Identification of Polymer of Counterfeit Documents

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Abstract

Modern identity and travel documents, such as identity cards, driver's licenses, residence permits and passports are made entirely or partially of polycarbonate. Polycarbonate documents are well secured since polycarbonate enables the incorporation of various fraud-resistant security features. Due to a wide range of temperature resistance, it is possible to individualize polycarbonate documents by laser engraving.

Various printing techniques, such as thermal printing, laser, and inkjet printing, have been used for individualization of counterfeit travel and identity documents made of polymer. However, counterfeit documents made of polymers that have similar general characteristics such as polycarbonate have recently been detected where laser engraving of the photograph and data of the holder has been used.

The subject of this paper was to identify polymers used for production of counterfeit documents individualized by laser engraving.

IR- spectroscopy was used for analysis of the qualitative chemical composition of the polymer of counterfeit documents. The obtained IR-spectra were compared with the IR-spectra of the document specimen, as well as with the IR-spectra available in the European Network Forensic Science Institute database, while the search was performed using "KnowItAll" software.

Key words: counterfeit documents, laser engraving, polymers, polycarbonate, IR spectroscopy

1. Introduction

Polymers are all natural and synthetic substances and materials whose basic ingredient is a system of macromolecules (polymer molecules). [1] Over the last decades polymer materials have been frequently used for the production of many documents, such as identity documents, health cards, credit cards and many others, while the most frequently used polymer materials are the following: polycarbonate (PC), polyvinyl chloride (PVC), polyethylene terephthalate (PET), Teslin®, composite PET/PVC, acrylonitrile butadiene styrene (ABS) and others. [2 - 4]

Modern identity and travel documents, such as identity cards, driver's licenses, residence permits and passports are made entirely or partially of polycarbonate (PC) which has become the most used material for the production of secured documents. According to the regulations of the European Union, defining the minimum security elements for protection against counterfeit identity cards of EU member states and a uniform format for residence permits issued by the EU member states to third-country nationals, it has been established that the secured documents of the card format (ID-1) shall be made entirely of polycarbonate (PC) or equally worth synthetic polymer (which can last 10 years at least). [5], [6] EU member states regularly produce their secured documents of polycarbonate since bodies of polycarbonate documents are made of several layers of polycarbonate films which are fused into an inseparable whole by means of pressure and high

temperature and therefore possess a high level of security. [7] Polycarbonate is extremely durable and chemically inert, while its wide range of temperature resistance enables individualisation of documents by application of the modern, highly secure technology of laser engraving. [3] The laser beam penetrates the transparent layers of the card and interacts with the carbon-enriched layer, while the temperature provokes a chemical reaction which burns or carbonizes the contact surface, the text and/or picture within the polycarbonate card (Figure 1) being created by multiple repetitions. This type of individualisation prevents the removal of the photograph or data from the document since they are constituent parts of the structure of the polycarbonate card.

Until recently, counterfeit documents were made of polymer materials and individualised

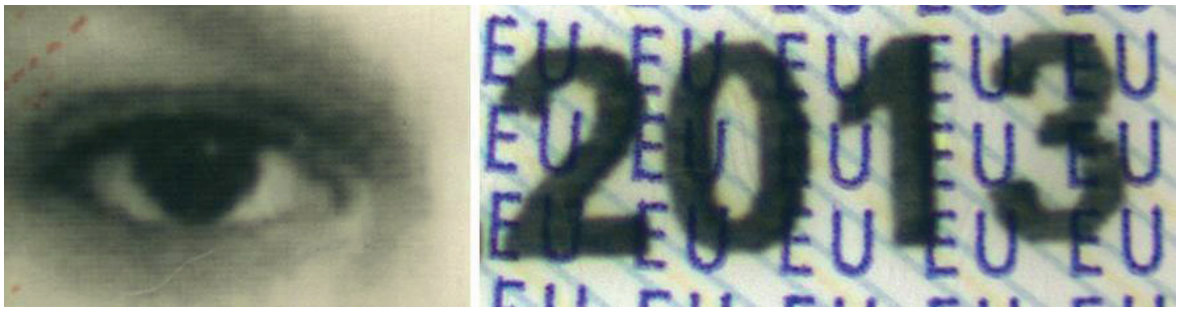

Figure 1. **Enlarged detail of laser engraving on an original document made of polycarbonate (PC)**
Source: Collection of original documents, FSC Ivan Vučetić

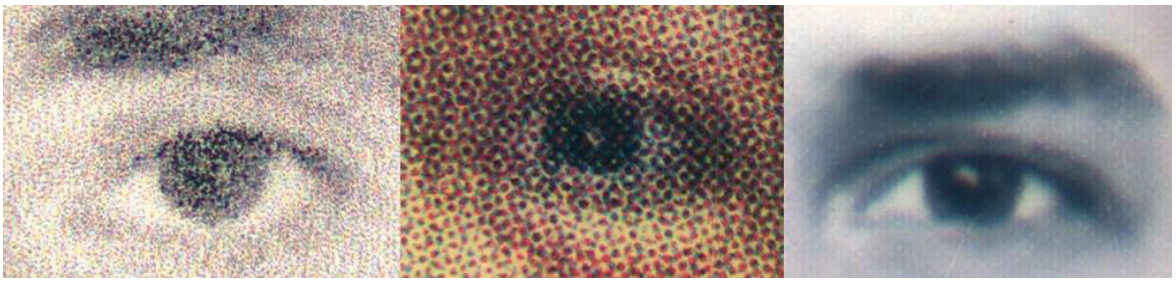

Figure 2. **Individualisation of polymer documents by inkjet printer (left), laser printer (middle) and thermal sublimation (right)** *Source: Collection of original documents, FSC Ivan Vučetić*

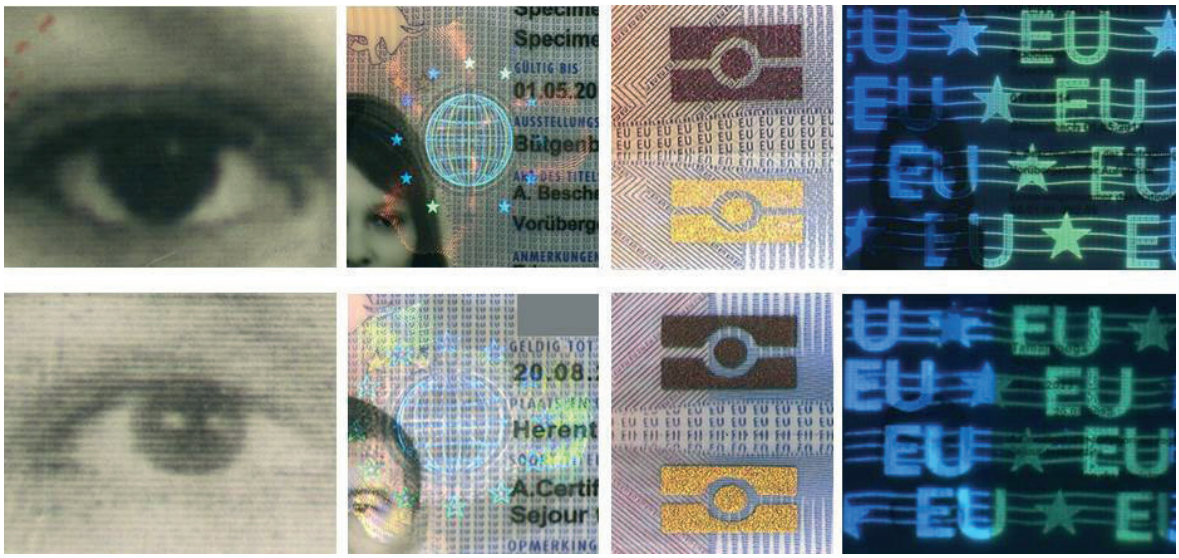

Figure 3. **Laser engraving and security elements of the original document (above) and laser engraving and imitation of security elements on a counterfeit document (under)**
Source: Collection of original and counterfeit documents, FSC Ivan Vučetić

by inkjet and laser printers or thermal printing – thermal sublimation or thermal transfer (Figure 2).

We have recently been witnessing an ever more frequent form of forging residence permits and other documents made of polymers where the photograph and the data of the holder are laser engraved, just as in the case of the legally issued documents of the EU member states made of polycarbonate. In addition to laser engraving, the said counterfeit documents also possess well-imitated security elements, such as UV protection and optically variable security elements (Figure 3).

2. Goal and subject of research

The goal of this paper was to identify the chemical composition of polymers enabling individualisation by means of laser engraving which is used for production of counterfeit EU residence permits.

The subject of research were three counterfeit residence permits of an EU member state.

3. Reference material

The following was used as the reference material:

- an original specimen of the residence permit equivalent to the disputable material (hereinafter: SPECIMEN); [8]
- IR spectral database (ENFSI/EPGWG); [9]
- professional and scientific literature.

4. Method and instruments

ATR-IR spectroscopy was used for the analysis of the polymers of counterfeit residence permits. The said spectroscopy is the most popular technology to determine the chemical composition and identify the polymers and is based on the interaction of substances with IR radiation. Attenuated total reflection (ATR) is a reflective method which identifies the IR spectrum of the surface of the material and can provide valid IR spectra of samples which are either too thick or too strongly absorbing IR radiation. ATR - IR spectroscopy enables direct analysis of samples in a solid or liquid state without further preparation. Almost all substances selectively absorb IR radiation and give a characteristic IR spectrum which presents the recording of the absorbed light as the function of the wavelength and provides vital information about the chemical nature and molecule structure of the substance [10, 11].

The following instruments were used for the research:

- stereomicroscope OLIMPUS SZH –ILLD,
- a Bruker Tensor 27 IR spectrometer with Diamond ATR Helios attachment.

5. Results

5.1. Visual/ microscope inspection

Polymer cards of counterfeit residence permits marked as SAMPLE 1, SAMPLE 2 and SAMPLE 3 were examined under OLIMPUS SZH –ILLD stereomicroscope (enlargement 120 X) and no mechanical damage to the cards was found. The surface of the card was cleaned on both sides by a tissue soaked with distilled water and 70% ethanol in order to remove the dirt from the surface of the card.

5.2. IR-Spectroscopy

ATR - IR spectroscopy method was used for the analysis of the disputable SAMPLES 1, 2 and 3 of residence permits and the SPECIMEN of a residence permit. IR-spectra were shot on the obverse and reverse sides of the SPECIMEN and the disputable samples (5 times on each side). The shot IR spectra are presented in Pictures 4 – 7 while the comparison of the IR spectra of SAMPLES 1, 2 and 3 is presented in Figure 8.

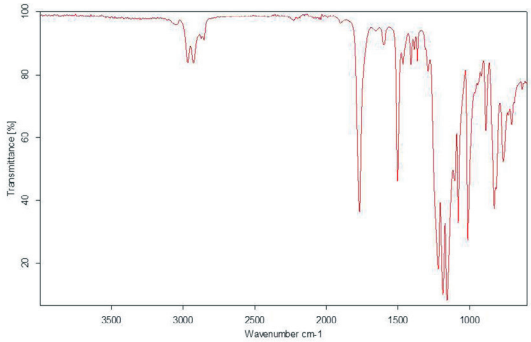

Figure 4. IR-spectrum of the SPECIMEN of a residence permit

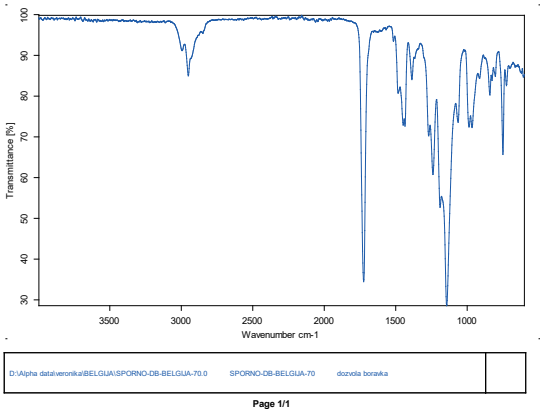

Figure 5 IR-spectrum of the disputable SAMPLE 1

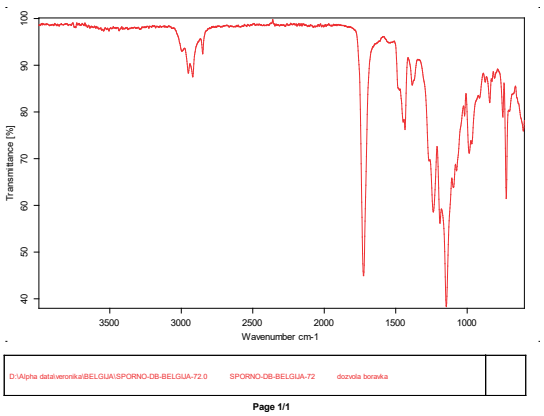

Figure 6 IR-spectrum of the disputable SAMPLE 2

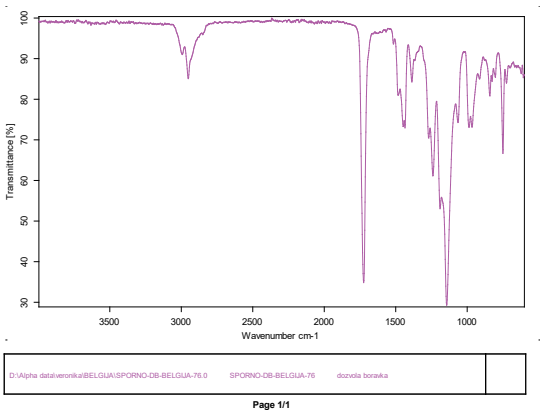

Figure 7 IR-spectrum of the disputable SAMPLE 3

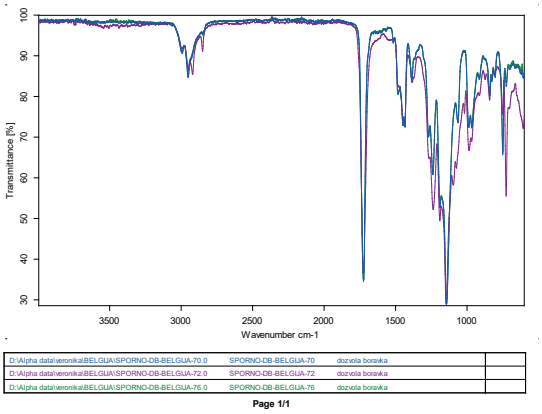

Figure 8 Comparison of IR-spectra of SAMPLES 1 (blue), 2 (red) and 3 (green)

Comparison of IR-spectra of the disputable SAMPLES 1, 2 and 3 showed that their chemical composition coincides.

In addition, the comparison of the IR spectra of SAMPLES 1, 2 and 3 and the IR –spectrum of the SPECIMEN was made and it showed that the chemical composition of SAMPLES 1, 2 and 3 is different than the chemical composition of the SPECIMEN (Pictures 9, 10 and 11).

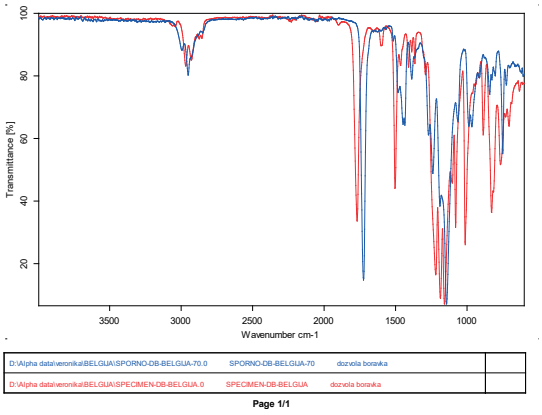

Figure 9 Comparison of the IR-spectrum of the SPECIMEN (red) and the IR-spectrum of the SAMPLE 1 (blue)

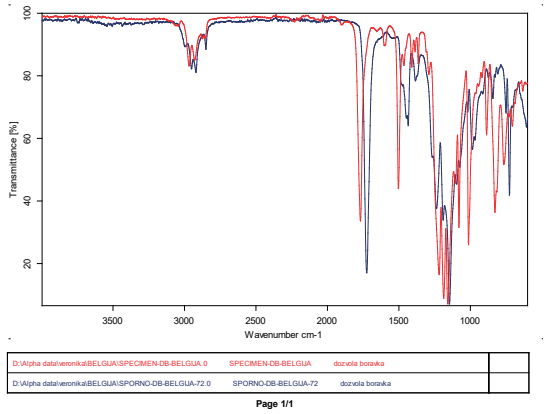

Figure 10 Comparison of the IR-spectrum of the SPECIMEN (red) and the IR-spectrum of the SAMPLE 2 (blue)

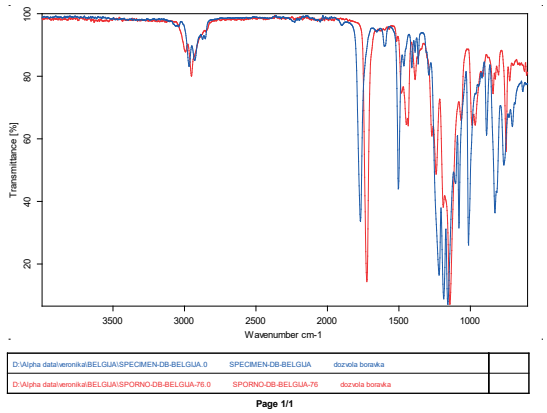

Figure 11 Comparison of the IR-spectrum of the SPECIMEN (blue) and the IR-spectrum of the SAMPLE 3 (red)

5.3. ENFSI/EPG database of IR spectra

The search of the ENFSI/EPG database of IR-spectra and the comparison of the IR-spectra of the disputable SAMPLES 1, 2 and 3 with the IR-spectra from the ENFSI/EPG database showed that the disputable material is polymethyl methacrylate (PMMA) (Pictures 12, 13 and 14).

The analysis of the IR-spectra of SAMPLES 1, 2 and 3 also showed that they do not contain the tapes characteristic of polycarbonate (PC) [12-14], but the tapes characteristic of polymethyl methacrylate (PMMA). [15], [16]

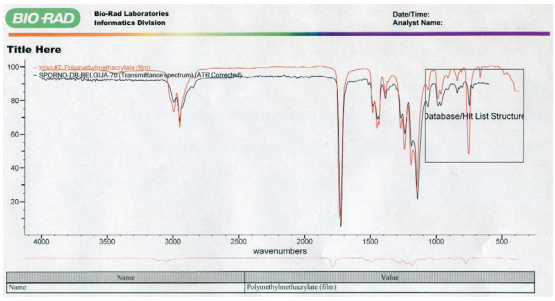

Figure 12 Comparison of the IR-spectrum of the polymer of SAMPLE 1 and the IR-spectrum from the ENFSI/EPG database

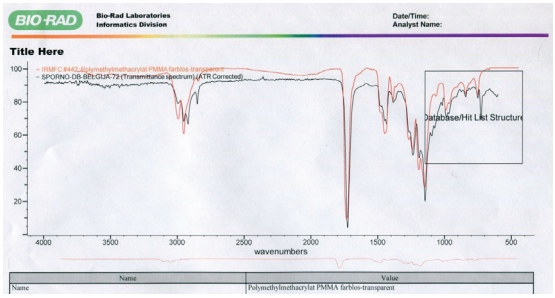

Figure 13 Comparison of the IR-spectrum of the polymer of SAMPLE 2 and the IR-spectrum from the ENFSI/EPG database

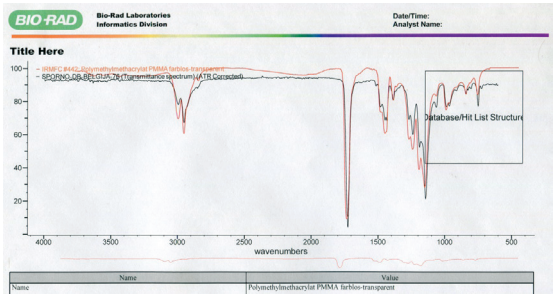

Figure 14 Comparison of the IR-spectrum of the polymer of SAMPLE 3 and the IR-spectrum from the ENFSI/EPG database

6. Conclusion

The type of polymer can be identified using the non-destructive ATR - IR spectroscopy technique for chemical characterization of polymers from which polymer cards for personal documents are made and comparing the received results with the results of characterization of polymers described in the literature as well as comparing the IR-spectra of the disputable samples with the IR-spectra from the available databases which contain the information about polymers.

In this paper, the chemical composition of polymers of counterfeit residence permits (SAMPLES 1, 2 and 3) has been examined by using

the IR-spectroscopy method and it has been established that they are made of polymethyl methacrylate (PMMA), and not of polycarbonate (PC) which is used for the production of original residence permits. Polymethyl methacrylate (PMMA) is better known under the commercial name Plexiglas and it is a transparent colourless polymer which transmits 93% white and 75% ultraviolet light which provides better optical features than glass and It is therefore also called "organic glass". It is the most transparent of all plastomers, with a very rigid and hard surface, and is also shatter-resistant, UV-resistant and temperature-resistant [1, 4]. Mainly due to its properties, but also due to its availability and wide-spread commercial use, polymethyl methacrylate (PMMA) is suitable for the production of counterfeit documents because it enables laser engraving of the photograph and data of the document holder without any destruction of the polymer.

This paper showed that it cannot be definitely stated that the document is original, made of polycarbonate or counterfeit, made of some other polymer, such as polymethyl methacrylate (PMMA), only based on the fact that the disputable polymer document has been individualized by laser engraving and without examining the chemical composition of the polymer. Therefore, police officers on the first and second line of border control who check the validity of identity and travel documents cannot make a conclusion that the document has been legally issued only based on individualization by laser engraving. In addition, it is necessary to make a detailed analysis of numerous other security features which are a part of contemporary identity and travel documents.

7. References

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[7] False and Authentic Documents Online (FADO) – A European Union internet-based image-archiving system of genuine, false and forged documents established by a Joint Action of the Council of the European Union EU 98/700/JHA of 10 December 1998.

[8] *Source: Collection of original documents, FSC Ivan Vučetić*

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