

HISTORICAL DEVELOPMENT OF SECURITY FEATURES OF DOCUMENT PROTECTION

PhD., **Matej Barta**,
Academy of the Police force in Bratislava,
Sklabinská 1, 835 17 Bratislava, Slovakia,
<matej.barta@minv.sk>,
<matej.barta@akademiapz.sk>

Summary

In the presented article, the author discusses the historical development of technical protection of documents in the conditions of the Slovak Republic, as well as new trends in document protection. The aim of the paper is to point out the importance of constant development of technical protection and security elements that are used in document protection.

The elements of technical protection and their constant development contribute to a large extent to the prevention of falsification and alteration of the documents in question.

Keywords: criminalistics, documents, technical protection, travel document, ID cards, security threats.

Introduction

The historical development of documents as well as elements of protection began with the development of security, printing and printing techniques. The most widely used printing techniques in the production of documents include, for example, surface printing and gravure printing, which began to develop in 1880. Height printing is one of the oldest printing techniques and is used to print serial numbers.¹ Following this development, documents and security features were also developed. The methods of technical protection of protected documents vary considerably, depending on the document in question. There are a large number of security features that are used in technical protection and therefore it is very difficult to assess whether the feature is more important and significant for the protection of the document. For banknotes, the backing material used plays a major role in protection. We consider the introduction of polymer and hybrid substrates to be one of the major trends, which enables

the emergence of innovative safety features. The properties of the polymer substrate, such as transparency, allow the protection elements to be placed in transparent windows such as eclipse, latitude, horizon etc. For passports, we can assume that in the future, biometric protection will include elements such as retinal analysis, ear shape, body odor, voice recognition and DNA analysis. Criminalistics deals with the issue of documents not only in criminalistic technology, but its elaboration can also be found in tactics, such as document inspection. Document inspection is a broad concept, but for the purpose of clarification we can understand it as an inspection of paper materials and documents. Documents from a forensic point of view may be examined separately, provided that they have been delivered to the investigating entity and that there are other forensic traces, such as biological traces, on the documents in question.²

Development of technical protection of documents in the conditions of the Slovak Republic

The ID cards of the Czechoslovak Socialist Republic (ČSSR) issued since 1960 were in book form. The main protective elements included a watermark in the shape of a five-pointed star and the text „Czechoslovakia“. Two printing techniques were used in the production, namely printing from above and printing from the surface. The data during personalization were written by hand and the holder's photograph was protected by a wet stamp and riveting (Fig. 1). The citizen's card of the Czech and Slovak Federal Republic (CSFR) issued since 1990 was also in book form with a dark brown cover. The security paper contained a watermark in the shape of the letters „CS“. Two printing techniques were used for printing, namely printing from the height to the registration number of the document and printing from the area. The data were listed manually. The photograph was

protected by a wet and dry stamp (Fig. 2). On September 1, 1993, the Slovak Republic began issuing identity cards, which contained more complex elements of protection. A layer of laminate was added to the base material (paper) and it took the form of a card. The base material contained a watermark in the shape of linden leaves and the coat of arms. Protective fibers visible only in ultraviolet light were added, as well as fluorescent elements on the data side in the form of national emblems in a circle. The following printing techniques were used: vertical printing and surface printing, supplemented by iris color transition and microtext. The photograph was protected by a two-dimensional hologram and applied transparent foil (Fig. No. 3). The breakthrough in the issuance of ID cards occurred on July 1, 2008, when polycarbonate began to be used in Slovakia. At present, polycarbonate with an

1 Panák, J., Čeppan, M., Dvonka, V., Karpinský, L., Kordoš, P., Mikula, M., Jakuciewicz, S. (2008). *Polygrafické minimum*. 12.
2 Laca, M. (2017). *Obhliadka*. 41.

applied contact chip is used as the base material. From the printing techniques that complement the protection, surface printing is used, complemented by an iris color transition. It also contains negative and positive microtext. The basic motif of the protective underpressure consists of five-pointed stars and hexagons. The ID card also contains UV graphics, an optically variable color in the shape of a linden leaf in the upper

right corner of the front of the document and in the shape of a coat of arms in the upper left corner on the back. Laser engraving is used for personalization. The photo is partially covered with a hologram with motion and color effects. An important element is the contact chip, which stores the data about the holder and the machine readable zone. The latest version is an identity card issued since 2015 (Fig. No. 4).

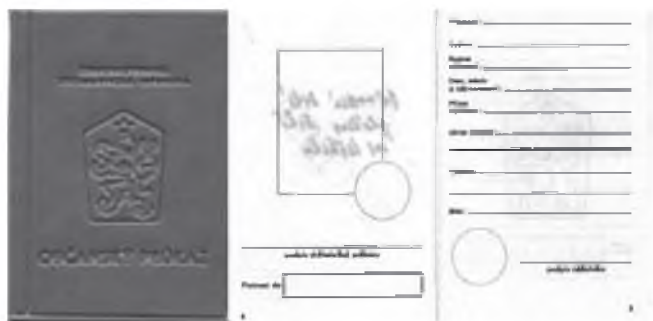


Fig. no. 1 – ID Card ČSSR (1960)



Fig. no. 2 – ID Card ČSFR (1990)

(Source: www.minv.sk)



Fig. no. 3 – ID Card SR (1993)



Fig. no. 4 – ID Card SR (2015)

(Source: www.minv.sk)

Passports issued from 1 April 1994 to 31 March 2005 were printed on security paper, which contained a watermark in the shape of a linden leaf and a tri-fold with a double cross. In the production of paper, yellow protective fibers and fibers that react in UV light were incorporated in the waist. Under UV lighting, we can observe the state emblem in a circle on this type of document, as well as the page numbering. Three of the printing techniques were used, namely depth printing, which is used in the printing of the hidden inscription „Slo-

vákia”. Height printing used to print a passport serial number and other graphics completed by printing from an area that includes an iris gradient. On the data page there is a photo of the holder and the data, which are protected by a linden leaf-shaped print with a laminate foil (Fig. No. 5). Passports in the Slovak Republic have also undergone the development of security features and the latest version is a passport issued from 26.11. 2014 (Fig. No. 6).



Fig. no. 5 - Passport SR (1994)



Fig. no. 6 - Passport SR (2014)

(Source: www.minv.sk)

Driving licenses issued in the Slovak Republic until 30 April 2004 took the form of a laminated paper card. The backing material (paper) did not contain watermarks or protective fibers. Height printing and surface printing were used to print

the serial number. The data was filled in by a typewriter, later on computer printers. The photograph and data were protected with laminate (Fig. No. 7). The latest model is a driver's license issued since 16 September 2015 (Fig. No. 8).



Fig. no. 7 - Driving license SR (do 2004)



Fig. no. 8 - Driving license SR (2015)

(Source: www.minv.sk)

Documents in the Slovak Republic, resp. most, with the exception of the passport (also made of paper), are made of multilayer polycarbonate and personalized by laser engraving technology. The photo and personal data are laser engraved in plastic foil or card. During laser engraving, the data is recorded by blackening the laser-sensitive film.

Iris color transition / iris printing - line printing with smooth color transitions. A dyeing process that is used to protect against color separation or copying by gently blending the colors to produce a smooth color change.³

Protective print / underprint - serves as protection against data manipulation, which consists of printed patterns and security features, such as. guilloche, iris color gradient, microprint, hidden pattern. The basic motif of the protective print is the graphics of hexagons in combination with five-pointed stars.

Microtext - microprints are lines that consist of very small and hard-to-see letters, numbers or images. They are visible only at magnification and are often used as elements of protective printing and on protective strips. Microprinting cannot be achieved by conventional means of reproduction, so it is often illegible in false documents. The term infinite text is often used for this type of text, which is repeated on the strips and is usually without spaces. In the conditions of

3 Panák, J., Čeppan, M., Dvonka, V., Karpinský, L., Kordoš, P., Mikula, M., Jakucewicz, S. (2008). *Polygrafické minimum*. 184.

the Slovak Republic, positive and negative microtext is used for document protection, which means small letters printed in a positive and negative image visible only at magnification.

Optically variable color (OVI) - a color containing pigments that act as interference filters, which cause significant color changes when changing the angle of view, e.g. change of linden leaf color from purple to green on the identity card.⁴

UV graphics - the main element of UV graphics is a fluorescent color that fluoresces under UV (ultraviolet) light. Fluorescent printing is created by printed security features on the film, which are usually located on the inside of the film to protect them from abrasion or tampering with the authenticity of the document. Fluorescent fibers are added in the process of making a paper substrate in which they have a protective function. They are located on each side in random places and at random depth.

Hologram - a diffractive optically variable image element that belongs to the traditional types of technical protection. We know 2D holograms (two-dimensional) with a change in structure and color or 3D holograms (three-dimensional) with motion effects.⁵

Foil embossing - consists of transferring the foil using a heated embossing mold. It is one of the forms of printing from above. Relief structure created from the text „Slovak Republic” and the abbreviation „SVK”.

Contact chip / microchip - an integrated circuit for storing and processing data on the holder of an identity card, which contains, for example: name and surname, date and place of birth, digital version of the holder's form. The chip enables electronic use of the document and is secured by active and passive authentication mechanisms. The visible part of the chip are gold-colored contacts.

Contactless chip - a contactless integrated circuit that is integrated, for example, into passports and residence permits. Used to store holder data. On polycarbonate cards, the chip is visible in oblique light and the surface of the card is almost always finely embossed. This overhang cannot be felt because the surface change is too slow, but if the card is tilted, the microchip can be seen with the naked eye. The chip is connected to an electromagnetic loop antenna, which allows the chip to communicate with the card reader via electromagnetic waves. The contents of the chip can be read from a distance of 0 - 10 centimeters. The chip is incorporated into passports in various ways, either in a thick transparent foil, in the packaging of the document or in the polycarbonate side with personal data.⁶

Machine Readable Zone (MRZ) - contains information about the holder and the document in the form of alphanumeric characters and the symbol „<”, which consists of two

to three lines. Readers can read this series of characters to simplify document control. The ID1 ID card format used in Slovakia contains three lines of 30 characters on the back of the document. For passports, the ID3 format contains two lines of 44 characters at the bottom of the personal data page.

Kinegram - a transparent optically variable element with color effects. a computer-generated hologram that can create high-resolution, multi-color images. It contains special types of diffractive optical elements that can be arranged to create color change, motion effect, contrast change and other special effects. The kinegram serves as a security feature on the residence permit.⁷

Guilloche frame / guilloche - contains latent text. Drawings that consist of intersecting lines arranged in geometric shapes. Guilloches are sometimes combined with an iris color gradient.

Variable laser pattern - is made by laser engraving and applied to plastic cards. The individual elements of the shape are engraved at different angles. The variable laser pattern, referred to as the CLI (Changeable Laser Image) vertical grid, is located on the vehicle registration certificate and the MLI (Multiple Laser Image) horizontal grid pattern contains passports with a secondary holder and date of birth.⁸

Protective strip - is made of plastic, metal or other material. It is applied to the substrate during production and serves as an additional element of technical protection. There are various types of protective strips such as polymer strips, strips with a metal surface, colored laminate strips with microprinting and the like.

Watermark - the traditional watermark is incorporated into the paper during production. Watermark patterns are created by applying pressure to the substrate. Which leads to a change in paper thickness. It is sometimes called a Fourdrier watermark. We know 3 types of watermarks:

- Monotone watermark - light or dark
- Two-tone watermark - is both dark and light
- Multi-tone watermark - sometimes referred to as shadow watermark. Used in the production of banknotes or passports.

Watermark is an extremely effective and still unsurpassed barrier against forgery of documents. The true printing watermark has specific features that can only be mimicked by paper technology. Through these properties and using appropriate identification methods, always reliably determine the authenticity of the watermark. Nowadays, the development of the production of original chemical watermarks, which are a cheaper option than protecting important documents, is growing.⁹

4 REGULA: <<https://www.regulaforensics.com/en/support/glossary-banknotes/>>.

5 Straus, J. a kol. (2012), *Kriminalistická technika*. 262.

6 REGULA: <<https://www.regulaforensics.com/en/support/glossary-documents/>>.

7 Straus, J. a kol. (2012). *Kriminalistická technika*. 263.

8 REGULA: <<https://www.regulaforensics.com/en/support/glossary-documents/>>.

9 Provazníková, J., Tiňo, R., Kirschnarová, S. (2013). Metódy identifikácie a analýzy vodoznakov na papierových dokumentoch. *Kriminalistika v praktických príkladoch*.

New trends in document protection

Among the biggest shifts and advances in the technical protection of documents is visible in improving the security features of banknotes. The most important are:

AURORA - highly safe color substitution of inks. When viewed with the naked eye, two different colors are visible. The change occurs when the banknote is tilted, where these two different colors intersect to achieve the same color range, creating a significant visual effect. The aurora security feature uses an optical effect called angular metamerism (a phenomenon in which two colors appear to the human eye as the same, even though they are not the same in terms of spectral characteristics)¹⁰, in which a set of different colors appears at a certain angle of light as one color and subsequently at a different angle than a completely different color. This is a comprehensive, high-security security feature used in transparent windows on both sides of the banknote.¹¹

ECLIPSE - is an optically variable element in a transparent window that reveals a hidden image in transmitted light. This element is unique in that it can be seen to some extent even at night or in low light. Mechanical and optical methods of reproduction are so complex that they have so far withstood all attempts at counterfeiting, which have even come close to this visual effect.¹²

LATITUDE - This is the first diffractive optical effect to be created by a diffractive structure embedded in a substrate layer and coated with silver nanoparticles. The element is formed during the manufacturing process of the polymer substrate. Latitude is unique in its ability to deliver diffractive optical effects while creating a semi-transparent appearance. As a built-in structure in a transparent window, it can be designed in any part of the banknote. It allows unlimited design options as well as easy authentication.¹³

HORIZON - is an advanced lenticular technology¹⁴, which allows for a dynamic range of contrast-switching movements. A security element that uses the entire depth of the substrate, which makes extraction or reuse of the element extremely difficult. The structure of the transparent film and the printed image represents a significant technological barrier for counterfeiters.¹⁵

CAMEO - a security feature that can also be called a watermark in a polymer substrate. It is increasingly considered to be a much more effective element than the multi-ton watermark contained in a security paper, because we can examine it in both reflected and transmitted light. Cameo has been supported by the development of gravure technology to ensure consistent print quality and durability. Feedback

and counterfeiting trends have shown that a more complex picture has been an effective method of counteracting threats from screen printing and banknote counterfeiting.¹⁶

TRUEIMAGE - is the latest feature of the holographic image in polymer banknotes. The shapes are visually differentiated through their 3D photorealistic rendering with cinematic animation effects that address the needs of easy authentication and strong technical security.

PUREIMAGE - holographic protective fibers.

GEMINI - is a special printed security element that appears as a single color in normal daylight, but under UV light it transforms into two separate fluorescent colors.¹⁷

SIGNUM - is a type of watermark with a strong, easily recognizable effect, which opens up the possibility of creative banknote designs. A characteristic appearance is achieved by adding areas that are darker than the surrounding paper. Darker areas are created by a larger accumulation of paper fibers, making them very easily visible. Due to the high density and thus the strength of the paper in these areas, it is significantly suitable for use in thin papers applied to multi-layer substrates.¹⁸

Other new security features in the hybrid substrate are: Irisafe®Micro, an innovative feature that has sharply defined colored edges; Polarisafe®, which can be hidden or built into security threads or rainbow stripes.

Documents

Travel documents according to EU Council Regulation no. Regulation (EC) No 2252/2004 on standards for security features and biometrics in passports and travel documents issued by Member States, approved on 13 December 2004, must contain the first biometric features, such as a face and fingerprints. The introduction of biometrics brings new ways of protecting documents. Biometric features - we can divide them into two groups:

1) stable data - based on physical and physiological aspects that measure the physiological characteristics of a natural person. They include: fingerprints, iris recognition, face recognition, retinal analysis, head mark analysis, ear shape, body odor, voice recognition and DNA analysis.

2) dynamic data - based on measuring a person's behavior and include: signature verification, keystroke analysis.¹⁹

Security features:

SKYLIGHT - is a special, unique and complex watermark feature for use in passports, where small areas appear

10 GUARDIAN, Metamerics shine a new light on security inks, 2015

11 REGULA: <<https://www.regulaforensics.com/en/support/glossary-documents/>>.

12 CCLSECURE: <<https://cclsecure.com/eclipse/>>.

13 GUARDIAN, Keeping you notified, 2018

14 Lenticulárna technológia - tlač špeciálne pripraveného obrazu priamo na tzv. lenticulárnu fóliu, ktorá umožňuje prehliadanie rôznych obrazov podľa uhla pohľadu. V závislosti na technike prípravy a smere usporiadania prúžkov fólie sa dajú dosiahnuť rôzne vizuálne efekty.

15 CCLSECURE: <<https://cclsecure.com/horizon/>>.

16 GUARDIAN, Vignette design evolves into the CAMEO™ portrait, 2015.

17 DELARUE: <<https://www.delarue.com/global-insights/new-and-news/product-spotlight>>.

18 LANDQART: <<https://www.landqart.com/products/signum/>>.

19 Rak, R., Matyáš, V., Riha, Z. (2008). *Biometrie a identita človekaveforenzniých a komerčnich aplikaciách*. 104.

lighter and thinner than their background. SkyLight™ prevents paper splitting, laminate lifting and refolding with fraudulent data.

Optically variable color (OVI) - a color containing pigments that act as interference filters, which cause significant color changes when changing the angle of view, e.g. change of linden leaf color from purple to green on the identity card.

DYNAPRINT - combination MLI (MultipleLaserImage) horizontal raster OVI optically variable color.²⁰

TLE (Transparent Laser Engraving) - transparent laser engraving. It is in the form of transparent raised features on the outer surface of the substrate. It increases the security of the document without compromising its readability.

PCP (Polycarbonate Color Personalization) - polycarbonate color personalization. Technology of color personalization of polycarbonate cards within their structure. Increases the safety of the production process.²¹

Conclusion

Each method of examination helps to detect counterfeit, which are of different quality and made with different reproduction aids. The quality levels of counterfeits are divided according to the methods and devices used in the forgery. One of the most important methods of examining banknotes, travel documents, ID cards and others is microscopic examination, which serves to make the details of the examined objects visible. It is used when examining and observing the structure of the underlying material, when assessing the

authenticity of printing techniques as well as other protective elements of banknotes. The principle of examination consists in examining details under appropriate magnification. Microscopic examination takes place in cooperation with other non-destructive methods. It can be noted that not every examination method requires complex technical means to be effective in verifying authenticity. It is very important that the protective elements that are the subject of examination and at the same time counterfeiting are constantly improved.

DOKUMENTŲ APSAUGOS POŽYMIŲ ISTORINĖ RAIDA

Matej Barta

Santrauka

Šiais laikais yra įvairių patobulintų bazinių medžiagų naudojamų dokumentų gamybai. Dokumentų bazinių medžiagų ir jų rekvizitų gamyba užsiimančių įmonių nuolatinės pastangos buvo nukreiptos gerinti apsaugą vandens ženklų srityje, dėl ko atsirado pvz. pikselių vandens ženklai. Šiuo metu naudojami polimeriniai ir hibridiniai dokumentų pagrindai užtikrina didesnę dokumentų apsaugą. Polimerinio pagrindo savybės, tokios kaip skaidrumas, leidžia į skaidrius langus dėti papildomus apsauginius elementus. Asmens dokumentų, vairuotojo pažymėjimų, kelionės dokumentų, prekių ženklavimo techninė apsauga prasideda jau gaminant

pagrindinę dokumento medžiagą. Šiandien apsaugai naudojamos sudėtingesnės technologijos ir vis sudėtingesnės funkcijos, pavyzdžiui, paso biometriniai duomenys, kurie turi didelę reikšmę nustatant paso turėtoją. Apsaugos elementų, kurie naudojami techninei apsaugai, yra labai daug, todėl labai sunku spręsti, ar elementas svarbesnis ir aktualesnis dokumento apsaugai.

Raktiniai žodžiai: kriminalistika, dokumentai, techninė apsauga, kelionės dokumentas, asmens tapatybės kortelės, grėsmės saugumui.

20 REGULA: <<https://www.regulaforensics.com/en/support/glossary-documents/>>.

21 PWPL: <https://www.pwpl.pl/en/Competencies/Security_features.html#inne_zabezpieczenia>.