APP NOTE NUMBER 24

JANUARY 24

MATERIALS PROCESSING: NITINOL

Nitinol is a highly unusual metal alloy of Nickel and Titanium. You can bend, twist, and crush it out of shape, only for it to jump back into its original shape when heated or submerged in hot water. In addition to the memory property, it also possesses extraordinary super-elasticity. It can survive repeated compressions and levels of repeated strain where an equivalent piece of stainless steel will have long succumbed to fatigue. Nitinol is nontoxic and does not promote genotoxicity, thus making it widely suitable for long-term medical implants.

The super-elastic properties of Nitinol coupled with its excellent biocompatibility means it has been the metal alloy of choice for demanding medical applications since the late 1980s. Early medical uses of Nitinol include bone anchoring, tumor localization of specific cancers and filter implants to trap and manage blood clotting. It is now widely adopted with growing use in minimally invasive surgery and dentistry.

The expected market growth for Nitinol in the medical market is expected to grow at over 9% CAGR, driven by improved therapy of chronic diseases and preference for minimally invasive procedures. Nitinol is well suited to meet these needs.

Stents as an alternative to open surgery

Stents made from Nitinol are used to reinforce strictures within various ducts and canals of the human body caused by trauma or chronic medical conditions. The use of stents negates any need to perform grafts or bypass surgery which makes it a highly desirable alternative to open surgery, where risks of secondary infection are higher.

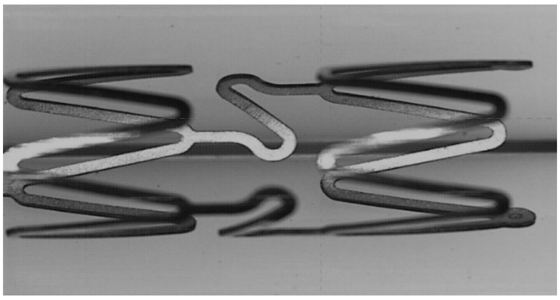

Fig. 1: Arterial stent showing a design cut with an ultrafast laser.

Minimal thermal impact

Ultrafast lasers are a natural choice to machine Nitinol stents and are widely used for this purpose. The near diffraction-limited optical beam delivery yields a focused spot size optimized to machine small features. The short pulse dynamics of ultrafast lasers machine the Nitinol with minimal thermal stress or damage to the substrate.

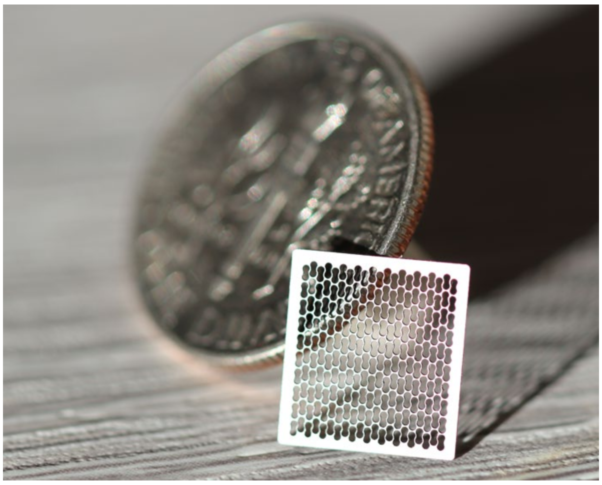

Fig. 2: Nitinol test piece against a US Dime for size comparison. Cut with an aeroPULSE FS50 laser.

The test piece shown in Fig. 2, shows the result of machining Nitinol with feature sizes consistent with an arterial stent. This test piece was machined using an NKT Photonics aeroPULSE FS50 laser using a single pass.

The laser beam was delivered using a commercially available processing head with an axial jet with a suitable cover gas to suppress oxidation and manage the generated plasma.

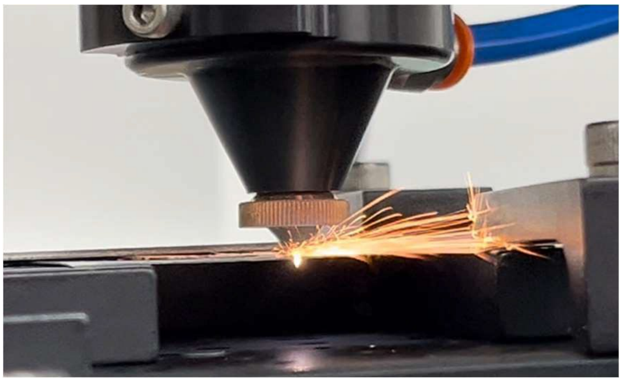

Fig. 3: Laser beam delivery of aeroPULSE FS50 with co-axial jet.

The results were an excellent simulation of the feature size and typical thickness of stents. The side walls are less than 65 μm and the feature sizes are <300 μm.

NKT Photonics lasers ideal for Nitinol

The aeroPULSE FS50 is an ideal laser for cutting Nitinol. The combination of near perfect beam quality, pulse energy and repetition rate selection mean that it can cut delicate features such as arterial stents but can also process larger stents or bulk Nitinol at higher speeds due to the option for higher repetition rate and average power.

The aeroPULSE series of lasers is based upon NKT Photonics' photonics crystal fiber technology. As a result, it is an extremely reliable laser system ideal for industrial or scientific use. The FS50 is also used for cutting-edge neurostimulation research.

The ORIGAMI XP-S is also a strong candidate for Nitinol machining. Its excellent beam quality and high pulse energy is perfect for cutting fine features into Nitinol.

The ORIGAMI laser is a diode pumped solid state laser architecture with proven medical pedigree. It is used in a variety of biomedical applications, including ophthalmic laser surgery.

Both the ORIGAMI XP-S and the aeroPULSE FS lasers can be converted to different wavelengths via additional wavelength conversion units, which extend the range of materials they can process.

Both lasers also benefit from NKT Photonics' powerful Software Development Kit (SDK), which can be used to independently control almost all laser output parameters.

Using the SDK, the laser, scanners, and stages can be automated to work together, enabling rapid research or production optimization. Both laser sources are your ideal tool for basic Research & Development, or full-scale volume production.

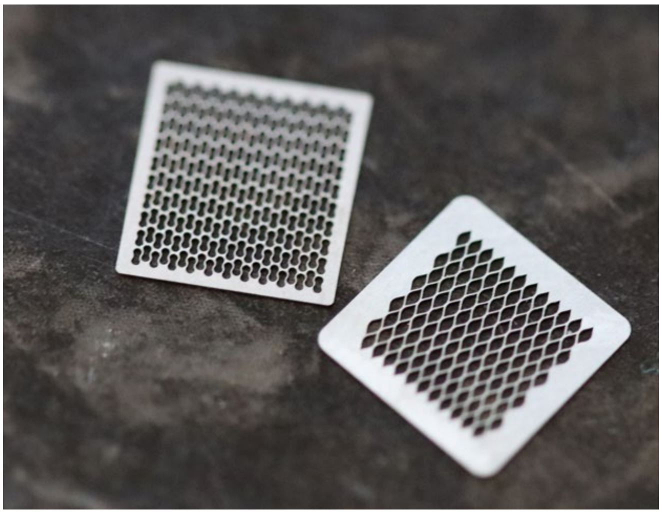

Fig. 4: Different planar Nitinol test pieces cut with an aeroPULSE FS50 laser.

PRODUCT INFORMATION

aeroPULSE FS50: With >50 W average power and >40 µJ pulse energy, < 450 fs – 3 ps pulse duration, single shot – 2 MHz repetition rates the FS50 is an ideal partner for Nitinol processing.

ORIGAMI XP-S: With >5 W average power and >70 µJ pulse energy, <350fs pulse duration, single shot – 1 MHz repetition rates the ORIGAMI is also an ideal partner for Nitinol processing.

Contact information

For more information about these laser platforms, please contact one of our sales team.

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