Data driven strategies for heat management in high density drilling

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Nanosecond diode pumped solid state lasers are easily affordable nowadays for laser microdrilling many different materials. However, their mode of ablation is predominantly thermal, leading to unwanted effects such as a large heat-affected zone, undesirable surface oxidation and recast around holes. These are particularly problematic for high-density drilling applications and further accentuated if high-indexing speed from hole to hole is used. To minimise such undesirable effects, often the incident laser power has to be moderated. But this restricts the drilling speed and minimum hole pitch as the taper increases and often necessitates post-processing to remove oxidation and recast. However, for high volume manufacturing it would be very valuable to utilise nanosecond lasers over ultrafast ones, as the technology is more mature and lower cost.

At Oxford Lasers we are tackling this problem with a data driven approach. Our ability to automatically inspect 100% of holes drilled quickly and accurately allows innovative drilling strategies such as tuning the incident laser energy into each individual hole, minimising the laser heat load on the part and ensuring production uniformity. Additionally, we can monitor the temperature of the part in-situ to gain a better understanding of the overall heat distribution produced by nanosecond laser drilling at high speed, which enables us to predict a good starting point for our drilling strategy. We will also discuss a hybrid approach which combines the first two by using the temperature monitoring data to feed back in real-time to the laser and tune the incident laser energy on the fly.

Preliminary results have already shown that improvements can be made in the repeatability and quality of nanosecond laser percussion drilled holes with such heat management strategies. We believe our approach unlocks further potential for nanosecond lasers and enables high throughput processing using faster toolpaths.