



INTERIOR PROCESSING OPTICS (IPO) FOR LASER POLISHING

Task

So far, polishing by means of laser radiation has been developed for 3D freeform surfaces. The laser polishing of the inner surface of bores or tubes is constrained, however, since the scanner systems used have limited accessibility to the workpiece. The maximum ratio of hole depth to diameter is about 1.5 and, thus, too low for many applications. For this reason, a processing optics should be developed, one which allows the polishing of cylindrical internal surfaces with higher ratio of hole depth to diameter.

Method

The goal is to develop a suitable optical system to laser polish the inner surfaces of pipes that have a maximum length of 100 mm and an inner diameter of 15 - 30 mm. Due to the high scanning speeds, especially when polishing with pulsed laser radiation, these internal processing optics (IPO) must be suitable for rotating speeds of up to 700 min⁻¹. The requirements are, thus, much higher than in internal processing optics for Laser Metal Deposition, which are used at speeds of up to 5 min⁻¹.

Result

The IPO consists of a mounted hollow shaft, which is driven by a belt drive and has a deflection mirror arranged on the end. In the shaft and in front of the deflecting mirror, there is a focusing lens whose position can be varied by using different spacers which make it possible to adjust the focal position to inner tube diameters from 14 to 30 mm. The ratio of hole depth to diameter can be up to 6.7. The maximum speed of the optical system is 1000 min⁻¹.

With the IPO, half of the inner surface of the pipe – made of grade 2 titanium shown above (internal diameter 16.5 mm, length 80 mm) – was polished with pulsed laser radiation. The processing time is approx. 2 - 3 minutes (net) at a rotating speed of 600 min⁻¹.

Applications

The internal processing optics can be used to laser polish pipes for various applications. These are, for example, blood-carrying implants for medical technology or components for the automotive and chemical industries. In addition to its use for polishing, the optical system is also suitable for other laser-based material treatment processes.

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2 Partial (front) internal-polished pipe made of grade 2 titanium with an inside diameter of 16.5 mm.