

## LASER ABLATION

# DOWN TO THE WIRE – LASER ABLATION OF MEDICAL MICRO WIRES

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In early 2020, Fort Wayne Metals, Indiana, challenged Blueacre Technology to develop a solution for micro wire stripping that would meet the needs of its customers. Despite the turmoil and restrictions of lockdown, Blueacre Technology engineers designed and built a bespoke laser system to meet these most exacting requirements.

## The Challenge

Fort Wayne Metals produces wires made out of a range of materials, including stainless steel, nitinol, titanium and high performance alloys. For many applications these wires need to be coated. The coating is an important part of the wire's functionality, and the coating material reflects the functionality required, whether it be for conductivity or insulation, chemical separation or lubricity. There might be one layer, or there might be several, and the thickness of each layer can vary from 200 nm to 1 µm. Coatings include metals such as platinum, silver or gold and fluoropolymers such as ETFE, PFA, FEP and PTFE.

The wires need the functionality provided by their coatings for specialised medical applications such as guidewires, implants and nerve or brain stimulation devices. Once coated, for some applications the coating then needs to be stripped at various points along the wire. The wire must remain clean and undamaged, and the locations where the coating is stripped needs to be ultra-precise. This is a challenge, particularly for ultra-fine wires such as those used for applications inside the human brain.

Where there are several layers it may be necessary to remove one layer, such as an insulation layer, while leaving another underlying layer of coating intact.

Adding to the complexity of the task, the wires being stripped are extremely fine, as small as 0.3 mm in diameter. To give an idea of how small these types of wires can get Figure 1 compares a micro wire with coating to a standard coated electrical wire and ball point pen.

## Why use laser processing?

A typical wire stripping exercise – akin to stripping the ends of electrical cables in the home – uses mechanical methods, which are ultimately a more sophisticated version of our trusty home wire strippers. This will work for standard gauge wire. For larger gauge wires a small scratch or nick is insubstantial

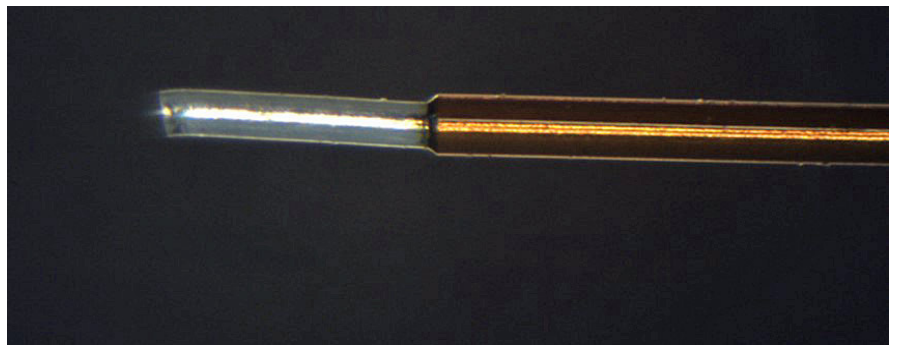


Figure 1: Silver coated copper wire with kapton insulator

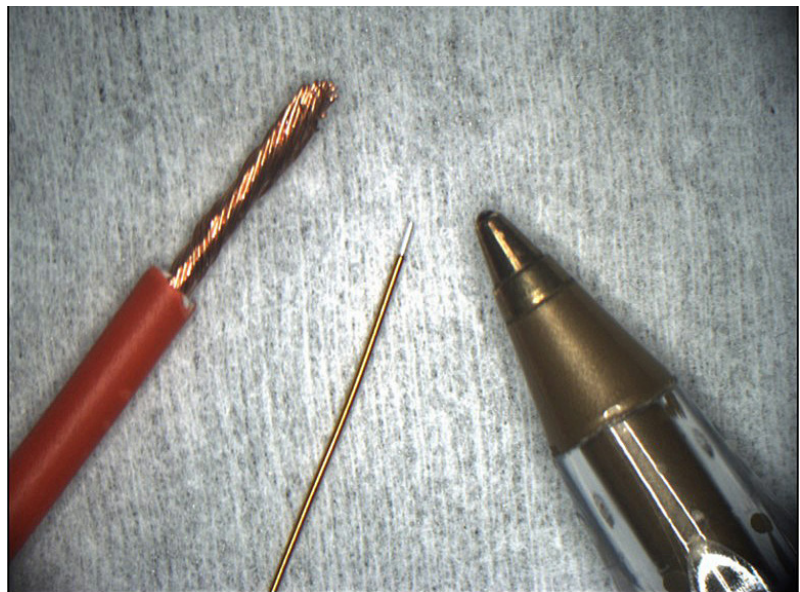


Figure 2: Micro wire compared with a standard electrical wire

compared to the size of the overall part and will not pose significant quality issues.

However, as the diameter of the wire gets smaller and the coating layers get thinner – as with Fort Wayne Metal's advanced wire products – there is substantial risk to wire damage from a purely mechanical stripping process. In an industry where precision and accuracy are literally life-and-death matters, a potentially damaged or broken wire presents an unacceptable level of risk.

The next step up from wire strippers is mechanical grinding using diamond discs or chemical etching, but these methods also risk damaging the underlying material. The key to avoiding damage is a non-contact process, and

this is where laser technology comes in.

As well as the non-contact nature of the process, laser processing also grants the ability to accurately control the laser energy, enabling tailored stripping with high levels of precision and accuracy.

## A flexible solution

As mentioned above, the wires and coatings manufactured by Fort Wayne Metals come in an infinite variety of materials, diameters and lengths. The solution needed to be able to handle the following variables:

- Varying wire diameters, from 0.3 mm to 1 mm.
- A variety of materials: the system needed to work with wires made from stainless steel,

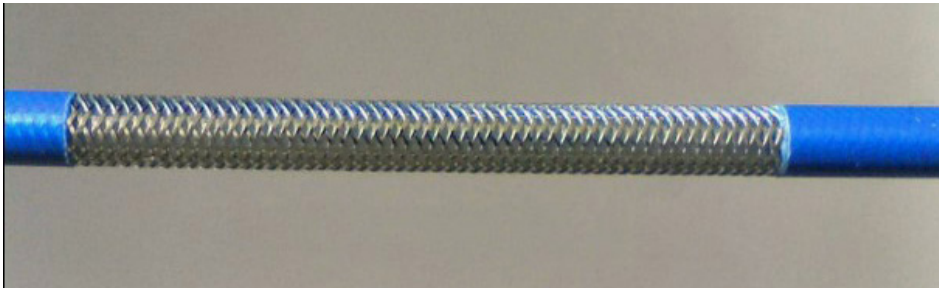


Figure 3 : High quality laser stripping with zero damage to either the PTFE or metal wire.

patterns, depth and lengths of the cut, enabling highly tailored removal.

**Successful trials**

Once the system was built, it was verified and validated for ISO 9000 and ISO 13485 (medical devices) by processing a batch of wires which were tested by Fort Wayne Metals to ensure they met their strict quality requirements. Feedback and fine-tuning enabled further enhancements and improvements.

**Summary**

Blueacre Technology had previously been asked to handle laser ablation, or stripping of wires, but the project described in this article was of a whole new level of magnitude. Choice and deployment of the right laser type was only the beginning for this type of challenge. Factors of equal importance were:

- How the materials were handled.
- How to create a process that was tailored and flexible but also locked down from a quality perspective.
- How to achieve predictability and uniformity in medical devices.

The best laser technology is only as good as the process and system in which it is deployed.

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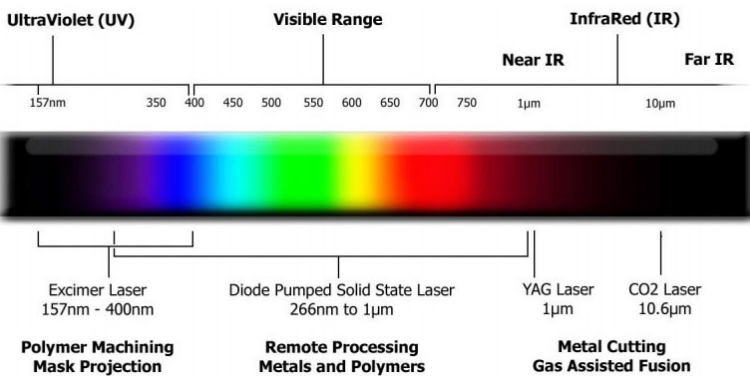


Figure 4 : Laser processing spectrum

high performance alloys, nitinol, titanium and even precious metals.

- A range of coatings: the coatings for the wires are different colours and contain different blends of polymers. Each of these will react differently to the laser beam, and so expert knowledge is needed to manage the laser process.
- Differing patterns of coating removal: some wires needed coatings removed at the ends, some at regular or irregular intervals along the length of the wire.

These variables meant that no one type of laser would work in all situations. Blueacre Technology built a proprietary laser system with multiple “plug and play” laser modules, all managed from a central control centre that is programmed to meet the parameters needed. In-line machine vision systems accurately align the laser beam to the wire. Movement of the wire is controlled by high end linear tables, capable of sub-micron accuracy.

**A cost-effective solution**

While this is a high precision and technically demanding requirement, the devices the wires are deployed in are usually single-use, disposable devices, so the solution needed to be high throughput, and low cost but with zero compromise on quality. This also impacted on the choice of laser source: neither the most expensive femto laser, nor the cheapest CO<sub>2</sub> laser would fit the bill – the choice of laser had to

hit the “sweet spot” of price and functionality.

To handle high throughput, Blueacre Technology’s system can process up to 50 wires at the same time, precision rotating the wires as the laser modules strip the wires according to the pre-programmed “recipe” governing the

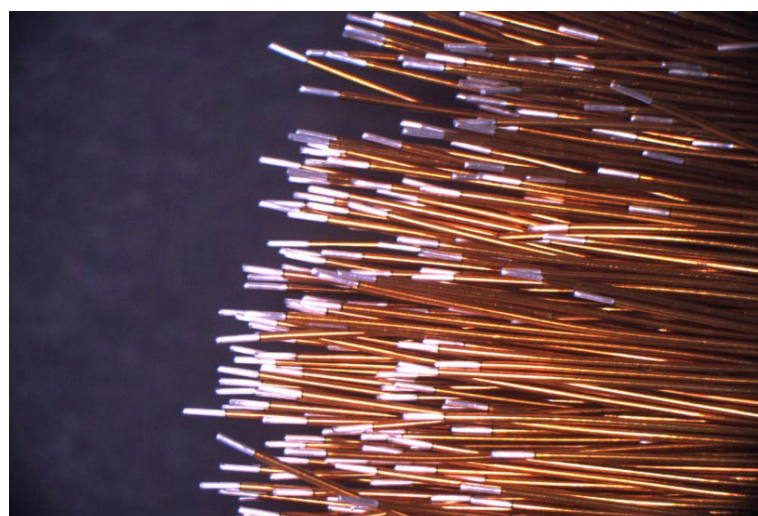


Figure 5: High throughput precision wire stripping.



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