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## INTRODUCTION

Laser marking of ID documents is increasingly becoming the new standard for personalisation and security, with a recent and sharp rise in implementation across many types of ID documents around the globe. In 2013, more than 250 million documents were personalised with laser marking — representing 45% of national ID, 35% of driving licences and over 20% of passports. The technology is now mandated in European Union driver's licences, has been selected by governments on every continent to personalise over one fifth of all 2013 passports and is proliferating in national ID projects around the globe. To gain insight on this rapid growth, lasermarking technology will be examined using the QSDC best practice methodology. This examination will also shed light on the importance of following best practices and the value of working with an experienced technology provider that can help an organization implement laser-marking technology for maximum value.

### **Overview of QSDC best practices:**

Quality, Security, Durability and Cost (QSDC) are the cornerstones of any successful Identity Document program. These criteria have trade-offs and compromises, and the relative value of each must be considered when designing the most appropriate ID.

The QSDC criteria can be summarised as follows:

**Quality:** A high-quality document will be consistent in appearance and closely match all other documents issued in the same ID program. The security features — in particular, the primary portrait — will be crisp and clearly defined to allow easy authentication. Overall, a high-quality identity document will look and feel authentic.

**Security:** The security of an ID is a measure of how well it resists deliberate attack, whether by simulation/counterfeiting or by tampering to alter the information. The security of the document also depends on the ease of verifying a genuine document.

**Durability:** The durability of an ID defines its resistance to environmental change. A document encounters a variety of hazards during its life, including accidental attack — such as laundry — or deliberate misuse. An ID needs appropriate durability to survive the required validity period without significant visual change, and without compromising its performance. A useful approach to achieving ID card durability is set out in ISO/IEC 24789, where the use and storage of a card are considered, as well as the required lifetime.





**Cost:** The cost of the document refers to the fixed and variable costs associated with production, including enrolment, components, manufacture, personalisation, issuance, shipping, and the many administrative functions necessary to manage and secure these activities. Understanding the total cost of ownership, and the issuance cost per card over the validity period, is an important yet often challenging task.

Using the four QSDC criteria, a particular personalisation technology can be assessed before implementing with an ID document program.

For laser marking, the traditional assessment has been high security and high durability, but at high cost. Quality is seen as excellent, though some have felt a monochrome image evokes "old technology."

Figure 1 summarises the important aspects of QSDC with respect to laser marking.

Before considering each characteristic in turn, it is important to consider the fundamental principles of laser marking. Personalisation by laser occurs when energy is focused within the body of a suitable substrate to produce a permanent darkening of the material. As this involves reaction within the body of the material, the marking quality is affected by the construction of the layers, as well as their chemistry. Other components, such as pre-print, adhesives and Optically Variable Devices (OVDs) must also be considered.



FIGURE 1 - Summary of QSDC factors in the laser marking of ID documents



# **QUALITY**

The quality of laser marking essentially depends upon the control and optimization of three factors:

- SUBSTRATE: The material being marked, including any surface printings
- HARDWARE: The laser and ancillary components of the system
- FIRMWARE: The instructions that drive the marking process

First we consider the substrate to be marked; the material, its chemistry, construction, any additional components, and the pre-print design.

### **Substrate - Material**

Polycarbonate (PC) material that is suitable for laser marking is available from several sources. However, it is very important to note that not all PC is the same and not all sources of PC result in good quality personalisation.

Although a material may be referred to as "polycarbonate," and its principle chemistry might be that of polycarbonate, this is no guarantee that it will react to laser energy marking in the same way as a different PC substrate. Some new PC grades are available which offer shorter marking times, and thus a higher throughput of documents. It is important that the system is correctly tuned for the grade of polycarbonate selected.

New markable materials that are not PC-based are beginning to show very promising results. These materials are typically based on doped polyester (PET), and may offer an interesting alternative to traditional PC for ID documents.

**There is no substitute for thorough testing.** All materials needed to make the product such as the pre-print, adhesives, embedded holographic component, lens structures, contactless chip inlays, etc. should be tested to verify suitability. Also, it is recommended that white stock, as well as pre-printed stock, be tested to assure the product will meet end-user requirements.



#### **Substrate - Construction**

There are guidelines and rules regarding the sequence, thickness and chemistry of layers required to optimise the quality of laser marking. These are particularly important when specific features are required, such as MLI/CLI or tactility, or when embedded holograms are used. Other components may also need to be considered, such as security pre-print and the use of contactless chip inlays.





Insufficient laser reactive material

Optimum laser reactive material

#### FIGURE 2 – Burning of pre-print when construction not optimized

For example, several important guidelines exist for pre-print design, including the carbon content of the ink, its density and the layer within the substrate on which it is printed. Details of construction best practices are available, though they are outside the scope of this paper.



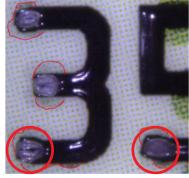


FIGURE 3-Bleeding & Bubbling when construction and pre-print not optimized

In practice, issuing offices may be faced with the challenge of laser personalising multiple documents that vary in their chemistry, construction and pre-print design. Modern high-speed laser personalisation systems are configurable to handle different batches and utilise optimum laser parameters specific to each document. For example, the system can be set up to optimise laser marking quality on alternate batches of PVC and PC with different pre-print and layouts. This can be done simply to speed set up or at a more detailed level as required.

### **Hardware**

Generally, materials are designed for marking with laser wavelengths of 1064nm. Best practice consideration of hardware selection includes:

- Marking speed of system
- Flexibility of features available
- Precision and accuracy of location of ID document in marking module
- Control and accuracy of laser beam position and focus

Much R&D activity is now focused on emerging laser hardware, which could permit higher speed or lower cost, and may also enable new security features.

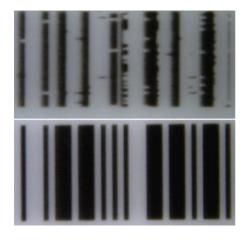


FIGURE 4 - Better control of laser improves barcode quality

#### **Firmware**

Firmware can be thought of as instructions to the laser and its importance in achieving optimum quality should not be underestimated. The critical requirements for quality marking are the precise positioning and characteristics of the laser beam — to achieve these, control of the following is required:

- Power, pulse rate, scan speed and resolution. There may be trade-offs between quality and throughput.
  For example, delays may be required to improve the edge quality and sharpness of the laser mark.
- Size and shape of the marking field
- Distortion correction, such as that caused by lenses in the beam train. There may be as many as 20 firmware parameters available to correct for distortion.

In addition to a negative impact on visual quality and aesthetics, poor laser marking can render machine-readable features such as barcodes and optical characters unreadable, further hindering security.

Years of experience have created a solid foundation of knowledge of laser marking best practices with R&D and real programs contributing to a better understanding of cause and effect. The practical benefit of this know-how is seen in the implementation of best practices that include design rules and guidelines for substrate, hardware and firmware.

Optimisation of firmware is not only critical for quality; it is also a key factor in achieving the security features produced during personalisation.



## **SECURITY**

Laser-marked polycarbonate offers great potential for security features that are easy to verify and defend against both counterfeiting and alteration. However, a laser-marked polycarbonate ID is not automatically secure — it must be designed to optimise security.

Put another way, *most counterfeits of laser marked polycarbonate are neither laser marked nor polycarbonate*. Instead, criminals most commonly use digital black graphics and PVC to simulate or alter an ID. The most secure ID programs leverage the key security characteristics of laser marking to defend against these threats, including writing beneath a surface, exceptionally high resolution, and true greyscale and tactility, to name just a few. In addition, under low magnification (for example: a simple x10 loupe), true laser marking exhibits certain characteristics that can help indicate tampering or counterfeiting. Ironically, artefacts of the marking process that are often regarded as unique faults can be used by a document examiner to verify the use of genuine personalisation technology.

One important security advantage of laser marking is the flexibility of marking parameters it offers. The wide range of energies and other laser settings enable a single piece of hardware to interact with the substrate in multiple ways, to produce many different security features, at overt, covert and forensic levels. This flexibility also enables laser systems to accommodate a variety of materials, variety of elements, and combinations of both to obtain the desired quality and throughput.

Security features are especially strong if they include personal variable data. Security at Time of Personalisation™ creates security that is both anti-tamper and anti-counterfeit, encourages strong first-line verification, and helps defend against mass counterfeiting and even component theft.





FIGURE 5 - SAFEWindow™: Example of a new laser-based security feature

Examples of strong overt laser personalisation features include CLI/MLI lenticular devices, tactile elements and perforation. More recently, cards and passports have been constructed with PC containing clear and/or foiled windows, which are laser personalised using marking or ablation processes.



FIGURE 6 – LaserTact™: Example of a new laser-based security feature

More sophisticated lenticular features — which are marked by laser to exhibit very strong 3D optical effects — as well as more extreme tactile features are becoming more common. Covert and forensic personalisation features are also available using laser systems, including the incorporation of personal data hidden within the portrait.

Because laser marking is a technology relatively limited in availability, its use as a secure personalisation technology guards against attempts to simulate or alter ID documents. Even counterfeiters with access to laser marking technology would almost certainly lack the know-how and expertise required to create good simulations of genuine features.

# **DURABILITY**

Durability of IDs is generally examined using test methods that measure resistance to flex, abrasion, chemicals, daylight and extremes of temperature and humidity. Important durability standards for ID documents are ISO/IEC 24789 (for cards) and ICAO's "Durability of Machine Readable Passports." The durability performance of both material and personalisation are considered in these documents.

When compared with most common polymer substrates, polycarbonate performs extremely well in most, if not all, of these tests. Together with certain grades of polyester, polycarbonate is widely considered to offer the longest lasting and best protection to the personal data held on an ID document, whether that data is printed, laser-marked or in electronic form.

In addition, the laser marking is itself inherently durable. The mark formed by the personalisation process is typically carbon, which is chemically inert and does not fade, discolour or migrate. Protection against harsh environments is achieved by creating the mark deep inside the layers of PC. This helps defend against criminal attempts to alter the document.

However, high durability is not automatically assured by the use of laser-marked PC. Construction design and processing conditions must also be correctly defined and diligently followed to ensure the required lifetime is achieved.



## COST

#### **Entrust Datacard**

Phone: +1 952 933 1223 www.datacard.com info@datacard.com The advantages considered previously in this article help to explain the recent increased interest in laser marking. However, cost reduction is perhaps the biggest reason for its global popularity.

The costs of the hardware and substrate material have both fallen substantially over the last five years, bringing a solution that was formerly beyond most budgets into practical and affordable reach, particularly when factoring in the longer validity periods enabled by higher durability.

The drop in cost is being driven by higher production volumes, as well as more competition and technological innovation. Competition from other laser markable substrates, including PET polyester and PVC, is helping to keep PC prices lower, while cost reduction due to innovation applies to both substrate and laser marking systems.

Another driver for PC is the high cost associated with including a microchip in the document. If this expensive device is to survive in circulation, a robust physical "package" is preferred, and well-designed and well-constructed PC is proven to offer suitable protection.

### **SUMMARY**

As the recent surge in the popularity of laser marking of secure ID documents is undoubtedly leading many organizations to consider implementing this technology, it is important to consider the complexities of implementation — and the numerous opportunities to get it wrong. Experienced technology providers can help guide successful implementation and optimisation, drawing on best practices and know-how built up over years of research and implementation. Following these best practices, organizations and their technology partners can work together to design, manufacture and personalise cost-effective ID documents that deliver outstanding quality, security and durability performance.

