Accent On Applications

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Hybrid Laser Process Cuts Medical Stents

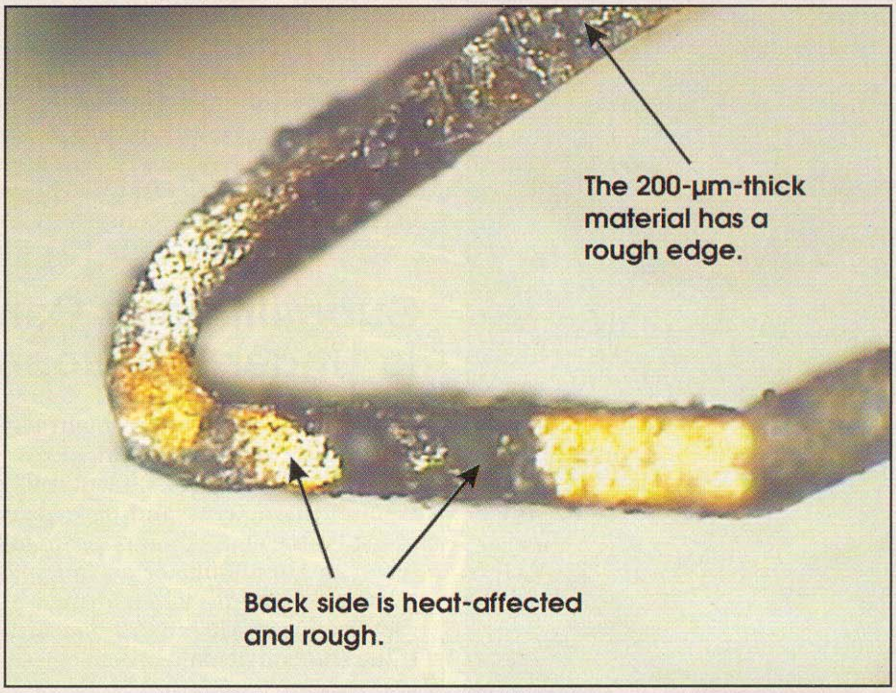

Figure 1. *Stents cut with conventional laser technology require postprocessing as illustrated with a 120-µm-thick device, twisted to show the back side and edge.*

In recent years, medical stents have revolutionized the treatment of arteriosclerosis and other vascular diseases. Designed to improve blood flow in vessels, these complex mesh tube structures are manufactured from very heat sensitive materials, such as Nitinol shape-memory alloy. As with all applications of this type, biocompatibility is paramount. Fine surface finishes without edge cracks or burrs are required to facilitate coating the surface of the stent with antirejection drugs.

One major manufacturing problem is that, because work materials are very heat sensitive, low thermal loading becomes essential. To address this, stents typically are produced by combining conventional lasers, such as pulsed Nd:YAG systems, with a gas jet to remove the molten material from the cut. However, postprocessing is necessary to remove burrs or heat-affected zones that could induce surface cracks (Figure 1). An alternative is to obtain the requisite cut quality during the initial cutting process, reducing the number of postprocessing steps.

One option uses a hybrid process that combines laser cutting and water jet technology. The Laser Microjet technique from Synova SA in Lausanne, Switzerland, couples a high-power pulsed laser beam into a low-pressure water jet. This guides the laser beam by means of total internal reflection at the water-air interface in a manner similar to conventional glass fibers. The water jet effectively cools the material, preventing heat damage within. It also removes the molten material from the cut.

Because the water jet is very thin, the external force on the workpiece remains low but is still sufficient to limit vibrations. This produces a finer first-pass surface finish, with only some easy-to-remove, nonadhering dross remaining along the edge on the back side. Thus, although cutting speeds are comparable to conventional laser processing, there is significantly less postprocessing.

In a recent application, Synova engineers cut the Nitinol stents using a 700-W pulse peak laser with an 0.08-ms pulse duration, an 800-Hz repetition rate and a 150-mm focus lens. The 40-µm nozzle accommodated 220-bar pressure. This setup provided a 4-mm/s feed rate/cutting speed and produced a surface finish with a particle level less than 10 µm, which they report would be extremely difficult to achieve in the first pass with conventional laser processing.

Since the first hybrid laser cutting and water jet process was introduced in 1993, the design has seen several improvements. Nozzles are smaller,

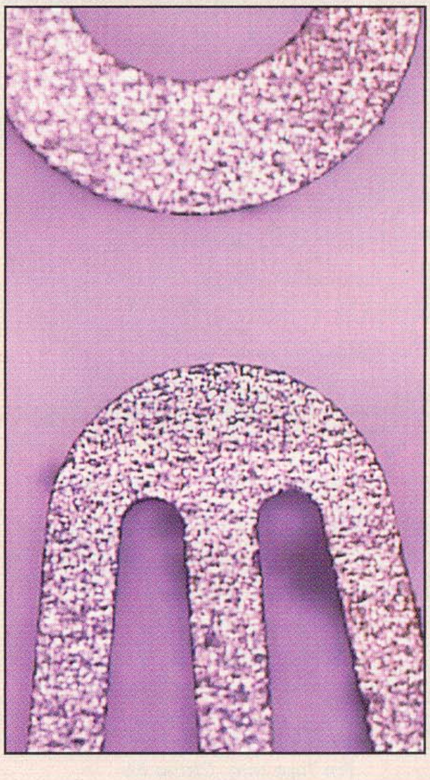

Figure 2. *The Laser Microjet process generates minimal or no oxidation, thermal deformation or change in elastic properties when cutting a 200-µm Nitinol stent.*

with diameters approaching 20 µm, depending on the application. The application space also continues to grow with the use of Nd:YAG lasers at different wavelengths (green, IR, UV). A fiber laser also has been tested.

The limits of materials processing are fairly basic. The processing speed depends on the material, the thickness of the sample and the required quality. For example, 100-µm stainless steel can be cut (diced) at 25 mm/s, with high quality. When processing stents, the cutting speed is lower because of the complexity of the structure (no straight lines). The system also can't cut materials with an insufficient absorption coefficient at the laser's wavelength (transparent polymers, for example). Limitations related to material thickness also exist; however, 200-µm-thick Nitinol used in stent manufacturing does not present a problem. □

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