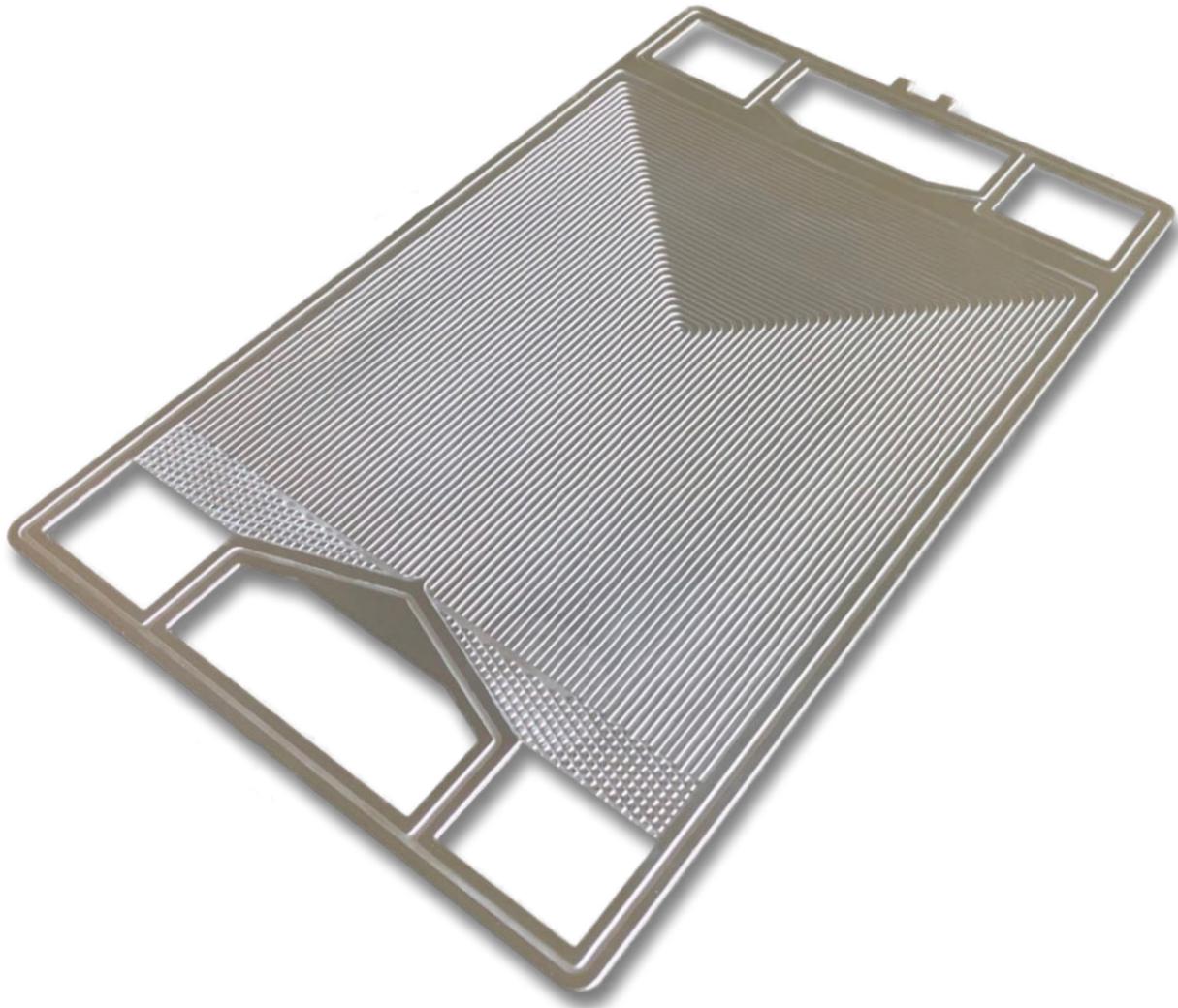


## Let's etch a more sustainable future.

### Photochemically Etched Fuel Cell and Electrolyzer Bipolar Plates

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Elcon offers aluminum, stainless steel, or titanium bipolar flow field plates with complex and precise liquid and gas flow channels. Our photochemical etching process allows designers complete flexibility for creating different groove and crossover channel patterns on either side of the plate. Channels can have near vertical walls and flat bottoms with feature sizes determined only by material thickness. The process is stress free and results in a smooth and flat surface ideal for stacking and sealing. To optimize manufacturability, we can also CNC machine and laser cut other features where required. The geometric complexity and close tolerances offered by photochemical etching not only make it a desirable manufacturing process, but in some instances, the only technology suitable for fine featured designs.



# Benefits

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## Product

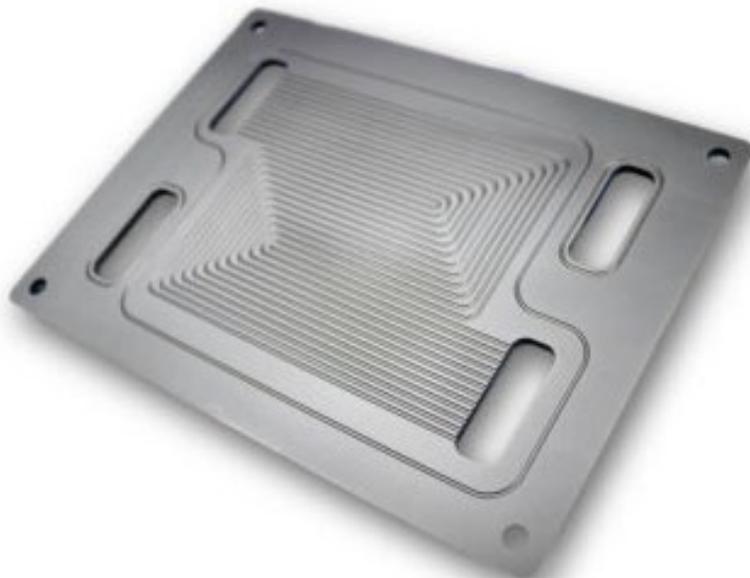
- Burr and stress-free surfaces that are flat, consistent and do not compromise stack bonding
- Unlike other processes, photochemical etching does not create mechanical or thermal stress that may affect metallurgical properties
- Multiple channel levels and patterns can be etched on the plate, including headers, collectors, and port features

## Manufacturing

- Dimensional repeatability
- Channel accuracy to  $\pm 0.020$  mm
- Plate materials include aluminum, stainless steel and titanium
- Volumes from rapid prototyping to full production

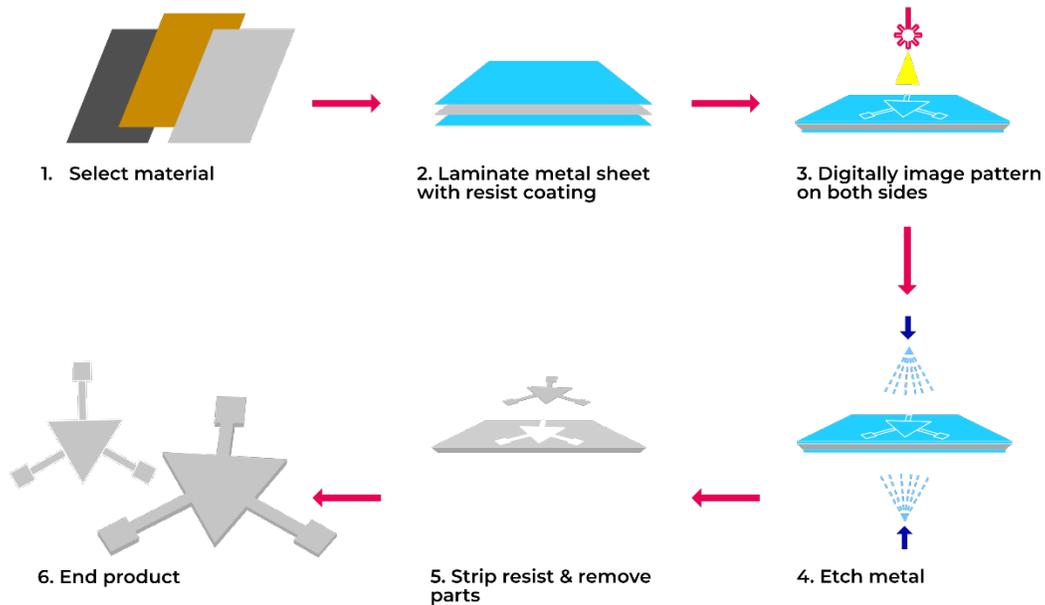
## Cost Efficiency

- Low-cost digital tooling can be changed quickly and inexpensively to optimize designs
- Increased design flexibility and complexity with no incremental cost



# General Photochemical Etching Process

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## Photochemical Etching versus Other Fabrication Processes

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There are several benefits to manufacturing fuel cell plates using photochemical etching compared to other fabrication methods.

The photo etching process removes metal from both sides of the plates simultaneously, so complex channels of different designs can be etched at the same time. Unlike stamping, hydroforming or laser cutting, chemical etching imparts no mechanical or thermal stress on the plates, both of which can compromise stack bonding and fluid flow. Furthermore, digital pattern tooling, which is low-cost and quick to produce, can be adapted easily and inexpensively to optimize designs. There is no incremental cost with increased design complexity or features.

	Photochemical Etching	Punching/Stamping/ Hydroforming	Laser	CNC Machining
Volume	High	High	Low	Low
Tolerances	High	Low	High	High
Tooling cost	Low	High	Low	Low
Stress	No stress	Stress at edges	Thermal stress	No stress
Burrs	No burrs	Partial burrs	Micro burrs	No burrs
Drawbacks	Limited to 1mm thickness unless combined with CNC machining	Long lead times & costs for producing tooling	Can only make one part or feature at a time; slag on edges	Inefficient with very thin materials

## Combine multiple services

Depending on your requirements, our engineers will work with you to determine what processes are suitable for your application. To reduce cost and production time as well as meet design specifications, certain features such as channels can be photochemically etched, while others can be CNC machined. If plates need to be stacked together, we offer brazing and bonding services.

We will work with you to find the best solution.

