

Bounce-back grant funds new laser erosion cutting service



Andrew May, director of ES Precision, describes the firm's recent investment in new laser technology to unlock exciting application sectors



ES Precision is an Oxford-based company providing laser processing services to technology companies in the UK and Ireland. The business is privately-owned by myself, a physicist, and Tim Millard, an engineer, each with decades of laser industry experience.

Our niche is galvo laser processing with five different types of laser. Galvo laser processing uses a pair of extremely rapid mirrors to deflect in the x and y directions and uses a flatfield lens to create a processing area in the range of 80 to 300mm², depending on focal length chosen.

The range of lasers we use enables us to mark or engrave most parts, and cut or drill most thin materials. We use CO₂ lasers to mark and cut plastics (for example 'Traffolyte' laminate for rigid signage), wood, leather, fabrics and laminated reel-to-reel tamper-evident label materials (Tesa laser labels). Our frequency-tripled vanadate laser provides extremely high beam quality in the UV wavelength (355nm), which can produce high quality dark marks on some plastics that 1µm wavelength lasers cannot. At 1µm output we use YAG, vanadate and fibre lasers to mark metals and most plastics.

Our 20W fibre laser can also be used to cut and drill metallic foils and very thin (around 0.2mm) sheet metal.

Spotting an opportunity

In recent years we have seen increasing opportunities to provide a service to cut fine structures in thicker metals (0.2 to 2mm) for motorsport, electronics, aerospace, medical device and instrumentation manufacturing. Examples include: profiling fine serpentine structures for flexible heater elements (such as those in car seats) and motor laminations in electrical steel for new motor and generator designs; cutting molybdenum x-ray targets; drilling and cutting components of fuel cells, batteries and bioanalysis equipment, where platinum and exotic metals are used as catalysts for chemical reactions.

Compared to the 20W fibre laser we currently use, a 100W fibre laser would be able to cut faster and process more than five times the metal thickness, owing to the nonlinear nature of laser ablation. Using a process known as erosion cutting, such a laser can make multiple passes (sometimes hundreds) at very high speeds. The same pattern is traced out with each pass, ablating several microns of material with each pass, until a complete cut is made. Unlike traditional fusion laser

cutting, material is cleanly ablated away, rather than being melted and then blown out of the kerf by high pressure gas. For very thin materials and tiny fragile profile shapes to be cut, supporting the metal foil on a bed of nails and high flow gas injection is often not a good solution. An investment case to offer a unique service in the UK using medium power fibre laser erosion cutting therefore looked interesting to us.

Overcoming investment challenges

Our company is a micro SME (fewer than 10 employees; less than €2m turnover) and during the four years since its foundation, all funding has been provided by the directors or from the reinvestment of profits. After year one we invested in the UV laser and after year two a machining centre was purchased. Year three concluded in the middle of the pandemic, which squeezed profits owing to many sectors contracting. This was frustrating as we wanted to develop the erosion cutting plan.

Retention of control of the business and a cautious approach to growth are important to us, but rather than delay the plan for growth we decided to see if government 'bounce back' funding could be secured. Oxfordshire Local Enterprise Partnership (OxLEP) offers funding via the UK Government's £900m 'Getting Building Fund', which aims to deliver jobs, skills

and infrastructure across the country in areas facing the biggest economic challenges as a result of the pandemic. Despite never having applied for any grant in 25 years as company directors, we felt that the capital investment project was such a close match to OxLEP's Business Investment Fund aims, that we should apply.

The online application process was straightforward, since the fit between several of ES Precision's target markets (such as fuel cells and photovoltaics) matched some of the fund's zero carbon objectives. Other expected applications in the biotech, instrumentation and lab-on-a-chip applications naturally fell in with the Covid zeitgeist.

Concern that the application process might become too time-consuming was not justified, not least because it was structured as a two-step process, so that only after the expression of interest passed to the shortlist was it necessary to commit to a lengthier submission. Overall, it took just 12 weeks from deciding to apply to learning of the grant being secured.

The investment

We chose to invest in Coherent's Powerline F series 100W fibre laser marker as its software is compatible with our other four Rofin laser markers and its CAN-bus control architecture allows us to configure it to control other motion systems such as xy



Keyence's Image Dimension Measuring System for QA on cut profiles

tables (to extend the cutting field by step-and-repeat motion) and rotary indexers (for cutting of cylindrical parts). It was important to us that we chose a supplier with a strong UK-based service department.

The investment also included purchase of an optical measuring system. Our customers are frequently at start-up or early growth phases – when outsourcing to specialist manufacturers is necessary and the benefits of a flexible service that can be economical at even low volume are clear. A typical customer will submit CAD drawings of the outline of the intricate part to be cut or the layout of perforations to be drilled, and this can be downloaded to the laser controller software directly. To close the loop for QA purposes, it is critical that ES Precision can provide a certificate of dimensional conformity for the components shipped. To this end, we selected Keyence's IM 8000 Image Dimension Measuring System. It is capable of providing a dimensioned image of the cut profile and, for serial production, a pass/fail QA test for each item according to whichever critical dimensions and tolerances we choose to set.

Launching a service to support the hydrogen economy

One particularly exciting sector currently, and looking forward, is a key part of the clean energy drive to reduce emissions and fight climate change. In August the UK Government announced its £240m Net Zero Hydrogen

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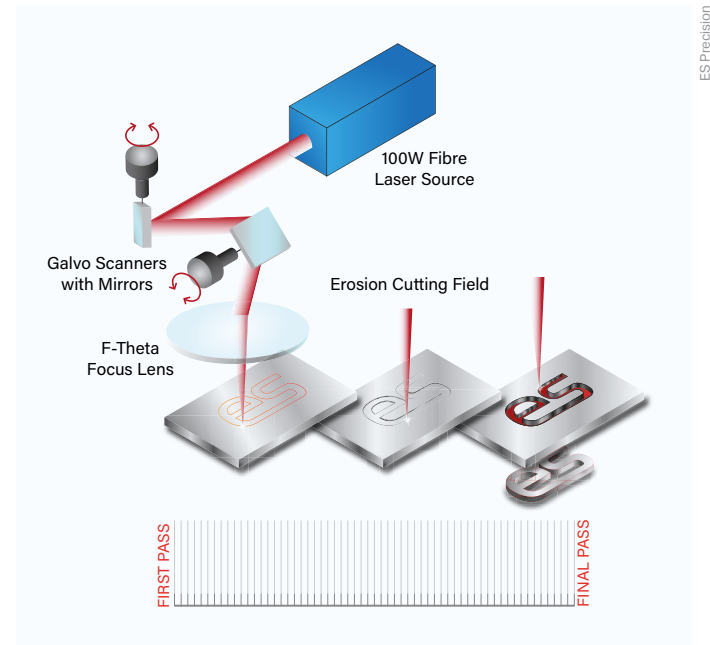
Fund, targeting 5MW of low carbon hydrogen production capacity by 2030. This is the equivalent of the natural gas used by three million homes. Hydrogen is therefore moving up the political agenda, and should continue to do so when the UK hosts the international climate change conference COP26 in Glasgow in November.

Fuel cells facilitate the 'hydrogen economy' and may be a vital component of a sustainable future, providing electrical power for electronics, transport and energy storage. Jules Verne, in a remarkably prescient vision, wrote that 'Water will be the coal of the future' in 1874 (see below). The modern version of the crude burning of the hydrogen he envisioned is the 'cold combustion' of hydrogen and oxygen within a fuel cell to create electricity and the waste product – water.

The hydrogen required can be created by electrolysis of water using surplus green electricity from windy or sunny days, and represents an effective store of electricity that current battery technology cannot compete with, in terms of efficiency and sustainability

VERNE'S VISION OF THE FUTURE

In his 1874 book *L'Île Mystérieuse (The Mysterious Island)* Jules Verne stated: 'water will one day be employed as a fuel, that hydrogen and oxygen that constitute it, used singly or together, will furnish an inexhaustible source of heat and light, of an intensity of which coal is not capable. Someday the coal rooms of steamers and the tenders of locomotives will, instead of coal, be stored with these two condensed gases, which will burn in the furnaces with enormous caloric power... I believe, that when the deposits of coal are exhausted, we shall heat and warm ourselves with water... water will be the coal of the future.'



Laser erosion process for thin metals

(all battery technologies are environmentally expensive).

There are several viable designs of fuel cells commercially available and in development. For low-medium output and low temperature operation, which suits personal electronics and transport, it is the PEM fuel cell which seems most promising. PEM stands for either 'proton exchange membrane' or 'polymer electrolyte membrane' and a single cell comprises the membrane (around 20µm-thick polymer, which transmits protons but not electrons), platinum catalysts on each side (to facilitate the H₂ molecule splitting into protons and electrons on one side and recombination with oxygen into water on the other) and gas diffusion layers on each side (to transport appropriate gases in and out). Each of these thin 'membrane electrode assemblies' generates of the order of 1V; multiple units are assembled into stacks to generate more useful voltages. Each assembly is separated by a bipolar plate and a gasket.

This is where our new investments come into use. It is these metal plates and rubber gaskets that can be erosion cut by fibre and CO₂ lasers respectively, the new 100W

laser being able to cut metal plates thicker than 0.2mm and at a rate which makes medium volumes still economical. Short production runs, prototyping and ramp-up also become viable since the laser system is digitally controlled so there is no need to manufacture conventional cutting tools.

The service ES Precision will provide is attractive for its quality and flexibility, both at development and production stages. QA reports from the optical measuring system provide buyers with the certainty that dimensional tolerances demanded have been met. Lasers can also be used to weld the whole assembly so that leaks cannot occur and also to mark unique tracking data on the assembly.

We're excited to launch this service with the help of OxLEP and the Getting Building Fund. The Keyence system has arrived and is proving invaluable already. Arrival of the laser in November will trigger a phase of R&D to optimise the process of erosion cutting for a range of materials, and we look forward to working with companies at the forefront of medical device, electronics, instrumentation and, especially, green electricity – from batteries and motors to photovoltaics and fuel cells. ●