Precision Marking in Industrial Manufacturing with Pulsed UV Explorer One Lasers

In recent years the demand for precision marking in industrial manufacturing is experiencing positive momentum. In particular, production of premium consumer products is driving this trend to ensure highest quality, e.g. marking of logos and superfine 2D-matrix codes for parts tracking, managing supply chain quality, and protecting against product piracy. In many cases, such codes are intended to be invisible to the consumer but readable by sensors in the production process. As a result of these benefits, precision laser marking has increasingly been utilized in diverse industrial manufacturing segments including microelectronics, semiconductor, and automotive sectors.

To realize these precision marking results, the choice of laser type is of paramount importance. Lower precision, lower quality laser marking predominantly uses IR fiber lasers due to their low cost. At the other extreme, ultrashort pulse picosecond and femtosecond lasers are capable of generating the highest quality marking results and 2D-matrix codes in most any material, but at a much higher cost. The solution to this dilemma of cost vs. performance is a well-engineered pulsed UV nanosecond laser such as the Spectra-Physics Explorer® One™ series.

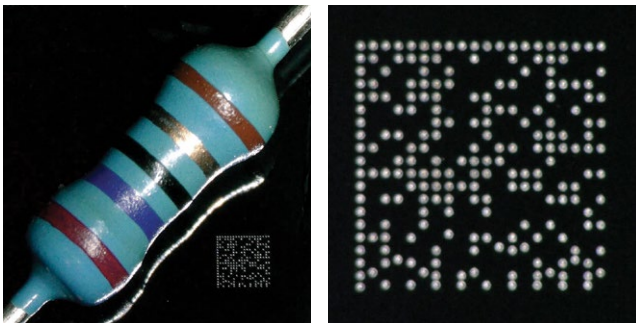

Figure 1: 20 x 20 dot data matrix marked on a ceramic cover part for the mobile device market with a total matrix size of 900 x 900 µm

The Explorer One series fulfills all of the critical requirements necessary to mark superfine data matrixes to sizes as small as 100 µm. The UV wavelength results in finer features and marks due to the ability to focus to tighter spot sizes and the shallow absorption depths in most materials. The Explorer One also delivers a very high beam quality, i.e. circular beam profiles with low astigmatism and low M^2 that allows the user to realize near-diffraction limit focus spots. Explorer One lasers typically have an ellipticity <1.1, astigmatism <0.1* and M^2 of ~ 1.1.

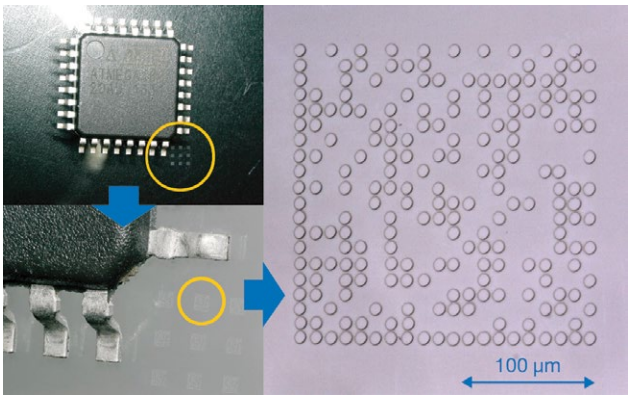

Figure 2: 20 x 20 dot data matrix marked on soda lime glass

As a high quality result also depends on the specific material being processed, a broad and flexible range of laser parameters is needed to cover various materials. The Explorer One series offers high energy models with >100 µJ in UV and >200 µJ at 532 nm as well as higher power versions up to >4 W at 355 nm and >5 W at 532 nm with high repetition rates to match those needs.

Advanced pulse control features are also needed to facilitate high quality processing. Pulse on demand with constant pulse energies (E-Pulse™) enables rapid precision marking and provides PSO motion capability (application focus #44). The closed loop pulse energy control feature of Explorer One known as E-Track™ (reported in application focus #32) enables fine control of every laser pulse to produce superfine structures.

With the Explorer One series, we demonstrated marking of superfine machine-readable barcodes in ceramics used in mobile device applications (Figure 1) as well as in soda lime glass (Figure 2). With UV wavelengths, we were able to generate dot sizes of less than 10 µm resulting in a data matrix of 200 µm with 20x20 dots. Due to the excellent beam properties of the Explorer One lasers, these small dots were achieved using a galvo scanner with a telecentric f = 100 mm lens, i.e. with moderate focusing and without sophisticated sample positioning requirements. The use of a galvo scanner allows high processing speeds and marking times in the range of ~100 ms for a 20x20 barcode.

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Another application where superfine structures are needed is direct writing of logos. Demanding surface quality requirements dictate the use of superfine structures such that the contrast of such a logo generates a novel and high quality appearance without sacrificing the surface topography. In many cases, the surface must remain smooth or have a certain feel to the human touch. In Figure 3, we demonstrate such a logo marked with an Explorer One UV laser on a ceramic part.

In summary, pulsed UV ns lasers with a compelling cost and performance are effective in generating superfine structures on a broad range of materials used in 2D data matrices as well as logo marking. The Explorer One lasers are ideal for these demanding applications.

** Normalized to Rayleigh length*

Figure 3: Marking of a logo on a polished ceramic surface

PRODUCTS: *EXPLORER ONE*

The Explorer One Laser Series is the most compact active q-switched laser series in the power range up to 4 W UV and 5 W of 532 nm. High performance standards such as a typical mode quality M^2 of 1.1, short pulses, and high peak power as well as the capability of fast power modulation and short rise time guarantees the best process quality in our customers' applications. High quality standards including tight system-to-system specifications, longevity and the rugged and durable design ensures lowest cost of ownership. Software features and the compact size result in fast and cost efficient integration and ensure our customers a fast time to market with their own products.

	Explorer One HP 355	Explorer One XP 355	Explorer One XP 532	Explorer One 355	Explorer One HE 355	Explorer One HE 532
Wavelength	355 nm	355 nm	532 nm	355 nm	355 nm	532 nm
Power	4 W @ 80 kHz	2 W @ 80 kHz	5 W @ 80kHz	800 mW / 300 mW @ 50 kHz	80 µJ @ 10 kHz (800 mW)	200 µJ @ 10 kHz (2 W)
Repetition Rate	Single shot to 500 kHz	Single shot to 300 kHz	Single shot to 500 kHz	Single shot to 200 kHz	Single shot to 60 kHz	Single shot to 60 kHz
Pulse Width	<12 ns	<10 ns	<12 ns	<10 ns	<15 ns	<15 ns

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