Fiber Laser Processing of Fine Wires in Medical Devices

Materials
The list of materials used consists of Stainless steel, Nitinol, Titanium, Molybdenum, Kovar, Tungsten, Tantalum, and Platinum.

Introduction
As the medical industry continues to demand smaller and more intricate components and devices, so the challenge for manufacturing them increases. One specific aspect that has been successfully tackled by the fiber laser is the processing of fine wires. The need to join fine wires has grown significantly over recent years and the medical industry has provided some challenging applications.

Working with fine wires the fiber laser can be used in a number of different processes:

- Laser welding
- Laser brazing
- Laser balling

Fine wires are used for a number of applications from leads for electrical connections to joining of wires for a variety of insertable devices.

Laser welding of fine wires, as small as 100micron, can be achieved in a number of ways including butt welds (when wanting to weld two wires together) and lap welds (often used to join adjacent wires). Also spot welding can be used when joining a wire to another part or component.

Material use within the medical industry is diverse posing a challenge for any joining technology. However, the fiber laser has excelled and some of the materials that have been successfully joined include; stainless steel, nitinol, titanium, molybdenum, kovar, tungsten, tantalum and even precious metals such as platinum. It is worth noting that the different melting points and thermal conductivities often require careful selection of the laser processing parameters in order to generate a successful joint.

Results
Butt welding:
For butt welding of wires there is often a requirement to minimize joint diameter. This requires careful preparation of the wire ends prior to welding, the fixturing of the wires and the selection of laser processing parameters. A cover or shield gas is sometimes required to prevent weld contamination through oxidation. A good example is the joining of titanium wires (figure 2) - it can be seen that there is no appreciable increase in the diameter at the weld point and due to proper shielding, the weld is bright.

Figure 2: Butt welding of titanium and stainless steel wires. 200W SPI fiber laser, set to 20W, single 1ms pulse.

Lap welding:
In some instances wires can be welded together in a lap configuration. Again, the fixturing is critical when achieving a good contact between two parts. This type of weld can be achieved as a spot weld, or a series of spots generating a lap weld.
Spot welding:
For joining wires to other components, which can act as significant heat sinks, spot welding can be used. Figure 4 shows a fine wire stainless steel wire being joined to a chromel bar.

Brazing:
Brazing is a good solution for joining wires and rods especially for materials that exhibit very different melting points, or whose chemistry means that direct welding of the components may give poor properties. In such cases, a brazing alloy is used. An example of joining two molybdenum parts shows how brazing can be used. Joining dissimilar materials can also be achieved such as in figure 5 which shows a kovar pin joined to a tungsten/rhenium wire.
Conclusion
The joining of wires is a highly skilled operation that is made easier with the fiber laser. Most applications require some development work in order to get good results.