# Combining fire and water

Swiss company Synova is commercializing an innovative materials processing technique that uses a water-guided laser beam to allow 'cold laser cutting'. **Nadya Anscombe** talks to the company's chief technical advisor, Alexandre Pauchard, to find out more.

### What makes your company's laser MicroJet technology unique?

The technique combines the advantages of water and laser cutting for the first time in one operation. In the machine tool industry, water has been used for many years to cool a workpiece and remove waste. It has also been used as high-power jets for cutting. In our technology, the water does not cut, but instead a narrow jet simply guides the laser beam to the workpiece, cools the workpiece and removes waste. The water jet acts like an optical fibre, completely surrounding the laser beam and guiding it by internal reflection. This prevents the divergence of the laser beam and means the cutting head can be up to 10 cm away from the workpiece, giving the system great flexibility. The water jet is very thin — between 30 and 150 μm in diameter — and this allows precision cutting of sensitive material with negligible thermal influence.

### What advantages does it have over conventional laser materials processing technology?

A conventional focused laser beam has a limited working distance of just a few millimetres, owing to beam divergence. In addition, the conventional laser generates a heat-affected zone in the material, causing damage. Contamination can also be an issue, as the molten material can be redeposited on the surface. Unlike conventional laser cutting where thermal damage is a problem, our cut is cooled by the water jet between laser pulses, producing what is effectively 'cold laser cutting'. This method significantly reduces deformation and heat damage, allowing the material to retain its original structure. With our system, complex three-dimensional cutting is also possible because of the long working distance and fibre-like delivery of the laser beam. It can be used effectively with complex profiles and contours where normal access would be impeded or impossible.


**Synova's Alexandre Pauchard:** "With our system, complex three-dimensional cutting is possible because of the long working distance and fibre-like delivery of the laser beam."

### What are the main markets for your technology?

Our technology has a diverse range of applications. For example, in the photovoltaics industry our systems are used for omnidirectional cutting, drilling, scribing, grooving, edge grinding and marking. The semiconductor industry uses our systems for applications including wafer dicing, via-hole drilling, isolating and edge grinding of thin wafers. It can also be used in the medical industry for making stents, in the watch industry for fine cutting and in the automotive industry for the production of fuel injection nozzles. There has definitely been a slowdown in capital expenditure in most industries, but our sales into the automotive industry have not been as badly affected as other materials processing technologies. This is because fuel injection nozzles need to be changed regularly on all cars, so there is still a demand for making them. Our systems can make the nozzles much faster than conventional electro-discharge machining, so even in tough times it makes economic sense to invest in new equipment. And in the semiconductor industry our systems are replacing the well-established diamond saw technology because ours can cut any shape — hexagon or circle — so our system has a clear advantage.

### What laser technology do your systems use?

The wavelength of the laser we use is limited by the absorption characteristics of water. Water has a minimum in its absorption coefficient at 530 nm. By a happy coincidence this wavelength corresponds to that of frequency-doubled YAG lasers. At a working distance of 2.5 cm, water has a 0.1% absorption in the green area of the spectrum, so this region is ideal. For some applications we use the standard YAG wavelength of 1,064 nm, where absorption by water is about 40%, and this is still acceptable for most applications. The maximum average power we use at the moment is about 200 W. We would ideally want up to 500 W power from a green laser, but this just does not exist at the moment. We are investigating the use of disk lasers, which would increase the available power at the required pulse width and allow even faster processing. We have also started using shorter pulsed lasers (10-ns duration), but because the water cools the workpiece, there is no need to go shorter than this.

### How about future development of the technology?

As well as using different laser sources, we are also looking at using different liquids, instead of water, to guide the laser beam. This allows a process we call laser chemical processing. Together with the Fraunhofer Institute for Solar Energy Systems in Freiburg, Germany, we are developing a technique for the selective doping of silicon solar cells. Using phosphoric acid instead of water, our system is able to perform local diffusion at high speed and accuracy without the need for masks or any high-temperature processes such as annealing. The laser melts the surface of the silicon; the phosphoric acid mixes with this molten material; and the doped silicon then recrystallizes. Research has shown that this process can produce high-efficiency silicon solar cells with up to 20.4% efficiency. Its industrial implementation is expected to greatly reduce the cost of manufacturing selective-emitter solar cells. This technology is now close to maturity and we hope to introduce it to the market by the end of the year.

INTERVIEW BY NADYA ANSCOMBE

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