Bonding solutions in e-Passports

How adhesives contribute to secure biometric passports

by Erwin Herzog

In this article, Erwin Herzog describes how adhesives contribute to secure biometric and non-biometric passports during the production and personalisation stage and in daily use, and also why for future passports new adhesives are currently under development.

Since the introduction of the first booklet-type passports almost a century ago, passports have evolved into high-tech products with security features such as printed or laser engraved photographs, optical and electronic elements, laminates, watermarks and machine readable data, to name but a few. Many of those features are supposed to prevent or reveal any tampering and forgery attempts in modern passports. Although security features are generally difficult to counterfeit, it is clear that they are ineffective or even counter-productive if not properly integrated into the passport booklet. Therefore, sophisticated bonding solutions are required to ensure both secure integration of security features and high durability during the ten years of a passport's life.

Early predecessors of passports were signed letters or documents which allowed the holder of that document to travel to a defined place. The first booklet-type passports included a simple photograph to identify the holder. Over time, more and more security features were added: countries replaced the holder's glued-on photograph with a printed or laser engraved one, and started to incorporate an integrated circuit - thanks to the digital revolution.

From a technical point of view, the electronic passport is a complex combination of different materials bound together in a booklet-type document. The components used for passport production vary from country to country, resulting in many different national passport solutions (figure 1). Not only is the booklet and its content supposed to reliably withstand a time span of ten years in different climatic regions of our world, they need to withstand or reveal any illegal document manipulation and tampering attempts. In order to fulfil those demanding requirements and to produce a unique and tamper-resistant passport, secure bonding solutions are needed for the production of the passport cover, booklet and inlay, for protection of the personal data (both the readable data on the data page as well as the element containing the electronic data) and to grant additional rights to the owner of the document during the validity period of the passport (visa, permits).

ICAO e-Passport requirements

Now that air travel has become common place for long distance journeys, and due to the need for increased security after 9/11, the International Civil Aviation Organisation (ICAO) has laid down the basic functional specifications for machine readable travel documents (MRTDs)[1]. The organisation also provides test specifications for biometric or e-Passports, i.e. machine readable passports which incorporate contactless integrated circuits. For these, ICAO specifies the minimum requirements to which e-Passports have to comply with regard to durability and quality level. The e-Passport as a whole must meet the laid down specifications; the booklet must not delaminate upon any of the stress tests thereby ensuring document durability of ten years.

Passport booklets are subjected to a number of mechanical, chemical and environmental stress tests, to simulate normal booklet handling over a period of up to ten years. These tests include:

- back pocket testing;
- thermal cycling;
- delamination sequence;
- exposure to aqueous solutions and chemicals;
- salt mist test.

These tests will have to show that all bonded parts must be difficult or impossible to delaminate in order to provide passport integrity and security. ICAO specifications, however, do not address any security concerns with regard to document manipulation and tampering attempts. For these issues, additional guidelines and requirements are forthcoming from suppliers, government agencies, system integrators and passport manufacturers.

Bonding technologies

Although there are several bonding technologies, nowadays passport production is dominated by a

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Figure 1
Passport specifications and components vary from country to country, resulting in many different national passport solutions.

wet bonding process. During this process the cover material, endpaper and inlay are bonded together by a water-based adhesive (figure 2).

Other bonding technologies are:
- moisture-curable hot melt adhesives, which are utilised to form the assembly of inlay and cover materials;
- adhesive films (reactive and non-reactive) that are activated by heat and pressure.

Security thread
The end page, data page and visa pages are sewn together using a security thread to form the book block. In order to enhance the mechanical stability and tamper resistance of the sewn pages, before sewing the book block together, across its spine a reinforcement tape is attached to the endpaper (figure 3). Additionally, the security thread can be fixed with an adhesive, making it more difficult to remove it from the finished product.

Passport cover and booklet production

Until recently, the passport cover mainly had to protect the passport pages from damage during its usage of up to ten years. Manufacturing properties and good mechanical stability of the laminate were more or less the only requirements for the adhesive used. However, new bonding solutions are required since the introduction of the e-Passport, as the passport cover may be constructed in a number of ways, involving new materials (inlay, shield material, etc.). The cover itself has now become a security feature to be protected, as it contains the integrated circuit and electronic information about the passport holder. This should be considered when determining specifications and requirements for the electronic cover.

Box 1

Reactive and non-reactive adhesives

Today, both reactive and non-reactive adhesive systems are applied for the different bonding solutions in electronic passports. Reactive bonding solutions are considered to provide an improved resistance to tampering, but is this really true? What is true, is that cross-linking enhances cohesion in reactive adhesive systems accompanied by an improved heat and chemical resistance. However, the adhesive is only one component of the entire system and therefore it is imperative that the final system is always taken into consideration.

All the materials and techniques used (machine, substrates and adhesive) have to match in order to end up with a comprehensive solution which considers performance and costs. Whether the adhesive system chosen is reactive or not is actually irrelevant. What is relevant is that the final system fulfils all requirements including tamper resistance.

Inlay production

An e-Passport contains a contactless integrated circuit which may be assembled between two sheets (e.g. polycarbonate, paper or synthetic paper sheets) to form the electronic inlay. In the passport booklet the inlay can be part of the passport cover, part of the data page or it can be placed in the middle of the passport booklet between two visa pages. Depending on the materials used, an adhesive must be applied in order to fulfil the specified ICAO requirements as well as to guarantee a passport lifetime of up to ten years. Both reactive and non-reactive bonding solutions can be used for this application (see box 1).

Protection of the data page

Once the booklet has been manufactured, it can be personalised with the picture and personal data of the holder. The data page is the most important part of the passport as it reveals the authenticity of the document and the bearer's identity. In the past - and in some countries still today - a photograph was glued onto the data page and protected with an embossing stamp, a seal and/or clear laminate.

For improved protection, the personal data and photograph are now either laser engraved into polycarbonate or printed onto a paper-based page. In the latter case, the data is present on the paper surface and therefore susceptible to illegal manipulation. In order to prevent any tampering attempts, a combination of visible and invisible features can be implemented, such as security print, microtext, latent image and optically variable devices (OVDs).

OVDs can be applied by hot stamping or hot laminating an overlay with the desired optical features such as a transparent hologram or Kinegram® onto the data page. Such an overlay has to pass all kinds of tests, such as conditioning tests, abrasion tests, bending tests and tests to prove that the overlay is resistant against solvents, water and mechanical attempts. These requirements can only be met by a careful deployment of the right system, i.e. the substrate, the adhesive and the bonding technology have to match perfectly.

Very often the adhesive used in such applications has to be tailor-made, taking into account the different types of hot stamping foils, optical features, papers, inks, and test methods. The adhesive layer must be thick enough to ensure good adhesion and at the same time thin enough to make it difficult for counterfeiters to attack the laminate from the adhesive side. Even though the adhesive is invisible, it is a vital part of the system: if the adhesive is not carefully selected, it might be possible to remove the security feature, thereby making the passport vulnerable and susceptible to fraud (see figure 4).

Figure 2
Sewn book block, to be bonded onto the passport cover, about to enter the bonding module of a Kugler-Womako passport line (source: Kugler-Womako).

Additional rights, visa and permits

E-Passports are issued with a validity period of up to ten years, depending on the type of passport, the applicant's age and government policy. During this period additional rights may be granted to the passport holder. Very often granted rights such as visa, residence permits and work permits are added to the passport booklet as a sticker attached onto a visa page of the passport. The adhesive used for this purpose is a pressure-sensitive adhesive, pre-applied on the back of the visa/permit to be granted. It has to demonstrate a high initial bond strength, good adhesion to passport paper and a good resistance to aqueous solutions, solvents and high and low temperatures, so that the granted right can't be removed and transferred from one passport to another. Naturally, the adhesive should not interfere with any chemical reactive feature present in the security paper, thereby causing the paper to stain.

Innovations

Travel documents have a long history and it is very unlikely that they will disappear in the near future. They will certainly continue to evolve, driven by technical developments, political aspects, and identity as well as document fraud. As long as there is a need for physical travel documents, there will always be a need for bonding solutions. Looking into the future of

Figure 3
Book block of a passport with reinforcement tape, bonded across the spine of the endpaper.

Figure 4
Even though the adhesive is invisible, it is a vital part of the system.

e-Passports, additional bonding solutions may be used for the following applications:

- a highly secure polycarbonate (or other polymer) data page with a printed colour photograph instead of the laser engraved black and white one. There are several technical solutions feasible; adhesion promoters can help to enhance adhesion between the printed areas and polymer layers, to make it more difficult to tamper with the data page;
- a flexible, ultrathin display integrated into the data page or passport cover (instead of or in addition to the printed/laser engraved photograph);
- new security features may be added, for example a transparent window on the data page.

New innovations will require new materials, new material combinations and new techniques, making it inevitable that adhesives are included in future passports (figure 5).

Conclusions

From a technical point of view, the electronic passport is a complex combination of different materials bound together in a booklet-type document. At the same time, a passport is a unique product for each national government. The booklet and its content are supposed to reliably withstand a time span of ten years in different climatic regions of our world, including withstanding and revealing any illegal

document manipulation and tampering attempts. In order to fulfil those demanding requirements, secure bonding solutions are needed for the production of the passport cover and booklet, for protection of the personal data and to grant additional rights to the owner of the document during the validity period of the passport. While there are methods to test the durability of a laminate in different stress situations, specifying methods to determine tampering is very difficult as counterfeiters are very creative when it comes to inventing new methods to manipulate a document.

The last decade has shown that the complexity and diversity of materials used in machine readable e-Passports is increasing, driven by technological progress, political circumstances and document fraud. The growing number of technical features used in national e-Passport programmes makes sophisticated bonding solutions vital. A close collaboration with a specialised adhesive manufacturer helps to find the bonding solutions needed and to reduce development time.

Figure 5
Adhesive lab: adhesives will inevitably be included in future passports.

1 ICAO's Doc 9303 lays down the requirements for machine readable passports, machine readable visas and machine readable official travel documents issued by participating countries.