Stent Cutting

A water jet guided laser has been introduced for stent cutting. Its capabilities are reported here.

Meeting demanding requirements

Stents are metal mesh-tubes cut from planar sheets or tubes, whose structures are often intricate (Figure 1). Their application requires them to be free from cracks and have clean surfaces with no dross or burrs. Because the materials are heat sensitive, low thermal loading is essential. Dross and moderately heat-affected zones can be removed after cutting by mechanical and chemical methods, for example, sand blasting or electropolishing. However, it is more effective to achieve the required quality as much as possible during the initial cutting step and avoid postprocessing follow up. Furthermore, better surface finish without postprocessing eases the application of additional coating with antirejection drugs.

Figure 1: Stent cutting needs a precise machining technique.

The benefits of a hybrid system

A common method of producing stents employs conventional lasers, typically pulsed Nd:YAG lasers, with a gas jet to remove the molten material from the cut. However, this process can create burrs, depositions and heat-affected zones in the material, and the cut pieces need to be treated (Figure 2).

The water jet guided laser system is a hybrid of laser cutting and water-jet technology. A high-power, pulsed laser beam is coupled with a low-pressure water jet and the laser beam is guided by means of total internal reflection at the water–air interface, in a manner similar to conventional glass fibres. The light is guided into the glass fibre because it is totally reflected on the internal wall of the fibre. With water jet guided laser technology, the interface between the air and water enables the total reflection of the light (Figure 3). The hair-thin jet of water provides clean kerfs and simultaneously cools the edges and prevents heat damage within the material. It also removes the molten material from the cut. Because the water jet is extremely thin, the external force on the work piece remains low and is sufficient to avoid vibrations causing defects in the thin and delicate structure of stents. There are no heat-affected zones and thus there is no oxidation, thermal deformation, change in elastic properties or cracks (Figure 4). Only some small, easy-to-remove, nonadhering dross along the back edge of the cuts remains. Postprocessing can be reduced to a minimum. Figures 2 and 4 show the difference in quality that can be achieved with a conventional laser and the water jet guided laser. mdt

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Figure 2: Back of a stent cut with conventional laser, without any postprocessing; 120-µm wide, dross formations and heat affects are visible.

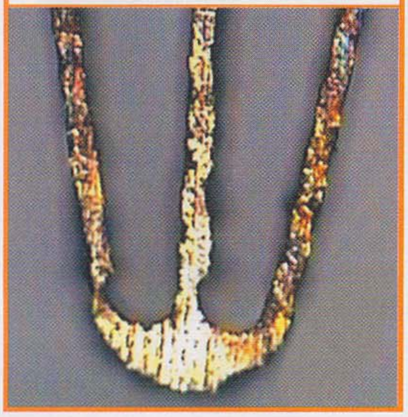

Figure 3: Schematic showing how the laser light is guided inside the water jet.

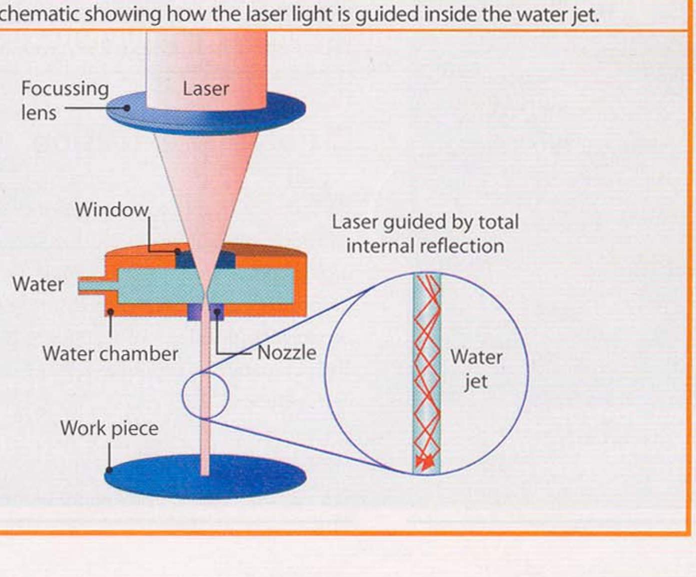

Figure 4: Stent fabricated from Nitinol directly after cutting with water jet guided laser, without any post-processing, 200-µm thick, 120-µm wide.