Surgical instruments with electronic serial numbers

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This is a surgical retractor with an integrated irrigation tube and connecting piece. It is additively manufactured from stainless steel. Credit: Fraunhofer IFAM

Gone are the days of having to compromise on surgeons' demands because of the limitations associated with metal processing: Laser melting has abolished production-related restrictions on surgical instruments. The technique permits customized tools to be manufactured in a single step and also allows the integration of additional new functions such as RFID. Researchers from the Fraunhofer-Gesellschaft will be exhibiting a surgical instrument with an integrated electronic chip at this year's MEDTEC Europe trade show in Stuttgart.

Be it a heart transplant or a Cesarean section, every operation requires a wide variety of surgical instruments, from simple retractors, clamps,

scalpels and scissors to more specialist devices such as cerclage wire passers, which surgeons employ to repair long, oblique fractures in bones. These are shaped in such a way as to half encircle the broken bone, and incorporate a hollow channel. In a process not unlike stringing a parcel for posting, thread or wire is fed through the channel around the damaged bone and then knotted in place, both to support the bone and to hold the broken parts together. "Until now, it has always been time-consuming and expensive to manufacture surgical instruments featuring this kind of channel," says Claus Aumund-Kopp of the Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM in Bremen. Because it is nigh-on impossible to machine curved channels, shaped tubes have traditionally had to be cast, or else welded or soldered retrospectively.

At the MEDTEC Europe trade show in Stuttgart from March 22 through 24 (Hall 6, Booth 6211), the Bremen-based scientists will be presenting a technique that enables the manufacture of surgical instruments of any shape, even those with complex interiors like channels, or those with integrated RFID chips. The technique in question is laser melting. Originally developed for the production of industrial prototypes, this manufacturing method uses an extremely fine laser beam to melt a powder material into almost any desired form, one layer at a time.

"Nowadays, laser melting is a mature technology, which has already proved its worth in the manufacture of medical implants," states Aumund-Kopp. Like all generative – i.e. bottom-up – manufacturing techniques, it has two major advantages: First, unlike in turning, drilling or milling, hardly any material is wasted; and second, there are no production-related restrictions on the shape or interior structure of the workpiece. "The designer can focus exclusively on the surgeon's stated requirements," says the engineer. For surgical instruments, either cobalt-chromium steel or titanium powders could be used – both are standard materials in generative manufacturing. Although no-one has yet begun

using the laser melting technique to produce surgical instruments, Aumund-Kopp believes it would be an ideal manufacturing method: "Even small quantities of customized surgical instruments incorporating completely new functions could easily be produced in this way," he reports. 3-dimensional model on a computer is the only template needed; intermediate stages, including the production of special tools or casting molds, are eliminated.

Steel components that are produced using laser melting technology also demonstrate particular electrical properties. Normally, metals shield against electromagnetic radiation such as radio waves, so whenever an RFID chip is cast in metal, a small opening must be left above it, otherwise it will not be readable. But this is not necessary with laser-melted instruments; even though they are completely shrouded in metal, the integrated RFID chips are still able to transmit and receive over short distances. "We assume that the layered structure of the material shapes the field in such a way that the chips remain readable despite their metal covering," explains Aumund-Kopp. This could prove advantageous in the operating room: After every operation, all surgical instruments have to be cleaned, sterilized and counted; if they had integrated RFID chips, quantities and individual numerical codes could be checked quickly and easily and could be electronically linked to the operation report or to specific instrument data such as date of manufacture, protocols for use or current state of cleanliness.

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