GREEN BEATS UV: NEW SOLUTIONS FOR DEPANELING & PCB CUTTING

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The trend towards ongoing miniaturisation of electronic components and printed circuit boards (PCBs) is creating new challenges in production. Typically large boards or panels are produced using surface mount technology (SMT) and these consist of multiple sub-units which must be accurately and consistently cut to separate them from the panel creating individual assemblies, in a process called depaneling. Unpopulated or even fully functional panels must be separated into individual PCBs with as little mechanical and thermal stress as possible. As component and track density increases, so to do the demands for precision, cleanliness and flexibility.

Laser cutting systems have already largely replaced traditional sawing, routing and punching. However, commonly used UV laser sources are high cost items and, more importantly, demand high maintenance costs when used in industrial manufacturing. This article describes a specially designed green laser source that provides the throughput and quality which is equal to, or higher than, current UV lasers, but with greatly improved efficiency and robustness.

The Global Marketplace for PCBs

Production of PCBs has become very heavily concentrated in the Asia/Pacific territory, where approximately 87.5% of global production was based in 2014. PCBs can be classified by type according to the number of layers and whether they are Rigid, Flexible or a Rigid-Flex combination. The fastest-growing PCB market segment currently is Rigid-Flex PCBs. These enable the electronics to wrap around other components to make consumer electronics smaller and lighter. Sometimes the flexible part is "bend once" where it is in a fixed location. In other products the circuit is designed to pass through a flexible hinge (e.g. a laptop screen attached to keyboard) and bend dynamically and reliably without failure for the lifetime of the product (see an example in Figure 1). This segment is one the fastest growing, and is predicted to continue growing by in excess of 10% per annum over the next few years (see Figure 2).

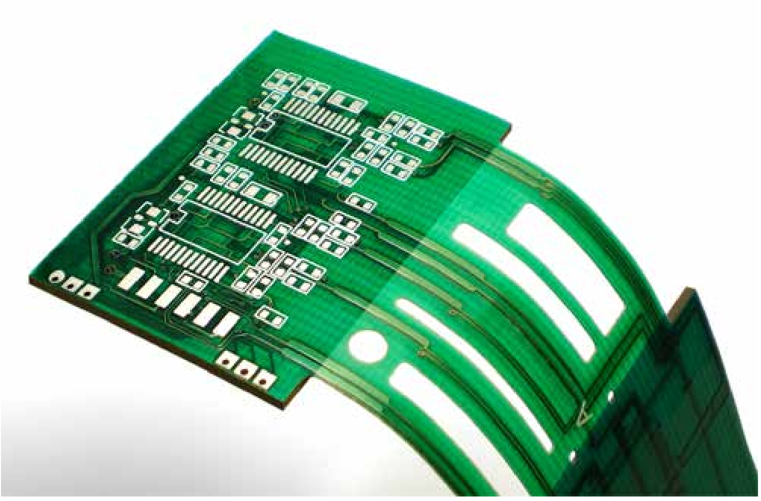

Figure 1: Semi-flexible Rigid-Flex PCB (courtesy Andus Electronic GmbH)

PCB substrates put high demands on the cutting process

The varying thickness and flexibility of the Rigid-Flex PCBs puts very high demands on the cutting process. On the one hand, there are different thicknesses and material compositions to cut in one process, and on the other flexible parts can move out of focus during cutting.

Epoxy resins, glass fibers, copper coatings and polyimide are all used in PCBs, making a complex task for the cutting process. To be able to cut all the materials above in a precise and clean manner with excellent edge quality needs a special solution. Conventional mechanical methods come with high maintenance and tool costs, limited flexibility and carry the risk of damage and contamination of the sensitive microelectronics. On the other hand, laser cutting has struggled previously as a result of insufficient absorption in some material components. For example, when using conventional CO_2 lasers, there is almost no absorption in copper - and the comparatively high thermal input can result in carbonisation issues.

What's wrong with UV laser sources?

Currently the majority of production PCB cutting is carried out with frequency-tripled UV laser sources, having a wavelength of 355 nm, which eliminates the above drawbacks of low

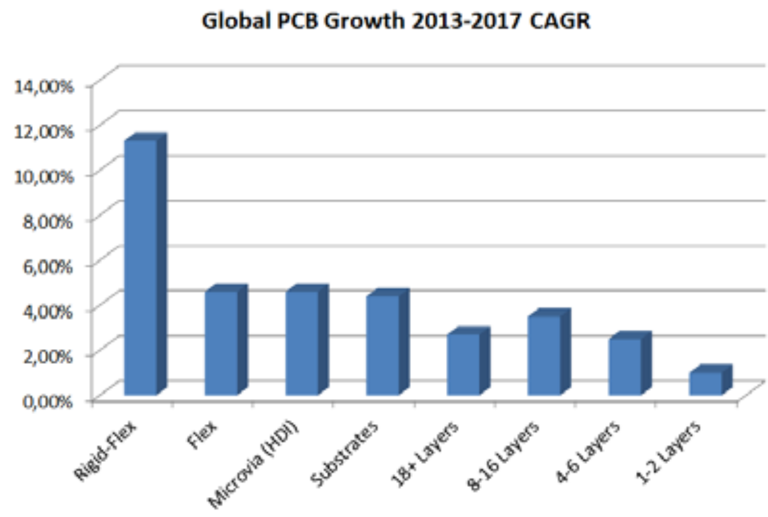

Figure 2: Global PCB Growth by Type 2013-2017 CAGR, source: TTM Technologies

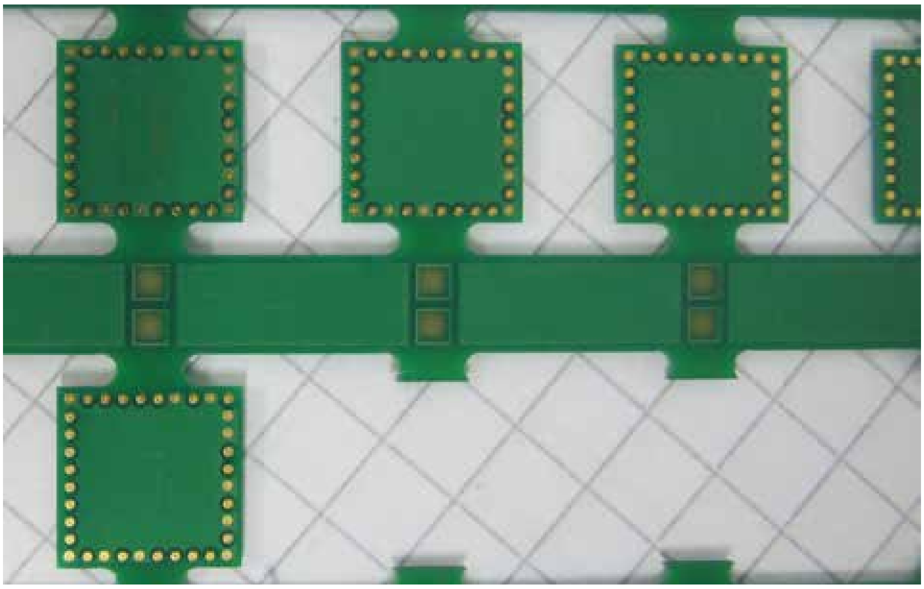

Figure 3: PCB Depaneling with 532 nm laser from InnoLas Photonics

absorption. All relevant material components absorb this shorter wavelength very well, sometimes even too well - with extremely high absorption in epoxy resin, for example. The use of small spot sizes and relatively long pulse lengths, characteristic of most UV laser sources applied in this area, means that high pulse energies are required in order to be able to cut thicker substrates not just the thinner ones. The high-energy UV laser radiation puts challenging demands on the internal laser components and optics which considerably shortens their lifetimes. Industrial 24/7 production therefore requires a cost-intensive maintenance plan with frequent downtime in the production schedule.

The green alternative

Frequency-doubled, green laser sources with 532 nm wavelength can achieve similar cutting results to the UV wavelength lasers but up until now did not provide enough peak pulse power for glass fibre cutting. InnoLas Photonics has addressed this gap using the BLIZZ 532–30-V. Producing 30 watts average power at 40 kHz pulse frequency, and having a pulse length of 20 ns, this laser source provides 35 kW peak power and 750 µJ pulse energy. These parameters enable a new, more cost-effective, approach to high-speed PCB processing. A typical UV laser used in the same application would have a longer pusle duration (typically 140 ns) and a lower average power and operating frequency.

Same speed & quality, but lower costs

In brief, the new green laser source can replace virtually all common depaneling and PCB cutting UV laser applications with comparable quality and speed, but at 50% lower investment costs and 90% lower maintenance spend. Comprehensive testing at InnoLas Photonics application lab and various installations already carrying out industrial production have shown results to back up this claim.

Of particular interest is the option of replacing an existing UV source with the new 532 nm product. The new laser source is more compact and it's wavelength is considerably less demanding to beam path design and optical components. As a consequence, any legacy UV application can easily be replaced with the more straightforward and cost-effective green solution.

Easier laser processing solutions, superior results with flexible PCBs

As a result of the high pulse energy and excellent beam quality it is possible to use galvo scanning optics with long focal lengths to cover a large field. A 420 mm focal length flat field (f-theta) lens fitted to a suitable galvo scanner can access a working area of 300x300 mm without moving the workpiece using motorised axes, a benefit in throughput and system simplicity.

Another advantage of using a longer focal length f-theta lens is that the depth of focus is increased which makes cutting of thicker materials easier, and also copes with the fact that during cutting a flexible part can move slightly out of focus – less of a problem with a longer focal length. This combination means that typically zero Z-axis adjustment is needed during processing. Examples of laser cutting with the green laser are shown in Figure 3 and edge quality and speed information is given in Figure 4.

Quite frequently, depaneling applications ask for component marking as well. The green laser from InnoLas can easily be used for marking by simply using different parameters. Marking quality is high enough to produce very small-scale 2D matrix codes with 0.8 mm edge length, something very important where the "real estate" available for coding is limited by the demands of function and available space.

Conclusions

The development of versatile laser sources in the green wavelength as a direct replacement for UV lasers in the application of depaneling PCBs offers advantages in reduced capital cost and running cost, with greater uptime owing to the reductions in maintenance interventions. As well as depaneling, these lasers can be used for marking and drilling, with the increase in average power and pulse frequency ensuring that the throughput and capability is a close match for the UV lasers they are aiming to displace.

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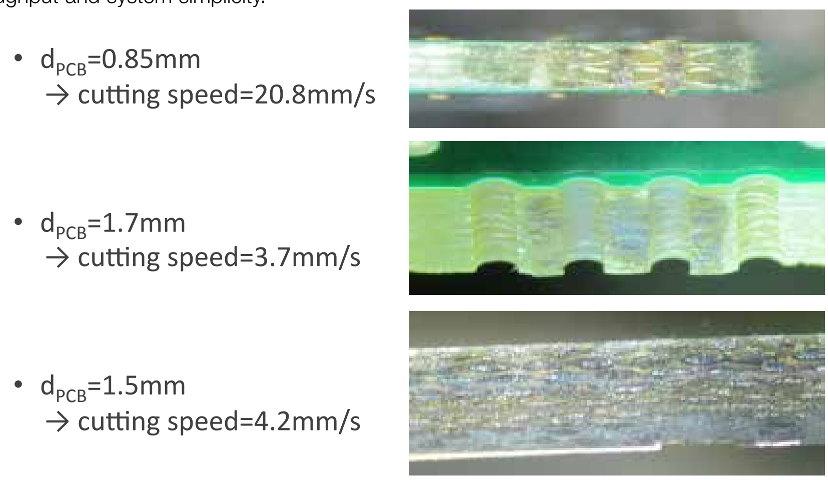

Figure 4: Edge quality and cutting speed using the BLIZZ 532-30-V laser from InnoLas Photonics

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