Remote laser cutting of Mg alloy with a ps-pulsed laser

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INTRODUCTION: Laser microcutting is the most widely used method for stent manufacturing in the industry [1]. It is by now an established process for more common permanent stent materials, namely stainless steel and Co-Cr alloys [2]. Concerning Mg alloys, the process yields different limitations due to low melting point, high reactivity and viscosity in the molten phase [3]. New high power ultrafast lasers operating with ps pulse durations and green/UV wavelengths allow for ablation based machining with improved cutting quality. In particular, these lasers can be used in remote cutting. The process is preferred for cutting low thickness materials with high sensitivity to heat input, being potentially appealing for biodegradable stent materials such as Mg alloys. The ps pulse duration avoids heat interaction compared to longer ns pulses and continuous wave lasers. Green and UV wavelengths provide higher precision compared to near infrared lasers.

This work demonstrates the feasibility analysis of remote cutting of Mg alloy using a ps-pulsed laser operating with green and UV wavelengths.

METHODS: Fig.1 reports the functioning principles of conventional laser cutting with the use of a process gas and remote cutting. In microprocessing, remote cutting is employed with pulsed lasers and scanner heads. By scanning the laser beam over the surface, limited amount of material is removed at each scan pass. The material is cut by applying multiple scans on the cut area until a through kerf is obtained.

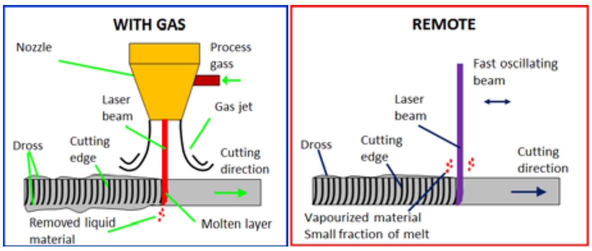

Fig. 1: Working principles of conventional and remote laser cutting.

The laser source used in this work produced pulse durations shorter than 15 ps and allowed to operate with fundamental emission wavelength at 1064 nm as well as second and third harmonics at 532 nm and 355 nm (Coherent Lumera Hyper Rapid 50 HE). Remote cutting was applied on AZ31 Mg sheets with 250 µm thickness. In a preliminary analysis parameter combinations were analysed for quality comparisons.

RESULTS: Fig. 2 shows representative cuts obtained by laser remote cutting with the ps-pulsed laser and compared to a ns-pulsed laser operating at 1064 nm wavelength. It can be observed that the ps-pulsed laser provides much cleaner and regular kerf. The use of 355 nm wavelength with the ps-pulsed laser provided a cleaner kerf compared to 532 nm wavelength. The required power density for through cuts was found to be around 130 Ws/cm^3 for both of the wavelengths indicating similar levels of efficiency in material removal.

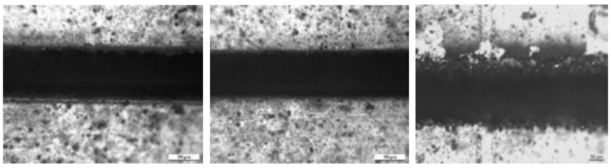

Fig. 2: Cut kerfs obtained with ps laser operating 532 nm (left) and 355 nm (middle) wavelength and ns pulsed laser at 1064 nm (right).

DISCUSSION & CONCLUSIONS: This work provides an extension for microcutting strategies on Mg alloys. The results demonstrate that ps-pulsed remote cutting can provide excellent cutting quality and reduce post-processing complexity. The laser microcutting quality can be further improved through the control of pulse profile and pulse train shaping.

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