Enhanced Polycarbonate

Making the most of Polycarbonate for ID documents

White Paper
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About Gemalto

Gemalto is the world leader in digital security with 2013 revenues of €2.4 billion.

In the public sector, Gemalto provides secure documents, robust identity solutions and services for governments, national printers and integrators in the service of citizens. Its products and solutions are deployed in more than 80 government programs worldwide.

Gemalto has a solid experience in polycarbonate documents. In 1989, the company issued the first polycarbonate ID document (the Finnish driving license) and the first passport with a polycarbonate datapage in 1997 (Finnish passport). In May 2014, Gemalto announced Sealys Color in Polycarbonate, a remarkable innovation that allows very high quality color photographs to be permanently embedded into polycarbonate documents such as IDs, driving licenses and passports. Images up to 1200 dpi resolution have been made robustly tamper-proof through a laser-engraving process, which applies markings deep into the document datapage.

Gemalto also collaborates with its clients to report and share best practices from around the world.
Summary

In 1989, Finland saw the arrival of the world’s first polycarbonate identity document: the Finnish Driving License.

Since then, polycarbonate has established itself as the most suitable material for electronic identity documents thanks to its exceptional optical and physical properties.

What sets it apart from other materials is the non-delaminable property of a full polycarbonate document. When used in pure form and not mixed with other plastics, the different layers of polycarbonate that make up the identity document fuse together to form a solid monolithic structure. All security features, including irreversible laser-engraved personalization information, are safely located within and protected by the 100% polycarbonate document. This is referred to as the one-block concept.

In addition to traditional security features – such as security printing, screen-printing with optically variable inks (OVIs), holograms and diffractive optically variable image devices (DOVIDs) – polycarbonate is unique in supporting highly fraud-resistant level-one security features; that is to say those visible to the naked eye. These features, which are easily authenticated by the relevant authorities, include surface embossing, changeable laser images (CLIs), windows and irreversible laser-engraved personalization.

Moreover, polycarbonate’s durability allows for the production of long-lifespan identity documents which can last for over ten years and is available in a choice of interfaces from chipless, contact, contactless, and dual interfaces (whether with one shared or two distinct microprocessors).

Polycarbonate has won the trust of governments across the world. Over 40 countries have chosen it for their national identity or residence permit programs. Close to 30 national passport programs are using it. The European Directive of 2006 (2006/126/EC) gave member states until January 19, 2013, to make the switch to a polycarbonate credit-card format driving license. The 28 members of the European Union are now implementing these requirements. Many other countries are following.

In addition new techniques allowing color photos to be laser-engraved in the polycarbonate documents and enhanced visual and tactile security features are providing more opportunities to better meet the evolving demands of government authorities and national printers.
Introduction

For centuries, paper was the material of choice when it came to producing identity documents. However, from the 1970s onwards, plastic has gradually taken its place. Specially-designed plastics have emerged that enable the same quality of security-printing as that of paper, but which are also more secure, more durable and more practical.

One particular advantage of plastic cards is that they are able to accommodate - and provide reliable and lasting protection for- the integrated microprocessor used in the most recent generations of identity documents.

Polycarbonate has been used in identity documents for more than 25 years now, and the wealth of experience accumulated, lessons learned and consequent improvements made over that period have made it the most suitable plastic for the purpose.

Sweden has been implementing polycarbonate for its ePassports and national eIDs since 2005. Here are the new generation of documents created in 2012.
Polycarbonate: unique physical and optical properties

Polycarbonate is a type of thermoplastic with excellent moulding and thermoforming properties. It is exceptionally robust and is used to make bulletproof glass. Its optical properties are excellent as its percentage light transmission stands at 90%, higher than that for many traditional glasses. Polycarbonate is employed for a variety of purposes, including the manufacture of indestructible eyeglasses and protecting the surfaces of DVDs. In terms of identity documents, polycarbonate makes it possible to incorporate a significant number of additional security features, including CLIs, transparent windows inside the document similar in effect to watermarks on bank notes, and positive and negative embossing, which are used for tactile recognition.

The Republic of South Africa selected polycarbonate for its new national eID in 2013

One property unique to polycarbonate document is that it is non-delaminable. It is impossible to separate layers of polycarbonate that have been fused together using temperature and pressure. During lamination, the constituent molecules in polycarbonate layers fuse together to form a homogeneous mass. The result is a single, solid document. In identity documents, this solid document serves to trap, and thus protect, all the security features that are printed or positioned on its various constituent layers.

It should, however, be noted that only documents made entirely from polycarbonate are non-delaminable. Hybrid documents -those made from a mix of polycarbonate and other plastics- do not share this property.

Polycarbonate documents contain special layers of carbon-enriched polycarbonate. When these layers are exposed to a laser beam, the carbon reacts to form a permanent black mark, trapped inside the material.

Even at temperatures as low as -35°C or as high as + 135°C, polycarbonate conserves its physical and optical properties, making it ideally suited for the normal conditions of use of identity documents.
A tamper-proof structure

A polycarbonate identity document is created by fusing together multiple layers of polycarbonate in a glue-free process, using temperature and pressure.

![Diagram of polycarbonate identity document layers]

Each layer has a specific role:

- The central layer is generally opaque and white. It can house an antenna to enable contactless reading of an electronic chip.
- Intermediate layers carry the security imprint and the specific security features, such as DOVIDs and screen-printed OVIs.
- A carbon-enriched intermediate layer supports laser-personalization.
- The outer layer bears the tactile embossing and the CLI.

A polycarbonate electronic identity document can be contact, contactless or dual-interface functioning in both contact and contactless mode. Dual-interface document may have a single shared microprocessor, or two separate microprocessors for each interface. The durability of the polycarbonate document is not affected by the electronic system.

All security imprints and security features are embedded and protected within polycarbonate, formed by the fusion of layers. Any attempt to tamper with the document will leave clear visible marks.
Irreversible personalization – now also in color

The most widely used polycarbonate ID personalization technique is laser engraving which results in the formation of a permanent black mark inside polycarbonate identity document. This mark is precise and non-reversible. The letters and figures are deep black, and may have a distinctive texture. The photo is black and white, with shades of grey and high contrast. Personalized engravings are made within the solid polycarbonate document and are therefore irreversible.

The security printing industry has long pursued to unite the benefits of laser-personalized polycarbonate ID with the detail and richness of color photo. Color photo can be personalized on polycarbonate document by "reversed printing"-based on a thermal dye sublimation technique called ‘D2T2’- similar to the process used for non-polycarbonate documents – or by inkjet printing. However, with such technology color photo needs to be protected by an overlay or a varnish, resulting in compromised document integrity as well as loss of tactile features. Printing color photo in one of polycarbonate layers before lamination step in manufacturing is another solution, however making the issuance inflexible.

Gemalto’s Sealys Color in Polycarbonate is a laser printing solution delivering an unalterable high resolution color image inside polycarbonate ID document. Color laser marking is based on the principle of selective bleaching. During manufacturing, photosensitive pigments are sealed inside the polycarbonate document. The Sealys Color in Polycarbonate solution features an optical laser beam with deflection system for precision focus. During the separate personalization phase, laser light irradiation bleaches the pigments to achieve a nuanced reproduction of the original color image embedded inside the document.
Main security features for polycarbonate documents

Polycarbonate identity documents support all traditional security features: guilloches, rainbow printing, screen-printing, optically variable inks, transparent and metallic holograms, ultraviolet inks, and taggants.

The first differentiator for polycarbonate is that all these security features are protected inside a single solid block. The second difference is that polycarbonate allows exclusive, difficult to counterfeit level-one security features.

Laser- engraving of personal data renders a precise, bold and irreversible mark securely inside the polycarbonate document. Numerous security features, such as CLI, DOVID and window, can be personalized by laser. Depending on the document structure, it is possible to create tactile effect by increasing laser power.

The surface of the identity document may have various distinctive, easily -recognizable textures, such as guilloches, designs, micro-text, and latent surface image, created by positive or negative embossing. New features for surface embossing include microscale 3D image, braille, optically variable surface with light reflecting elements, and animation effects similar to DOVIDs, enhancing the security of polycarbonate ID documents.

A CLI, personalized by laser engraving, will display two different images when viewed from different angles, such as a photo of the holder, and their date of birth. The next generation CLI developed by Gemalto offers complex shapes and possibility to combine with other elements, such as microtext or stand alone element inside the CLI, making it more difficult to be copied or reproduced.
A window feature through the entire solid document can be verified by the bare eye and does not require any special lighting. It makes the document even more tamper-proof by being impossible to copy and by combining the front and reverse sides of the document together.

Additional security features can be incorporated in the window, such as lenses, decoder, metalized foils, DOVIDs, various types of security printing, and personalization. Personalization of the window feature can be made by laser engraving. Tampering of personalized data in a window unavoidably leaves evidence in the form of scratches, seams, color changes, or altered thickness. A window feature is immediately recognized by human eye and easy to teach to anyone verifying identity documents.

Sealys Window with decoding lens can be seen in the current Swedish passport. The decoder in the window reveals the data encoded into the color personalized photo on the first visa page of the passport booklet.
Gemalto’s Sealys Edge Sealer feature consists of personalized data on the edge of the document made by laser engraving, protecting the document against grinding.

The new polycarbonate UK Driving license has been using this new security feature since 2013.

Easily authenticated

Border control authorities can easily check the authenticity of polycarbonate documents, thanks to the level-one security features exclusive to this material.

In situations where identification is checked, time available for the inspection of the document can be very short, only 3-10 seconds. Therefore, level-one features that guarantee the authenticity of the document and integrity of the personalized data without special tools, in an instant, are valuable.

Durable

Since 1989, numerous polycarbonate identity documents have been in use, even in the most extreme climatic conditions, such as in the cold Scandinavian climate of Finland, the tropical climate of Singapore and the arid conditions of Tunisia.

Whatever the weather, polycarbonate identity documents have proven to have a lifespan comfortably in excess of 10 years. Polycarbonate documents excel in extreme physical and chemical lab tests, but, more importantly, they stand up very well to normal, intensive, and even excessive use in real situations.
Flexible issuance procedure

The issuance procedure for polycarbonate documents renders any counterfeiting extremely difficult due to the considerable expertise and know-how required to personalize the document. First of all, special laser-engraving equipment is required for the personalization, and secondly, highly-qualified specialists are required to operate such equipment.

Personalization by laser engraving is particularly well suited to a centralized issuing model, using high-speed equipment with powerful lasers. Desktop laser-graving equipment may be used to issue documents locally, either in place of a centralized issuing system or in addition to it in a mixed model scenario. A mixed model is used for Swedish passports, which are centrally issued, but at some ports and airports it is possible to obtain an "express" passport that is personalized by laser engraving, like the standard-issued document. The issuance procedure does not involve contact or complex mechanical operations. It is therefore reliable and does not require the use of costly and environment-unfriendly consumables.

Neutral environmental impact

The environmental impact of polycarbonate is neutral. It is made from hydrocarbons, principally via the input of energy and carefully controlled chemical additives. The current production process generates no dangerous residue. At the end of use for the polycarbonate product, its combustion releases most of the energy used for its manufacturing. Combustion of polycarbonate produces carbon dioxide and water. No toxic gases are generated.

Furthermore, the polycarbonate personalization process relies mainly on energy from the laser beam and does not require consumables that generate waste.

Competitive cost

The cost of an identity document must be assessed over the whole of its lifetime, from production of the blank document to personalization for issue, and right up to destruction at the end of product’s life. Granted, a blank polycarbonate document can cost more to produce than documents made from other materials, but this is mostly because of the higher number of security features offered by polycarbonate.

However, the centralized personalization process using laser beams and no additional materials is particularly cost-effective, making polycarbonate solutions more competitive when it comes to processing significant volumes. Furthermore, polycarbonate’s exceptional durability allows for long reissuance cycles up to 10 years and also minimizes the risk of premature wear.

To be truly comprehensive, the cost assessment must also take into account costs ensuing from fraud. It is difficult to establish accurate simulations and estimates, but the enhanced security provided by polycarbonate offers significant cost savings in this area.
Solid experience

The Finnish driving license was the first polycarbonate ID document, issued in 1989. The Finnish passport was the first polycarbonate passport, issued in 1997. The Finnish national ID card was the first polycarbonate electronic national identity card, issued in 1998. Since then, many other countries have adopted polycarbonate material for their national identity documents:

- Worldwide, almost 30 countries issue passports with polycarbonate data pages
- All European countries are issuing polycarbonate driving licenses
- Over 40 countries issue polycarbonate national identity or residence permit cards
**Conclusion**

Polycarbonate identity documents are secure and reliable. Their quality resides in the exceptional optical and physical properties of polycarbonate. They are non-delaminable, and their personalization by laser engraving is irreversible. They incorporate easy to authenticate level-one security features.

The security industry is constantly engaged in research and development activities aimed at developing new and innovative security features using polycarbonate. Recent innovations, such as color laser-printing as well as enhanced visual and tactile effects, are giving additional opportunities to government authorities and national printers to seriously consider polycarbonate for their document projects.

To guarantee a smooth progression to the next generation of secure polycarbonate documents, it is important to select partners and suppliers with long-standing experience of the security printing environment and a proven track-record in document design, manufacturing and issuance.

Gemalto is one such supplier, expert in polycarbonate since 1989. The company provides technologies and services to over 80 national government programs around the world and is geared up to help you succeed in your project.
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This white paper is describing the major benefits of the new generation of enhanced polycarbonate secure documents.

The security industry is constantly engaged in research and development activities aimed at developing new and innovative security features using polycarbonate. Recent innovations, such as color laser-printing as well as enhanced visual and tactile effects, are giving additional opportunities to government authorities and national printers to seriously consider this enhanced polycarbonate environment for their document projects.