Water Jet–Guided Laser Cutting Improves Stent Fabrication

The process minimizes thermal damage

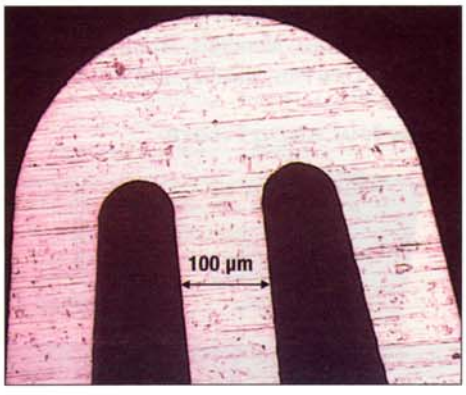
Cleanroom-compatible water jet–guided laser cutting reportedly eliminates many of the problems associated with conventional stent-cutting techniques. Manufactured by Synova S.A. (Ecublens, Switzerland), the LCS 300 laser cutting system minimizes heat damage, reduces the amount of debris, facilitates the deposition process, and streamlines secondary processes.

Stents are small, self-expanding, stainless-steel mesh tubes that are placed within a coronary artery to keep the vessel open. Cut out from planar sheets or tubes, they have to meet stringent manufacturing standards to comply with safety and compatibility requirements. "The surface quality and tube strength are critical, as a stent is designed to remain inside vessels for a long time," says CEO Bernold Richerzhagen. "Therefore, the potential causes of material damage during stent cutting need to be minimized."

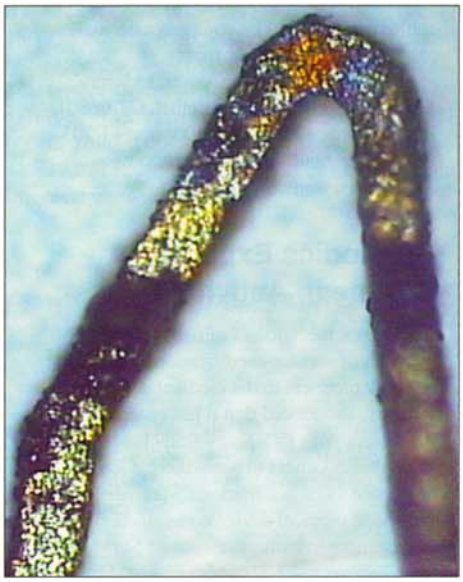
The material used to produce stents often is heat sensitive. "Minimizing thermal damage is particularly important," stresses Richerzhagen. Moreover, the stents' intricate structure and complex curvature requires a fast, clean cut that leaves no dross or burr. Biocompatibility is also crucial. An appropriate surface finish makes it easier to apply drug-eluting coatings to the substrate.

Conventional laser cutting processes tend to leave debris. They also may cause material damage incurred by heating, necessitating substantial post-processing, often involving sandblasting and chemical etching. It is more productive to obtain the prerequisite quality during the initial cutting step, according to Synova, or at least to minimize the need for electropolishing to round off the edges.

The LCS 300 is based on Laser-Microjet technology, a hybrid of laser cutting and water-jet techniques that ensures superior material removal, therefore resulting in cleaner cuts. A high-power pulsed laser beam is coupled into a hair-thin low-pressure water jet. Within the water jet, the beam is guided by the total internal reflection at the water-air interface. The jet ensures a consistent spot diameter and consequently enables a single centimetre-long focus. The water jet guides the laser beam as it cuts the metal, cooling the edges and producing clean kerfs.



Laser Microjet technology was used to cut this nitinol stent. It was not processed after cutting.



A cut with a conventional laser shows thermal damage on its backside, and has a rough edge.

"This technology has two main advantages over conventional dry lasers," according to Richerzhagen. "First, the water jet cools the material between laser pulses, so the heat-affected zone is negligible. Second, the water jet removes the molten material from the cut, reducing particle contamination. Because the molten material is instantly cooled, it does not attach to the stent's surface," he says.

Made of granite, the LCS 300 uses linear motors to cut, drill, groove, mark, scribe, or dice with a high degree of precision, speed, cleanliness, and reliability. It has a processing area of 300 × 300 mm and a maximum axis velocity of 1000 mm/sec. It can be equipped with a direct-drive rotary axis for easy processing of tubes, and features a precision of ±3 µm and high positioning accuracy. The system is equipped with a CCD camera and software, allowing rapid automatic alignment and inspection. A 15-in. flat colour screen with a touch panel serves as the user interface. Complex 3-D cutting is also possible using this equipment. ■

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