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Dear Readers!

We would like to present you with the first issue of Scientific Quarterly "Packaging Review", the magazine focused on scientific research, developmental activities and technological progress in the packaging industry in Central and Eastern Europe. Packaging for food production is a key industrial segment – and this periodical is developed for Poland and neighboring countries.
In this magazine we will present scientific findings and professional achievements from bona fide scientists. The articles will highlight the focused efforts of those professionals on all issues related to packaging science working in research centers and the most innovative companies in both Poland and abroad. We will communicate findings and report on scientific conferences. We are also a bridge between science and business – by communicating technological innovations we hope to make breakthroughs executable throughout the industry.
In the "Packaging Review" quarterly we intend to address the most current innovations, packaging automation solutions and sustainability issues.
Between 1955-2021, scientific articles were mainly published in the Polish language in "Opakowanie" magazine, but from 2022 onwards it will be English only, in order to better promote industry achievements and reach the international community. The journal is published only electronically with open access and has an international scope and focus.

Enjoy your reading!

Marek M. Kowalczuk is a professor at the Centre of Polymer and Carbon Materials, Polish Academy of Sciences, Zabrze, Poland, and head of the Group of Innovation, Technology and Analysis Service. He received a PhD degree in 1984 from the Faculty of Chemistry, Silesian University of Technology, Gliwice, Poland, and a D.Sc. degree in 1994 from the same University. Since 2010 he has been a professor of chemistry, nominated by the President of Poland. He was a visiting professor at the Ohio State University (Columbus, OH, USA), a visiting lecturer at the University of Massachusetts (Amherst, MA, USA), a Marie Curie EU fellow at the University of Bologna (Italy), and a professor in chemistry at the University of Wolverhampton (UK). Recently, he has been elected as a member of the Chemistry Committee of the Polish Academy of Sciences. He is the author and co-author of over 170 scientific papers and a score of patents.

Drodzy Czytelnicy!

Przed Państwem pierwsze wydanie kwartalnika naukowego „Packaging Review", prezentującego działania badawczo-rozwojowe oraz postęp technologiczny w branży opakowaniowej w Europie Środkowo-Wschodniej. To jeden z kluczowych – szczególnie dla polskiej gospodarki, stojącej produkcją żywności, ale i dla krajów ościennych – segmentów przemysłowych.
Na łamach czasopisma prezentujemy naukowe i zawodowe osiągnięcia naukowców dotyczące całokształtu zagadnień związanych z opakowaniami, pracujących w ośrodkach badawczych i najbardziej innowacyjnych firmach zarówno w Polsce, jak i za granicą. Informujemy o konferencjach naukowych oraz je relacjonujemy. Jesteśmy także pomostem łączącym naukę z biznesem – popularyzując innowacje sprawiamy, że mają one szansę na wdrożenie i zastosowanie w przemyśle.
W kwartalniku „Packaging Review" zamierzamy podejmować najaktualniejsze innowacje, rozwiązania automatyzujące produkcję opakowań, a także kwestie związane ze zrównoważonym rozwojem.
W latach 1955-2021 artykuły naukowe publikowane były głównie w języku polskim w ramach czasopisma „Opakowanie", a od 2022 roku wyłącznie w języku angielskim, aby lepiej promować osiągnięcia branżowe i dotrzeć do międzynarodowego środowiska. Czasopismo ukazuje się wyłącznie w wersji elektronicznej w otwartym dostępie (open access) i ma zasięg międzynarodowy.
Zapraszamy do lektury!

Marek M. Kowalczuk jest profesorem w Centrum Materiałów Polimerowych i Węglowych Polskiej Akademii Nauk w Zabrzu oraz kierownikiem Zespołu Innowacji, Technologii i Analiz. Stopień doktora uzyskał w 1984 r. na Wydziale Chemicznym Politechniki Śląskiej w Gliwicach oraz stopień naukowy doktora habilitowanego w 1994 roku na tej samej uczelni. Od 2010 roku jest profesorem chemii z nominacji Prezydenta RP. Był profesorem wizytującym na Uniwersytecie Stanowym Ohio (Columbus, OH, USA), wykładowcą wizytującym na Uniwersytecie Massachusetts (Amherst, MA, USA), stypendystą Marie Curie EU na Uniwersytecie Bolońskim (Włochy) oraz profesorem chemii na Uniwersytecie w Wolverhampton (Wielka Brytania). Ostatnio został wybrany na członka Komitetu Chemii PAN. Jest autorem i współautorem ponad 170 prac naukowych oraz kilkunastu patentów.

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COMPOSITE PACKAGING

ABSTRACT: Directive (EU) 2018/852 has modified the definition of composite packaging: packaging made of two or more layers of different materials which cannot be separated by hand and form a single integral unit, consisting of an inner receptacle and an outer enclosure, that is filled, stored, transported and emptied as such. Since January 2022, a change has been introduced in Poland regarding the classification of packaging waste as a recycled mass.
Key words: packaging, composite packaging, packaging waste

STRESZCZENIE: Dyrektywa (UE) 2018/852 wprowadziła modyfikację definicji opakowania wielomateriałowego: opakowanie wykonane co najmniej z dwóch warstw różnych materiałów, które nie mogą być ręcznie oddzielone i tworzą jedną integralną całość składającą się z przestrzeni wewnętrznej i powłoki zewnętrznej, którą napełnia się, przechowuje, transportuje i opróżnia w takiej formie. W Polsce od stycznia 2022 roku wprowadzona została również zmiana dotycząca zaliczania odpadów opakowaniowych do masy poddanej recyklingowi.
Słowa kluczowe: opakowania, opakowania wielomateriałowe, odpady opakowaniowe

DEFINITION

In Polish legislation, composite packaging is defined in the Act on management of packaging and packaging waste [1]. Until the end of 2021, the conception of „composite packaging" was understood as packaging made of at least two different materials which cannot be separated by hand or by simple mechanical methods. The mentioned definition derived from legal acts of the European Union (Commission Decision 97/129/EC [2], Commission Decision 97/138/EC) [3], published before 2018 to the packaging Directive [4].

In 2018, Directive (EU) 2018/852 [5] was established and introduced modification of the definition of composite packaging, aiming at its detailed specification: *Composite packaging shall mean packaging made of two or more layers of different materials which cannot be separated by hand and form a single integral unit, consisting of an inner receptacle and an outer enclosure, that is filled, stored, transported and emptied as such.*

The discussed definition, as being the translation of the provisions contained in Directive (EU) 2018/852 was introduced to the Act on management of packaging and packaging and is obligatory since January, 1, 2022: *Composite packaging is understood as packaging made of at least two different materials which cannot be separated by hand and form a single integral unit consisting of inner receptacle and an outer enclosure that is filled, stored, transported and emptied as such.*

The phrases such as receptacle and enclosure, as being employed in the translation, may suggest stiff packaging in spite of the fact that many types of composite packaging are flexible. It seems that the translation does not fully reflect the contents of the original document, which specifies that the layers of packaging material constitute the integral unit, consisting of inner space serving for its filling with the contents and the outer space constituting a barrier.

Modification of the conception of composite packaging dating to 2018 has not changed the classification, functioning for many years. The category of composite packaging includes flexible as well as stiff packaging, having the layers made of different packaging materials.

PIC. 1. BAGS MADE OF LAMINATES

TYPES OF COMPOSITE PACKAGING

The packaging materials are those ones considered in Annexes 1 – 6 to the Decision of the European Commission 97/129/EC of 28 January 1997 on establishing the identification system for packaging materials, i.e.:

- plastics, with classification into particular polymers,
- paper and paperboard (solid fibreboard and corrugated board),
- glass with division into colourless, green and brown glass,
- metals: steel and aluminium,
- wood and wood-derived materials,
- textile materials of natural origin (cotton, jute).

Annex 7 to the Decision includes packaging made with the participation of the mentioned above materials and considers them as composites.

In Polish legislation, the combinations of different packaging materials in composite packaging are specified in the regulation concerning the patterns of labelling of packaging [6] and binding since January 2015.

The basic groups of composite packaging include as follows:

a) packaging made of laminates, obtained by the combination of plastic films and layer of paper, board, aluminium foil, e.g.; LDPE paper, LDPE board, PET/Al/LDPE, PET/paper/Al/LDPE, LDPE/texture/Al/LDPE etc., and, also laminates made with the participation of metallised films e.g.: BOPP/BOPPmet, PETmet/PE.

   The examples of composite packaging made of flexible laminates are given in Pic. 1.

b) Coated and laminated paperboard packaging

   In relation to the products intended for longer shelf-life period (e.g. UHT treatment), aseptic packaging with the following material composition (Fig. 1) is applied:

   - 75% of mass is paper,
   - 20% PE-LD,
   - 5% aluminium (foil of 6.5μ thickness).

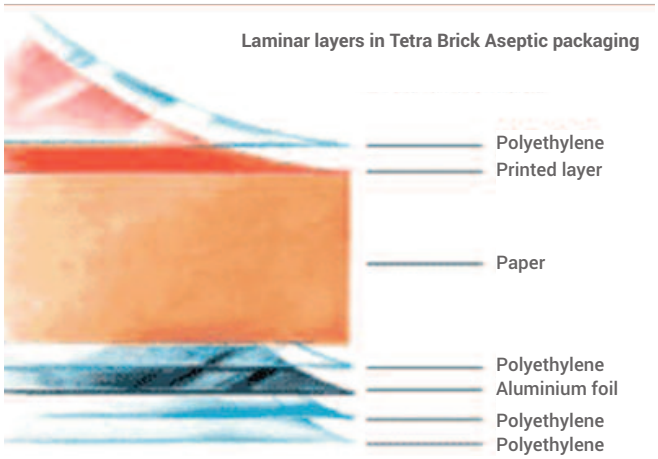


FIG. 1. LAYERS IN LAMINATE

In respect of the pasteurized products that require storage under refrigeration conditions, the packaging made of the following material composition is applied (Pic. 3):

- 80% of mass is paper,
- 20% PE-LD.

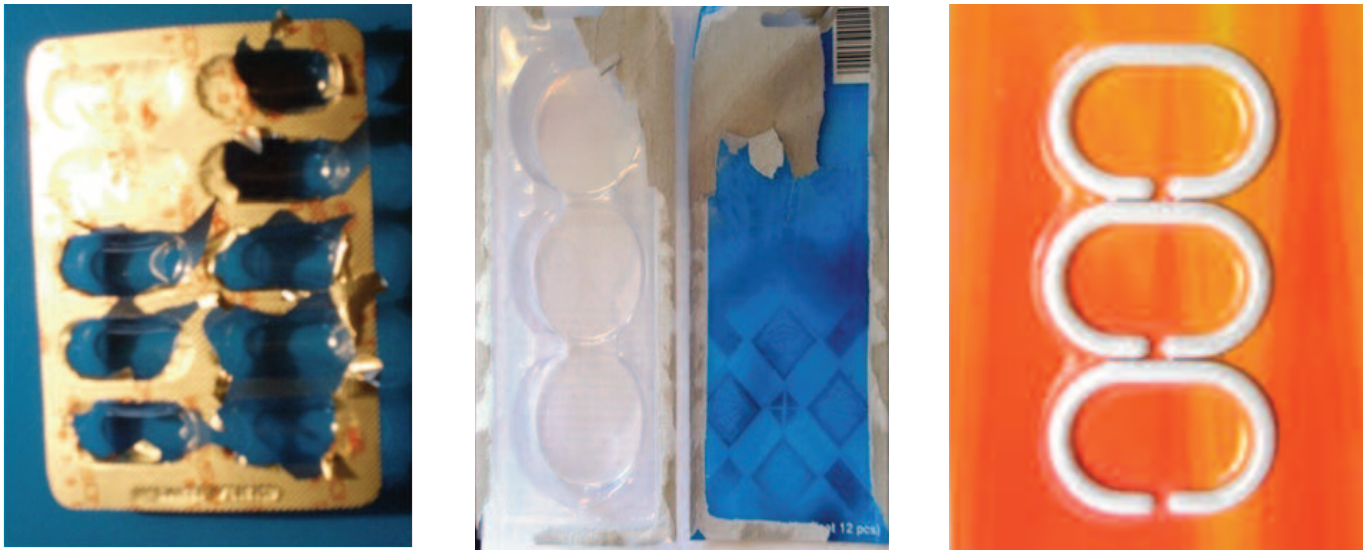
c) Packaging of blister pak and skin pak type which are composed of plastic film layer in combination with layer of paperboard or aluminium film which cannot be separated by hand

PIC. 3. COATED AND LAMINATED PAPERBOARD PACKAGING FOR LIQUID FOOD

Packaging of blister type consists of rigid layer made of plastics (in a form of shaped container) combined with a layer of cardboard or aluminium. On the other hand, packaging of skin pak type is composed of flexible layer of foil, formed on the packaged products by a vacuum method, in combination with the cardboard layer (Pic. 4).

CLASSIFICATION OF PACKAGING WASTE, RESULTING FROM COMPOSITED PACKAGING AS A RECYCLED MASS

Since January, 1, 2022 the regulation on detailed conditions of treating the packaging waste as a recycled mass [7] has become binding in Poland. The packaging waste generated from composite packaging materials or other packaging, consisting of more than one material are included to the mass of the packaging waste subjected to recycling in respect of mass of each material contained in the mentioned packaging. The condition for treatment of the packaging waste derived from the composite packaging, or other packaging made of more than one material as the mass of packaging waste subjected to recycling, lies in the fact that the mass of each of the remaining materials contained in the mentioned packaging does not exceed 5% of the total mass of the discussed packaging.



PIC. 4. THE EXAMPLES OF COMPOSITE PACKAGING OF BLISTER AND SKIN TYPE WHERE THE LAYERS MADE OF DIFFERENT MATERIALS CANNOT BE SEPARATED

The above mentioned regulation was published in connection with the changes which occurred in 2018 and 2019 [8, 9] in the Commission Decision 2005/270/EC [10] establishing the formats relating to the database system pursuant to Directive 94/62/EC. The mentioned decision modified the formats of the data transfer in conformity with art. 12 of Directive 94/62/EC as well as the principles of calculating, verifying and reporting in respect of the data concerning achieving the targeted recycling levels by the Member States of the European Union. For the purpose of calculation and verification of achieving the targets of Directive 94/62/EC, the composite packaging and other packaging consisting of more than one material shall be calculated and reported in relation to each material, contained in the packaging. The Member States may waive the mentioned requirement if a given material constitutes a small part of packaging unit and, in each case no more than 5% of the total mass of unitary packaging.

SUMMING UP

Modification of the idea of composite packaging dating back to 2018 has not changed the present classification. It has stressed that the layers of different materials in the composite packaging constitute a form of integral unit that is filled, stored, transported and empties. In the definition, there has been also more precise definition of the inner layers – as a sort of container to be filled with the contents, and the outer layer – as a protection, creating a closing barrier. In the definition, the minimum percentage content of material which could become the basis for elimination of a packaging from the composite packaging as well as the size /surface of the layers (inner and outer) in the composite packaging, has not been precisely defined. The definition of the composite packaging cannot be fully applied in relation to the elements of packaging, characterized by multiplicity of materials.

The introduction of 5-% threshold in the discussed regulation on the matter of detailed conditions for classification of the packaging waste in the recycled mass may be wrong (niewłaściwie) understood by the entrepreneurs and recovery-dealing organizations as approval of additional materials in the packaging. The package, as containing a dominating material and other packaging materials not exceeding 5% of mass, would be therefore classified as packaging made of dominating material. <<

REFERENCES

[1] Act of 13 June 2013 on management of packaging and packaging waste (Official Journal of Laws of 2020 item 1114, 2361, of 2021 item 2151) (Poland)

[2] Commission Decision 97/129/EC of 28 January 1997 establishing the identification system for packaging materials pursuant to European Parliament and Council Directive 94/62/EC on packaging and packaging waste (Official J. of Laws L50, 20.2. 1997)

[3] Commission Decision 97/138/EC of 3 February 1997 establishing the formats relating to the database system pursuant to European Parliament and Council Directive 94/62/EC on packaging and packaging waste (Official J. of Laws L 052, 22.02. 97)

[4] Directive of European Parliament and of Council 94/62/EC of 20 December 1994 on packaging and packaging waste (Official J. of Laws L EC L 365 of 31.12. 1994 with amendments)

[5] Directive of European Parliament and of Council (EC) 2018/852 of 30 May 2018 amending Directive 94/64/EC on packaging and packaging waste (Official J. of EU L 150/141, 14.6. 2018)

[6] Regulation of the Minister of Environment of 3 September 2014 on patterns of packaging labelling (Official J. of Laws 2014, item 1298) (Poland)

[7] Regulation of the Minister of Climate and Environment of 17 December 2021 on detailed conditions for classification of the mass of packaging as subjected to recycling (official J. of Laws 2021 item 2365) (Poland)

[8] Commission Implementing Decision (EU) 2018/896 of 19 June 2018 (Official J. of Laws L 160/6, 25.6. 2018)

[9] Commission Implementing Decision (EU) 2019/665 of 17 April 2019 (official J. of Laws L 112/26, 26.4. 2001

[10] Commission Decision 2005/270/EU of 22 March 2005 establishing the formats relating to the database pursuant to the European Parliament and Council Directive 94/62/EC on packaging and packaging waste (Official J. of Laws L 86/6, 5.4. 2005)

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THE STUDY OF THE MECHANISM OF IMAGE FORMATION DURING THERMAL TRANSFER PRINTING ON FABRIC PACKAGING

ABSTRACT: In the present paper, the peculiarities of the mechanism of image formation during thermal transfer printing on polyester fabric packages made of polyester fiber have been investigated. Physico-mechanical properties of fabric packaging, and, in particular, tensile load, elongation at maximum force and change of linear dimensions after wet treatment have been determined. On the grounds of the conducted thermogravimetric analysis it was found that active thermooxidative processes and the product combustion processes of fabric samples' destruction with the printed thermal transfer image were less intense as compared to the samples of unprinted tissue. This was evidenced by the gradual and less intense weight loss, and the emergence of less rapid exogenous effects, reflected on the DTA curves. Electron microscopic studies of the fabric structure confirmed that plastisol inks did not penetrate deeply into the fabric fibers, did not stain them, but enveloped them, forming mainly a mechanical connection. It has been found that the mechanism of printing image formation on polyester fabric packaging using thermal transfer presses depends on the technological printing modes, fabric structure, processes of ink polymerization and adhesion on the fiber surface, and requires further research.
Key words: fabric packaging, thermal transfer printing

STRESZCZENIE: W artykule zbadano cechy mechanizmu powstawania obrazu podczas druku termotransferowego na opakowaniach z tkaniny z włókien poliestrowych. Określono właściwości fizyko-mechaniczne opakowań z tkanin, w szczególności obciążenie rozciągające, wydłużenie przy maksymalnej sile oraz zmianę wymiarów liniowych po obróbce na mokro, porównywalne z próbkami tkanin niezadrukowanych. Na podstawie analizę termograwimetrycznej stwierdzono, że aktywne procesy termooksydacyjne oraz procesy spalania produktów niszczenia próbek tkanek z nadrukowanym obrazem termotransferowym były mniej intensywne w porównaniu z próbkami tkanki niezadrukowanej. Świadczyło o tym stopniowa i mniej intensywna utrata masy ciała oraz pojawienie się mniej szybkich efektów zewnętrznych na krzywych DTA. Badania struktury tkaniny pod mikroskopem elektronowym potwierdziły, że farby plastizolowe nie wnikają głęboko we włókna tkanek, nie plamią ich, lecz otaczają, tworząc głównie mechaniczne połączenie. Stwierdzono, że mechanizm powstawania obrazu drukarskiego na opakowaniach tkanin poliestrowych z wykorzystaniem pras termotransferowych zależy od technologicznych trybów drukowania, struktury tkaniny, procesów polimeryzacji tuszu i adhezji do powierzchni włókna i wymaga dalszych badań.
Słowa kluczowe: tkaninowe torby opakowaniowe, drukowanie termotransferowe

INTRODUCTION

The humanity is nowadays faced with the important task of preserving the natural environment. It refers especially to the urgent need to replace the plastic packaging that constitutes ca. 10% of all waste. Bags, foil bags and other plastic packaging are intensively employed in all domains of human activities. Plastics may be stored for many decades, accumulating more and more at landfills. Besides it, during the combustion of plastics, the harmful dioxins and other products of organic degradation are generated in the air. One of the methods for reduction of plastics quantity includes the application of reusable packaging, produced from

A B C D

PIC. 1. THE SAMPLES OF FABRIC FOR PACKAGING:

A) COTTON, B) SERGE, C) TARPAULIN, D) LINEN FABRIC (CANVAS – RAW LINEN).

SOURCE: [OWN DOCUMENTATION]

natural materials or polymers which are subjected to biodegradation [1, 2].

Fabric packaging, such as bags as alternative to plastic bags, is a popular product. Such packaging is made of durable material and serves for a longer period of time, considerably longer than the traditional plastic bags. Fabric-made packaging is environment friendly product and is suitable for its reuse. [3].

Fabric packaging has a certain international history, for example in the USA and in Europe. Such packaging was produced and used at the end of the 20th century. In many countries, the application of packaging made of natural materials has been promoted for a long time. For example, in Taiwan in 2003, plastic was removed from the trade centres; in Japan, the authorities run a campaign in favour of fabric bags' use and in certain states of America, the penalties have been introduced for the employment of plastic bags. In many developed countries, goods in the supermarkets are wrapped in paper and placed in common linen bags. The average Ukraine inhabitant spends ca 70 hryvnias annually for plastic bags. Reusable bag may be bought at 10 – 15 hryvnias or may be sewn and decorated by hand. Owing to a deep interest in the environmental problems, eco-bags are more and more searched by the inhabitants of big cities. The main property of high-quality environmental bag consists in resistance to use, durability, resistance to washing cycle many times and differing in naturalness and a low cost [4].

Therefore, it is important to select the appropriate fabric for production of packaging. It refers, in particular, to sewing of packaging such as eco-bags. In the opinion of scientists, the following products are especially popular: double-thread cotton fabric, serge, tarpaulin and canvas (Pic.1). The double-thread fabric is characterized by a high strength.

As a rule, double-thread fabric is made of cotton fibres; therefore, it is environment-friendly natural material. Its values are evident: strength, resistance to wearing, resistance to high temperature, good ventilation, capable of keeping a given shape of the product. It is worthy to know the important fact: the discussed fabric is characterized by unravelling at the edge when cut.

Serge fabric is also interesting material for production of bags (Pic.1 b). The mentioned fabric is multi-dimensional because, in case of this material, we may use natural fibres (silk, wool,

A

B

PIC. 2. THE SAMPLES OF TEXTILE PACKAGING:

A) PACKAGING OF SOUVENIRS, MADE FROM FABRIC BY HAND

[SOURCE: WIKIPEDIA – DIY.RUHTTP.//WWW.DIY.RU];

B) BAGS MADE OF FABRIC

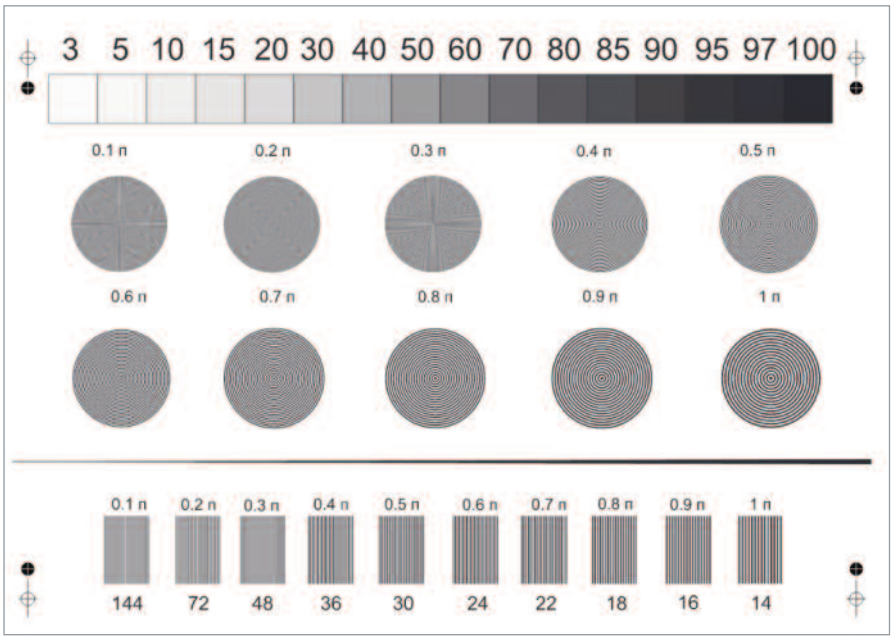
[OWN SOURCE].

cotton) as well as the synthetic ones (polyester, viscose, spandex). But the way of their weaving is unchanged – diagonally. Therefore, serge is easy to be recognized by texture: it is a relief fabric with the inclination. The mentioned fabric is multi-dimensional because, we may, on its basis, employ natural fibres (silk, wool, cotton) as well as the synthetic ones (polyester, viscose, spandex). Packaging made of serge has a high density, absorbs humidity well, is non-electrified, hygroscopic, and resistant to contamination and cheap [3].

The producers offer also a dense tarpaulin for production of fabric bags (Pic.1 c). The tarpaulin many be called one of the strongest types of natural textiles. Contrary to common tilt, the discussed material does not possess a synthetic waterproof impregnation and refraction. Depending on the composition, the tight tarpaulin may consist of the mixture of cotton and linen fibres, in a form of cotton yarn. Another high-quality and durable option includes jure tarpaulin in combination with cotton. The first component makes that the discussed material is reliable and resistant to deformations and cotton fibres allow bending of the material; it is also possible to make application or matrix on its surface. When choosing the tight tarpaulin for sewing of bags, we should take their destination into account. The compact eco-bags with wide straps require fabric with density of 300 g/m^2. If the big shoppers for voluminous packaging from supermarket are to be produced, we should choose density of 500 – 600 g/m^2 [4].

Canvas – i.e. raw linen (Pic.1 d) is a popular fabric for packaging. Canvas has an original texture. The history of linen was commenced at the middle ages when a strong sailing fabric was produced from hemp fibres for the sailing ships. The modern textile linen has preserved homage for traditions – a characteristic pattern in a form of weaving. The scientists distinguish 5 advantages of packaging (bags) made of linen fabric: long-lasting, with a high resistance, pleasant and rather soft in touch, having the effect of breathing material, and practically dirt-resistant. It may be easily decorated with thermal printing [5]. The samples of the textile packaging are given in Pic.2.

The aim of the present study was to examine the mechanism of adhesion of paint to the fabric on packaging during thermal



PIC. 3. TEST SCALE PRINTED ON A TEXTILE BAG

transfer printing, with the consideration of their physical and mechanical properties and modes of technological printing.

OBJECTS AND METHODS OF TESTING

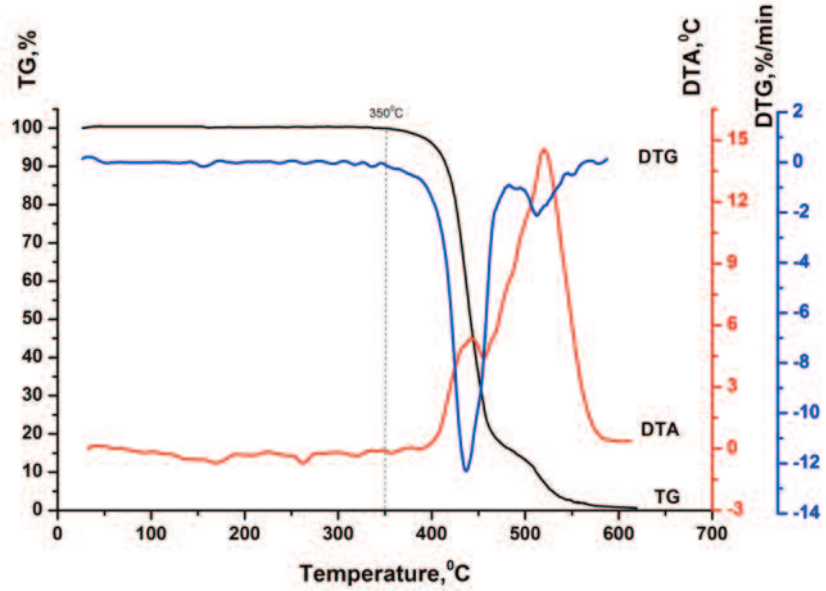
One type of fabric from which the packaging (bags) was produced, i.e. polyester fabric made of polyester fabric with polyethylene terephthalate was chosen for the tests [6].

Printing of the test scale on the fabric (Pic.3) was carried out in thermo transfer press EB 380 FN by EVER BRIGHT MACHINERY CO. LTD in the manufacturing conditions of LLC "Eney" company in Lvov. The printed image was transferred to the textiles in the following conditions: work temperature: 140°C, transfer time – 5 seconds, pressure – 3-4 bars. For printing, the plastic inks of the series Antex, NF, including NF 82 (purple), NF 83 (yellow), NF 84 (blue) and NF (black) were used. To increase the adhesion of the ink to the fabric, the coarse transfer adhesive TM 200 was employed. The mentioned transfer was carried out from paper 90/m^2. The physical and mechanical properties of packaging made of textile material were determined according to the following indicators: breaking strength, stretching of material at maximum effort which was tested in breaking machine RT-250 M-2 in conformity with DSTU EN ISO 13934-1:2008. As the packaging made of textile materials is reusable type of packaging, the test of changes in the dimensions of the discussed fabric after washing were carried out (DSTU GOST 30157.0:2003). The electronic microscope tests were performed in scanning electronic microscope JEOL JSM-T220A by a standard method [7]. To carry out the mentioned test, the surface of the fabric was metalized by a thermal sprinkling of a thin copper layer (up to 10 nm). The sprinkling was carried out with the use of sprinkler VUP-5.

Thermal tests of the samples of the printed images (Fig.3) on the textile materials were carried out on a derivate of system Q-1500D "Paulik – Paulik – Erdej" with the computerised registration of analytical signal of the weight loss and thermal effects. The samples were analysed by a dynamic method, with the rate of heating equal to 5°C/min at the air environment. The weight of the samples amounted to 100mg; aluminium oxide Al203 was the reference substance.

THE RESULTS OF THE TESTS

In the case of textile packaging, the resistance of the fabric is an important issue, especially its breaking strength. The physicochemical tests of polyester fabric, used in the tests, were carried out in accordance with the respective standards. The obtained results confirmed the consistence of the values with the required standards.



PIC. 4. THERMOGRAMS OF THE POLYESTER FABRIC SAMPLES

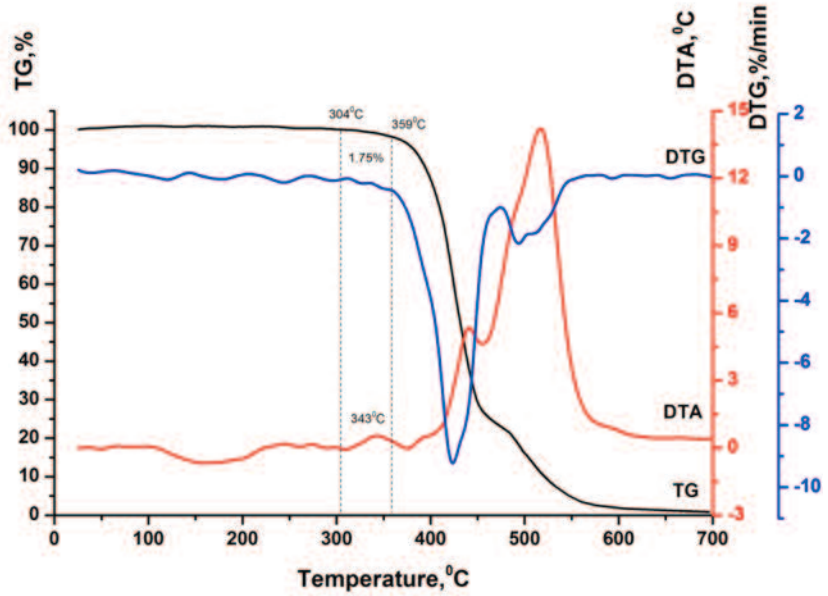
During the thermal transfer printing, the textile packaging is subjected to the impact of high temperatures. The method of thermal transfer printing consists in the application of image on intermediate paper (ribbon) with its later transfer on the printed material. The transfer and fixation is resulting from the effect of a high temperature. The transfer of the printed image is implemented with the use of "ordinary" thermal transfer paints (plastic or those on the water basis). In the discussed case, the image is printed in a mirror-like way, the colours are printed in a reverse sequence and finally, the layer of adhesive is placed, using a template (alternatively the adhesive in a dry form is placed on a wet layer of paint).

The composition of the thermal transfer ink includes not only pigment but also polymer. After heating up, it is melted and transferred onto a paper and then, solidified again. The advantage of thermal transporter consists in a good resistance of the paint fixation on the printed material.

DTA curve of the fabric (polyester) sample (Pic. 4) in the range of temperature of 20 – 270°C shows small endothermic effects which are not accompanied by the loss of the sample's weight and they correspond to processes of vitrification, softening and melting of polyester (PE) [8]. At the temperatures higher than 350°C, the active destructive and thermostatic processes occur in the samples of the polyester fabric; their culminating point is combustion of the destructive products. It is evidenced by intensive loss of the weight of the sample and occurrence of meaningful exothermal effects on DTA curves.

The samples of polyester fabric with the printed image are characterized by a lower heat resistance as compared to the samples without paint. It may be explained by the increased capability of paint elements to heat evaporation. The thermogram of the packaging sample with the printing on the polyester fabric (Pic. 5) shows that in the range of 304 – 359°C, the loss of the sample weight is found (1.75%) what is accompanied by exothermic effect on DTA curve. It is caused by a leakage in the sample during the initial process of thermal transfer. Contrary to the sample without printing in a given packaging, the thermal coupling processes run at temperatures higher than 350°C.

We should notice that in all cases, the active processes of thermal transfer and the processes of combustion of the products, destructing the fabric samples and printed thermo-transferred images proceeded less intensively as compared to the samples of pure non-printed fabric. It was reflected in phasic and less intensive weight loss of the sample at temperature above 248°C and occurrence of slower exogenous effects on



PIC. 5. THE THERMOGRAMS OF THE PACKAGING SAMPLE WITH THE PRINTING ON POLYESTER FABRIC

DTA curves. The lower capacity of combusting the printed samples of fabric results, probably, from the presence of the paint components which might slow down the combustion processes.

The tests of the samples with the thermal transfer printing, as made under the electronic microscope, allowed identification of mechanism of paint fixation. Polyester belongs to the class of polymers, containing a series of repeating significant groups in the polymer chain. The fibrous fabric has a curved pipe-like or cylindrical shape with microscopic pores and breakings. On the surface of the fibre, there are stains with irregular shape. The micrographs show that polyester materials are twisted mutually in a form of microfiber intertwining (Pic. 6). The threads twisted from the fibres have a great number of capillary channels which are able to attract paint during colouring of the fabric. As it was shown in the electronic microscope, the cross-section of the fiber tissue resembles a shape similar to circle. Printing on the textile material is performed with the use of plastisol paints. Plastic paints do not penetrate deeply the

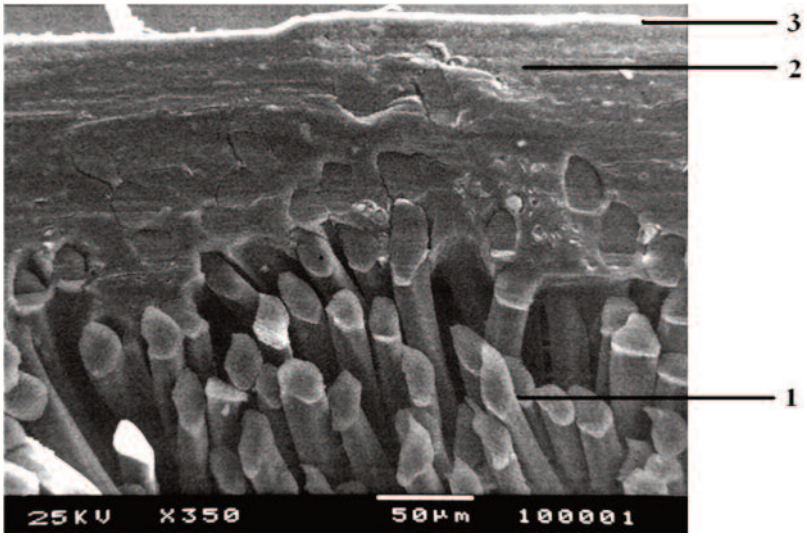
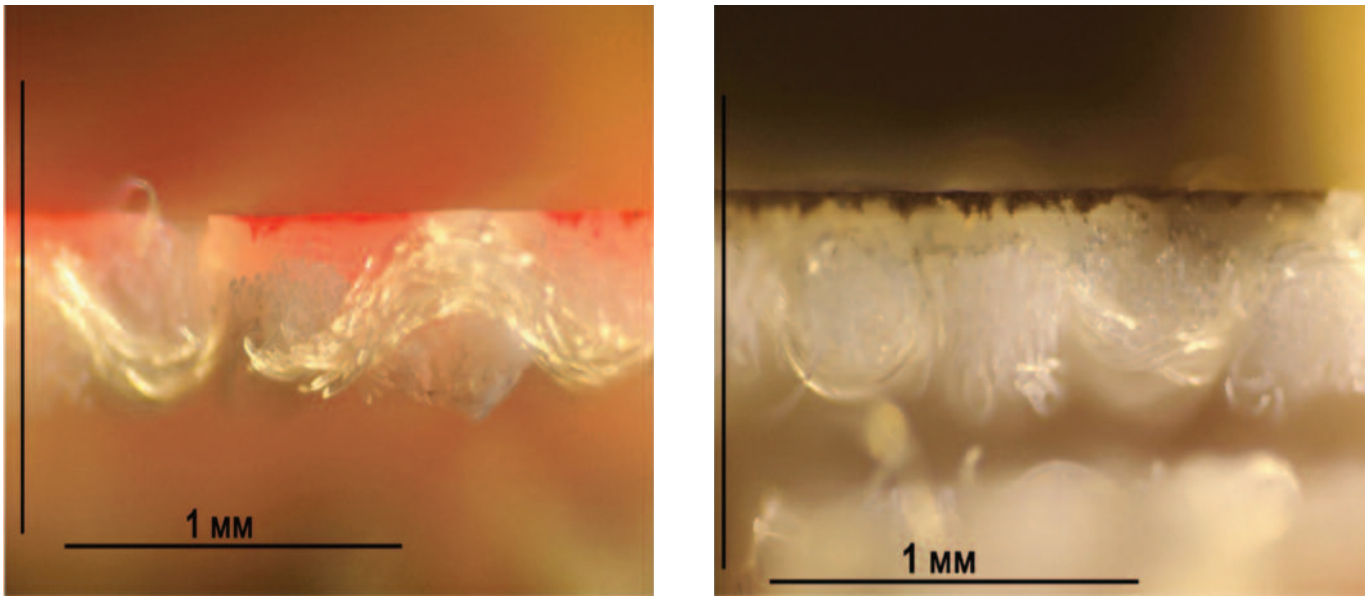


FIG.6. MICROPHOTOGRAPHY OF POLYESTER FABRIC WITH THE PRINTED IMAGE: 1- NON-PRINTED FIBRE; 2- TRANSFER ADHESIVE; 3 –PAINT



A B

PIC. 7. MICROPHOTOGRAPHY OF THE CROSS-SECTION OF PACKAGING FABRIC WITH THE PRINTED IMAGE

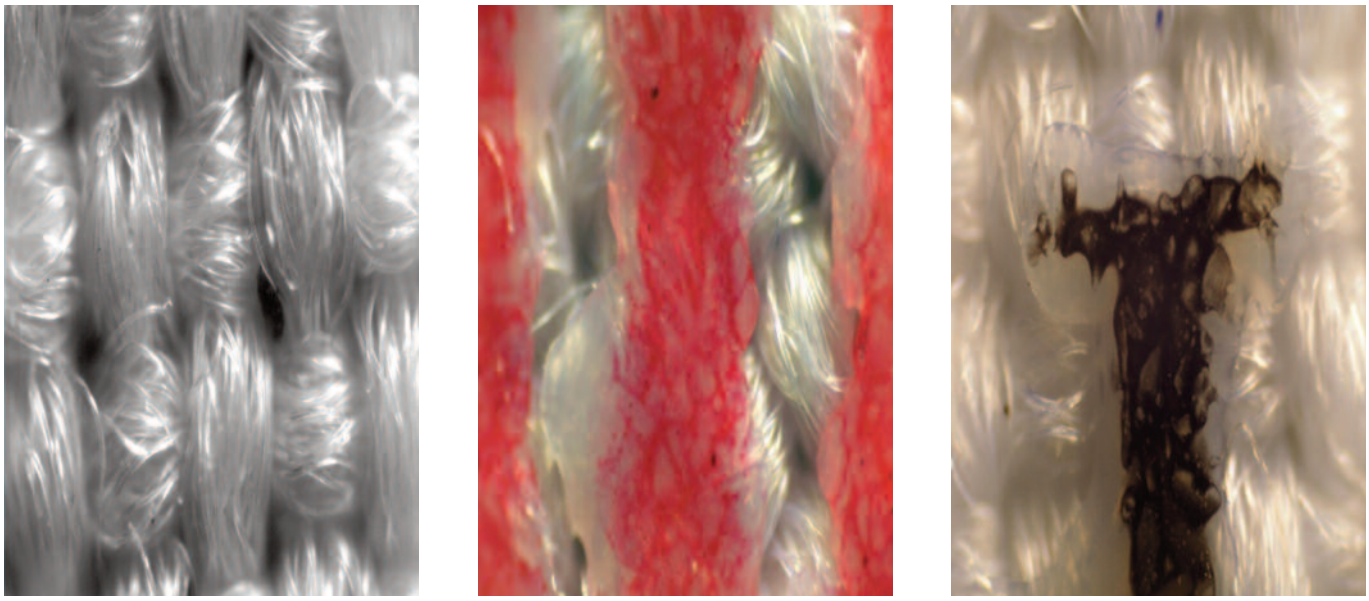
A – RED PAINT, B – BLACK PAINT

textile fibres, do not colour them but expose (distinguish) them, generating mainly mechanical coupling. It is distinctly visible in fragments of the cross-section of the images, printed on the bags, and made with the use of purple and black paints (Pic. 7).

As the paint is produced on the basis of polymers, the main components of which include PVC and plasticiser, the preservation of the image, transferred onto the fabric after heating up in the heat press occurs after the complete polymerisation (Pic. 8).

The analysis of the studies of the earlier authors [9] suggests that during thermal transfer printing on the fabric packaging, a physical heat sorption or chemical sorption of paint colours has place on the external (outer) surface of fibre. Fibres are two-phase, non-uniform in respect of their physical structure; the ratio between phases is dependent on the technological nature of their generation. According to scientists ( ), three-dimensional (3D) properties of fibres play the important role in preservation of the printed image. The exchange of weight occurs due to the diffusion flows in outer and inner environment. The fibre of the fabric, i.e. constant porous polymer is usually the mentioned medium. Transfer of the paint, as affected by the pressure and temperature is performed in few stages: firstly, in macropores, that is, in the empty spaces between the fibres and then, on the surface of the fibres where the catalyst of polymerisation is released due to the effect of temperature. The interfacial mask of the colour transfer is ended by the image preservation on the fabric in the process of the complete polymerization of the paint. The rate of the preservation of the image may theoretically depend on the kinetics of the polymerisation process and on the diffusion of colour in the outer phase on the surface of the fiber, paint heat sorption on the surface of the fabric and adhesion of the paint to microspores of the surface layer of the fibres.

Technological factors of heat transfer (temperature, pressure, time of contact with the textile, thickness of paint layer in the repeatable image) have a meaningful effect. Volume of fibre has an influence on the processes of partial paint sorption on its surface. Properties of 3D fibres are determined by a thin ultra-molecular structure and play the important role in preservation of the printed image on a textile packaging. To produce a high-quality printed image, fibre must possess active centres on which a given colour may be absorbed. The presence of the examined tissue fibres and system of pores, creating a developed internal surface (volume) as examined under a microscope, allows obtaining the printed images of high-quality.



A B C

PIC. 8. MICROPHOTOGRAPHY OF TISSUE FRAGMENT:

A – WITHOUT PRINTING; B – WITH PURPLE PRINTING; C – WITH BLACK PRINTING

CONCLUSIONS

The conducted analysis has confirmed the perspectives for utilization of heat transfer printing in decoration of fabric packaging. To ensure the quality of print, we should consider the structure of textile material and technological methods of transferring the image.

Mechanism of generating the thermo-transfer image on the fabric packaging, using the heat press is dependent on technological methods of printing, structure of fabric, paint polymerisation on the surface of fiber, adhesion of the paint to the surface of the textile, in particular, the adhesion to the surface of the fiber.

The discussed complicated process requires deeper further tests, in particular concerning the effect of the percentage of synthetic fibres in the fabric and the thickness of paint payer on the quality of the printed image. <<

REFERENCES

1. https://biotechnologia.pl/technologie/porozmawiajmy-o-opakowaniach,18777
2. http://drukarstvo.com/termotransfernyj-druk/ © (Portal poligraficzny)
3. Dmitrij Shchesiuk 2011. «Druk na tkaninie». Print plus 2 : 44 – 54. [Printing on fabric]
4. Liubow Dolgushina 2021. «Wpływ temperatury na materiały włókiennicze i możliwości identyfikacji tkanek». Syberyjski biuletyn strażacki i ratowniczy 3 (22): 64 – 70. [Temperature impacts on textile materials and the possibilities of identifying the tissues. Siberian fire-protection and rescuing bulletin]
5. Drukowanie na tkaninach. Metody oraz cechy nadruków//https://www.biznes-mentor.pl › [Printing on textiles. The methods and properties of printings]
6. Horst Köpnick, Manfred Schmidt, Wilhelm Briuging, Jorn Rüter, Walter Kaminsky. 2000. Polyesters. Ullmann's Encyclopedia of Industrial Chemistry, 623-649.
7. Jon Goldstein. 1984. Rasterowa mikroskopia elektronowa i mikroanaliza rentgenowska. Moskwa: Wydawnictwo Mir. [Raster electrone microscopy and X-ray microanalysis].
8 Walerij Niżnik, Taras Niżnik. 2009. Fizykochemia polimerów. Kijów: Wydawnictwo Centrum fitosocjalne. [Physico-chemistry of polymers. Kiiv, Publishing House: Phytosocial centre]
9. Svitlana Havenko, Hatalia Menżyńska, Svitlana Khadzynova. 2013. «Ocena jakości nadruku termotransferowego na etykietach i metkach odzieżowych». Przegląd Papierniczy 9 : 481-485.["Evaluation of the quality of thermal transfer printing on labels and clothing tags", Paper Review]

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MODULAR PRODUCTION SYSTEM OF PACKAGING OF SRP TYPE – TESTING OF PACKAGING IN DIFFERENT CONDITIONS. PART 1. NORMAL TEMPERATURE

ABSTRACT: The article presents the results of research on the resistance of packaging to static pressure. The test was carried out on Plaform® trays without a barrier coating and using the UKAPhob HR 530 barrier at a normal temperature, assuming a wide range of humidity. In order to determine the effect of the increased cardboard humidity on the value of resistance to static pressure, the tests were carried out after air-conditioning of the packaging in six different climatic conditions.
Key words: packaging boards, variants of research on the resistance to static pressure

STRESZCZENIE: W artykule zaprezentowano wyniki badań odporności opakowań na nacisk statyczny. Badanie przeprowadzono na tacach Plaform® bez powłoki barierowej i przy zastosowaniu bariery UKAPhob HR 530 w temperaturze normalnej, przyjmując przy tym szeroki zakres wilgotności. Dla określenia wpływu zwiększonej wilgotności tektury na wartość odporności na nacisk statyczny, badania wykonano po klimatyzowaniu opakowań w sześciu różnych warunkach klimatycznych.
Słowa kluczowe: tektury pudełkowe, warianty badań odporności na nacisk statyczny

INTRODUCTION

Packaging plays the important role in the economy of each country. Therefore, packaging industry to-day is racing in respect of designing and production of packaging and packaging modules which serve many different functional applications. From among many solutions, we should distinguish Shelf Ready Packaging (SRP). It represents the common present trend in exposure of consumer goods, facilitating reduction of service and logistics costs, with the simultaneous increase in value of the product's presentation [1]. The present study was undertaken with the aim to conduct the tests of packaging, having the application in the market as "ready to be placed on the shelf" (SRP – Shelf Ready Packaging). Their design and production were necessitated by the producers; they resulted from the need to lower the costs of work in trading facilities, reducing the time period, dedicated to arrangement of the products on the shelves, abbreviating the time of identification of the products within the shop and increasing the purchase attractiveness.

The planned cycle of the test of packaging at a normal temperature constitutes the first part of the project, the aim of which is the attempt to minimize the producers' costs of SRP packaging production as not to become a factor, significantly affecting the manufacturing costs.

[1] Modular production system of packaging of SRP type – testing of packaging, the tests were carried out for PROTIM SP Ltd., Poznań

Shelf Ready packaging (SRP) is a very popular group of the so-called packaging ready to be placed on a shelf. It is a sort of grouped packaging which, apart from the transport function, play many other additional functions such as exposure or promotion (advertisement). The discussed packaging simplifies a logistic process – there is no necessity of placing the unitary products on the shelves. The packaging itself may be easily placed on the shop shelf and opened. It facilitates optimization of the current supplementation of the shelves and increases the purchase attractiveness. SRP packaging considers many constructional solutions. They are widely employed as packaging of fast moving consumer goods (FMCG – fast Moving Consumer Goods).

Plaform® pattern was developed by the International Paper more than 30 years ago and now it is the packaging which is most frequently used in transport and exposure of fruits and vegetables. Owing to its construction and speed of folding, it is also the most profitable packaging solution[2]. They bear the overprints with information on product and brand.

Plaform® tray shows the products well and ensures an easy access to them. It allows application of attractive design and overprints, with the promotion of trade mark.

The properties of the discussed trays are as follows:

- good visibility of the exposed products and easy access;
- perfect protection of the products during transport;
- economic solution, serving simultaneously the transport and exposition;
- effectiveness of storage – they may be stored in a flat form before their folding;
- easy and quick folding, manually or mechanically;
- the possibility of placing design and overprints, promoting the trademark of the customer.

Plaform® tray is used in transport and retail sales of food products (RRP), including fruits and vegetables, fish and seafood, poultry and meat; it also employed in far distance exports.

PIC. 1. PACKAGING PLAYS THE IMPORTANT ROLE IN THE ECONOMY OF EACH COUNTRY

Packaging stacked on pallets (palletized) are characterized by one of the basic resistance properties of the packaging used in transport and storage as well as a shop exposition. It is resistance to static pressure. The mentioned property is determined by Box Compression test (BCT).

It is the method for testing the resistance to compression of ready formed box. The mentioned test may be used in evaluation of the properties of a given packaging in respect of its resistance to pressure of a degree of the protection of its contents from the effect of the crushing forces.

The discussed test may be conducted as an individual testing in order to examine the consequences of the pressure or stacking effect (deformation, crushing or breaking) or as a part of complex study, carried out with the aim to determine the resistance of the packaging to the threats, occurring in trade

[2] http://www.internaitonalpaper.com

PIC. 2. PACKAGING INDUSTRY TO-DAY IS RACING IN RESPECT OF DESIGNING AND PRODUCTION OF PACKAGING AND PACKAGING MODULES WHICH SERVE MANY DIFFERENT FUNCTIONAL APPLICATIONS

turnover where the damages may be caused by the pressure or stacking.

BCT test is a very good method for optimization of packaging costs. It has been revealed that the boxes made of the same types of paper possess different resistance values. Optimum packaging is such which obtains the required resistance (BCT) at the possibly lowest costs. The technology of paperboard production has a deciding meaning.

Paperboard is the environment-friendly paper material, used in packaging and protection of goods and in production of packaging. We can distinguish solid and corrugated paperboard. The solid paperboards are composed of one or few layers of paper mass, being wet combined during the manufacturing process, without use of adhesive. The corrugated paperboard is a packaging material consisting of alternatively arranges and glued flat and corrugated layers. Depending on the number of layers, we can distinguish single face corrugated board, double faced board, three-, four- layered boards and double wall corrugated board and corrugated seven-layered cardboard. Owing to its properties, the corrugated cardboard is highly appreciated packaging. The layers of the corrugated board affect good shock absorption abilities; due to this fact, the boxes protect sufficiently the packaged products from mechanical damages[3].

The corrugated paperboard is the most frequently employed material in production of packaging. It is manufactured in different varieties and its strength parameters may be shaped within very wide limits. The properties of the corrugated board are dependent, inter alia, on the semi-products and auxiliary materials, employed in its manufacture. Paper is the main raw material used in production of the corrugated cardboard.

The shape and the size of waves is a characteristic feature of the corrugated paperboard. The process of forming the waves and its gluing with flat layers has a basic meaning for the quality of the corrugated paperboard. A high wave causes that the paperboard has better springiness and higher rigidity whereas the paperboard with a lower wave has better resistance to flat crushing what causes a smaller risk of the cardboard puncture. Depending on the dimensions of the wave i.e. height of the wave (distance of the top of the wave from the basement or a distance between two flat layers) and its density, we can distinguish different type of waves[4].

[3] Modular production system of packaging of SRP type – testing of packaging, the test conducted for PROTIM Ltd., Poznań

[4] Korzeniowski A., Commodity science of industrial products, Part III. Testing of the quality of the products, Ed. by AE, Poznań 2006

TAB. 1. CONDITIONING BEFORE THE TESTS: 24 H, TEMPERATURE T 23°C, RELATIVE HUMIDITY RH 50%, BCT TEST WITHOUT BARRIER

No of sample	1	2	3	4	5	Mean
F [kN]	3,5	3,9	3,6	3,9	4,1	3,80

TAB. 2. BCT TEST WITH THE BARRIER

No of sample	1	2	3	4	5	Mean
F [kN]	4,2	4,6	4,7	4,2	4,9	4,52

TAB. 3. CONDITIONING BEFORE THE TESTS: 24 H, TEMPERATURE T 23°C, RELATIVE HUMIDITY RH 60%, BCT TEST WITHOUT BARRIER

No of sample	1	2	3	4	5	Mean
F [kN]	4,1	4,1	4,3	4,3	4,2	4,20

TAB. 4. BCT TEST WITH THE BARRIER

No of sample	1	2	3	4	5	Mean
F [kN]	4,3	4,5	4,2	4,1	4,8	4,38

TAB. 5. CONDITIONING BEFORE THE TESTS: 24 H, TEMPERATURE T 23°C, RELATIVE HUMIDITY RH 70%, BCT TEST WITHOUT BARRIER

No of sample	1	2	3	4	5	Mean
F [kN]	3,9	4,0	3,9	3,9	4,3	4,00

TAB. 6. BCT TEST WITH THE BARRIER

No of sample	1	2	3	4	5	Mean
F [kN]	4,0	4,0	3,9	4,0	3,2	3,96

TAB. 7. CONDITIONING BEFORE THE TESTS: 24 H, TEMPERATURE T 23°C, RELATIVE HUMIDITY RH 80%, BCT TEST WITHOUT THE BARRIER

No of sample	1	2	3	4	5	Mean
F [kN]	3,4	3,5	3,4	3,3	3,0	3,32

TAB. 8. BCT TEST WITH THE BARRIER

No of sample	1	2	3	4	5	Mean
F [kN]	3,7	3,3	3,3	3,4	3,5	3,44

TAB. 9. CONDITIONING BEFORE THE TESTS: 24 H, TEMPERATURE T 23°C, RELATIVE HUMIDITY RH 90%, BCT TEST WITHOUT THE BARRIER

No of sample	1	2	3	4	5	Mean
F [kN]	2,5	2,4	2,4	2,3	2,5	2,42

TAB. 10. BCT TEST WITH THE BARRIER

No of sample	1	2	3	4	5	Mean
F [kN]	2,7	2,5	2,7	2,4	2,6	2,58

TAB. 11. CONDITIONING BEFORE THE TESTS: 24 H, TEMPERATURE T 15°C, RELATIVE HUMIDITY RH 85%, BCT TEST WITHOUT THE BARRIER

No of sample	1	2	3	4	5	Mean
F [kN]	2,7	2,8	3,1	2,9	3,1	2,92

TAB. 12. BCT TEST WITH THE BARRIER

No of sample	1	2	3	4	5	Mean
F [kN]	3,0	3,0	3,1	3,0	3,2	3,06

THE AIM AND THE SCOPE OF THE STUDIES

In the research part of the study, the program of the tests of Plaform® trays made of double wall corrugated board without barrier coating and with the application of UKAPPhob HR 530 barrier, was implemented. Mechanical properties of paper, corrugated paperboard and the performed packaging vary according to the change in the humidity of the ambient air. Therefore, general assumptions of the research work consisted in determination to what degree the conditions of temperature and humidity of conditioning of the paperboard affected its properties and how the characteristics of the paperboard was changing together with the change in the mentioned conditions. The tests of the resistance of the packaging to the static pressure (BCT) by the method specified in standard PN-EN ISO 12048:2002E[5] at a normal temperature, were carried out for six conditions of air-conditioning.

TAB. 13. BCT TEST

	1	2	3	4	5	6
BCT without barrier	3,80	4,20	4,00	3,32	2,42	2,92
BCT with barrier	4,52	4,38	3,96	3,44	2,58	3,06
RH [%]	50	60	70	80	90	85
Temp. [°C]	23	23	23	23	23	15

[5] PN-EN ISO 12048:2002 Packaging – Complete, filled transport packages – Compression and stacking tests using a compression tester

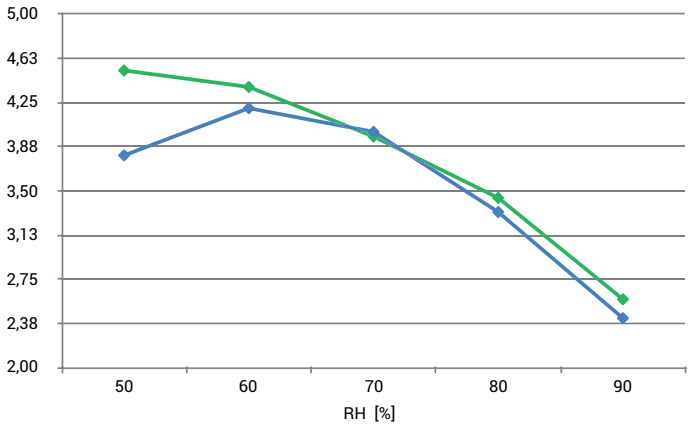

FIG. 1. THE OBTAINED VALUES OF DETERMINATIONS WERE GIVEN IN LINEAR DIAGRAM, ILLUSTRATING THE RELATION OF BCT VALUE DEPENDING ON DIFFERENT CONDITIONING VARIANTS.

PREPARATION OF THE SAMPLES

For the tests, the packages conditioned according to criteria adopted for Stage 1 – Preparation of the samples at a normal temperature, were used.

There were carried out 5 determinations for each Plaform® tray without barrier coating and with the application of UKAPPhob HR 530 barrier, successively for six climatic conditions.

THE RESULTS OF DETERMINATION

The test of boxes' resistance to static pressure were conducted without the contents, until loss of rigidity of packaging, with the registration of the level of compressing force at this moment, expressed in kN. The test of the resistance to pressure determines the resistance of the package to compression. It is expressed by the value of force, acting directly on the box during its compression, causing its destruction or deformation.

The tests of the boxes' resistance to pressure were carried out using Lorentzen& Wettre press type CT 100 with mechanical drive. The mentioned press consists of two rigid flat plates. The upper plate is a mobile compressing plate. The maximum force of the pressure by the described equipment is equal to 100 kN. The rate of the press move during the test amounted to 5 mm/min.

THE RESULTS OF THE TESTS

The results of the conducted tests have been given in tables and in diagrams, representing the range of the values of the examined parameters.

The tables show the results of the test of resistance to a static pressure (BCT, compression test) at a normal temperature, successively for six conditioning variants for packaging – Plaform® tray made of paperboard without barrier coating and with the application of the mentioned barrier.

SUMMING UP

In Stage 1 – Testing of packaging at a normal temperature, the determinations have been carried out and the results for Plaform® tray packaging made of paperboard without barrier coating and with the application of the mentioned barrier, successively for six climatic conditions have been submitted. The obtained values of determinations were given in the tables, showing the mean results for the selected climatic conditions. The analysis of the results of the obtained values of resistance to a static pressure (BCT, compression test) for Plaform® tray packaging indicates that the most favourable results were obtained for paperboard packaging with the application of barrier at the temperature of 23°C and relative humidity (RH) 50%. Under the successively increased humidity conditions, BCT values were distinctly dropping for the paperboard without the barrier as well as with its application; the paperboard with the barrier revealed better properties.

The obtained values of determinations were given in linear diagram, illustrating the relation of BCT value depending on different conditioning variants.

The analysis of the results of Stage 1 allows the conclusion that the conditions of packaging conditioning at various values of relative humidity affected significantly the results of determinations of the performed tests, both for packaging and paperboards without the coating and with its application.

When comparing the results for the selected conditioning variants and their mean values, certain regularities were recorded. The results of BCT determination for Plaform® tray packaging are most favourable for the conditions T=23°C and RH = 50% for the packaging without coating as well as in the case of its application. Throughout the whole cycle of the test with the successive use of all conditioning variants, the more favourable results were decidedly obtained for the packaging with the barrier.

The above fact indicates that the circumstances of conditioning the paperboard have the effect on the results of the conducted tests. Higher values of relative humidity have a negative impact on BCT test, decreasing the resistance properties of paperboard.

When analysing the obtained results of the performed determinations, we may observe that the highest differences were recorded in the comparison of the results obtained for the lowest and the highest conditions of relative humidity. <<

REFERENCES

1. http://www.internaitonalpaper.com/pl
2. A. Korzeniowski, Industrial commodity science, part III, testing the product quality, Published by AE, Poznań 2006 [in Polish]
3. Modular production system of packaging of SRP type – testing of packaging, conducted for PROTIM Ltd., Poznań, 2019
4. PN-EN ISO 12048: 2002 Packaging – Complete, filled transport packages – Compression and stacking tests using a compression tester

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PROF. EMERITUS STEFAN JAKUCEWICZ
DEPUTY EDITOR-IN-CHIEF OF THE PACKAGING REVIEW

NEW MONOGRAPH ON PACKAGING PRINTING

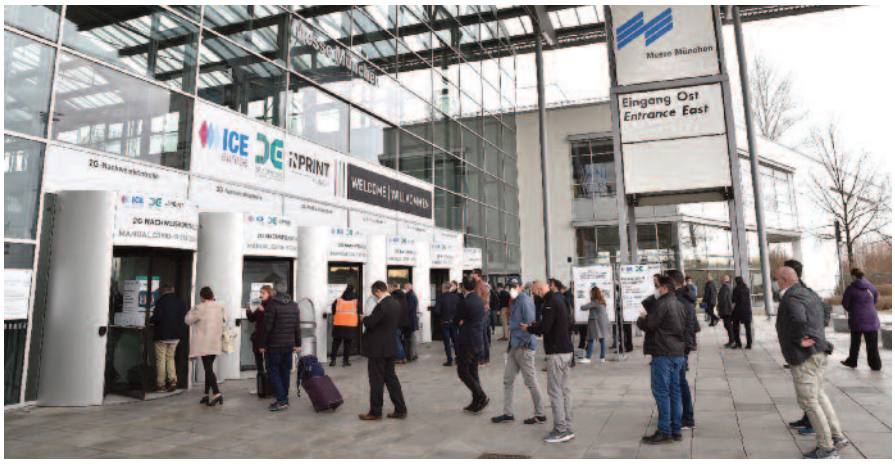
In mid-February 2022, Oficyna Wydawnicza Politechniki Warszawskiej (Publishing House of the Warsaw University of Technology) published a monograph authored by Mrs. Katarzyna Piłczyńska, PhD, entitled: „Industrial digital printing of packaging materials and packaging". The reviewers of the monograph were: Stefan Jakucewicz, Ph. D., professor of Warsaw University of Technology and Svitlana Khadzhynova, Ph. D.
The monograph consists of three chapters.

- Chapter 1: Introduction, which defines the basic terms and concepts used in the monograph, namely: the scope of the term packaging, the division of substrates for industrial packaging printing and the general characteristics of digital printing techniques.
- Chapter 2: Characteristics of digital printing technologies including those used for packaging printing together with a study of the quality of the printouts obtained.
- Chapter 3: Production digital printing systems. The monograph ends with conclusions.

The work is a relatively small volume of 88 B5 pages, edition of 100 copies, price 20 PLN. To be purchased online at the Publishing House of the Warsaw University of Technology.
The book is the result of lectures and research work conducted at the Department of Printing Technology of the Institute of Mechanics and Printing at the Warsaw University of Technology. It is intended for students and scientific employees involved in digital printing techniques – especially packaging and packaging materials.
It is the first book on o Polish publishing market dealing with the issue of digital printing of packaging industry products. <<

Nowa monografia poświęcona opakowaniom

W połowie lutego 2022 roku Oficyna Wydawnicza Politechniki Warszawskiej wydała monografię autorstwa Pani dr inż. Katarzyny Piłczyńskiej pt. „Przemysłowe drukowanie cyfrowe materiałów opakowaniowych i opakowań". Recenzentami monografii byli: dr hab. inż. Stefan Jakucewicz em. prof. uczelni – Politechnika Warszawska i dr hab. inż. Svitlana Khadzhynova – Politechnika Łódzka.
Monografia składa się z trzech rozdziałów. Rozdział 1. Wprowadzenie, w którym zdefiniowano podstawowe terminy i pojęcia stosowane w monografii, a mianowicie: zakres terminu opakowanie, podział podłoży do przemysłowego drukowania opakowań oraz ogólna charakterystykę cyfrowych technik drukowania. Rozdział 2. Charakterystyka technologii drukowania cyfrowego z uwzględnieniem stosowanych do drukowania opakowań wraz z badaniem jakości uzyskanych odbitek. Rozdział 3. Produkcyjne systemy drukowania cyfrowego. Całość zamykają wnioski końcowe. Praca jest stosunkowo niewielkiej objętości 88 stronic B5, nakład 100 egz., cena 20 zł. Do nabycia internetowo w Oficynie Wydawniczej Politechniki Warszawskiej.
Książka jest efektem prowadzonych wykładów i prac badawczych w Zakładzie Technologii Poligraficznych Instytutu Mechaniki i Poligrafii w Politechnice Warszawskiej. Jest przeznaczona dla studentów pracowników związanych z cyfrowymi technikami drukowania – szczególnie opakowań i materiałów opakowaniowych.
Jest to pierwsza książka na naszym polskim rynku wydawniczym podejmująca zagadnienie drukowania cyfrowego produktów przemysłu opakowaniowego.



A TOTAL OF 10,618 ATTENDEES FROM 65 COUNTRIES CAME TO THE BAVARIAN CAPITAL TO DISCOVER MACHINERY, SYSTEMS, MATERIALS, AND ACCESSORIES, OF WHICH 5,675 WERE TRADE VISITORS.

ANNA NARUSZKO, MSC
EDITOR OF THE PACKAGING REVIEW

EXHIBITION TRIO FOR THE CONVERTING AND CORRUGATED PACKAGING INDUSTRY

On March 15-17th 2022, ICE Europe, CCE International and InPrint Munich took place side-by-side at the Munich Trade Fair Centre in Germany, providing the industries with a much-needed live event. The three specialised exhibitions marked a long-awaited return of unrivalled business and networking opportunities. A total of 10,618 attendees from 65 countries came to the Bavarian capital to discover machinery, systems, materials, and accessories, of which 5,675 were trade visitors. A total of 474 exhibitors from 23 countries presented their latest technologies on a net exhibition space of some 12,500 square meters.

The majority of visitors came from Germany, Italy, UK, Spain, Austria and France. The most important exhibitor countries were Germany, Italy, France, UK and Switzerland. Taking place in early 2022, the exhibitions set a milestone for the whole converting, corrugated and industrial print industry since the outbreak of the pandemic.

To provide a central platform for the industries and to bring the right people together to do business has always been our contribution to the economy – says Nicola Hamann, Managing Director at Mack-Brooks Exhibitions. – *However, it was more important than ever to do our job this year. And I must admit, it felt good to see the appreciation in the attendees" smiles and to get the mainly positive feedback from all participants.*

The results of the visitor analysis have also shown that the visitors mainly came from the following industry sectors:

- Packaging, printing, plastics, engineering, paper, chemicals, automotive, textiles and nonwovens as well as electronics (ICE Europe)
- Corrugated board plants and sheet plants, packaging, printing, folding carton converters, packaging designers and specifiers, corrugated sheet feeders (CCE International)
- Printing Industry, packaging industry, manufacturing industry, designer/advertising agency (InPrint Munich)

ON MARCH 15-17TH 2022, ICE EUROPE, CCE INTERNATIONAL AND INPRINT MUNICH TOOK PLACE SIDE-BY-SIDE AT THE MUNICH TRADE FAIR CENTRE IN GERMANY, PROVIDING THE INDUSTRIES WITH A MUCH-NEEDED LIVE EVENT.

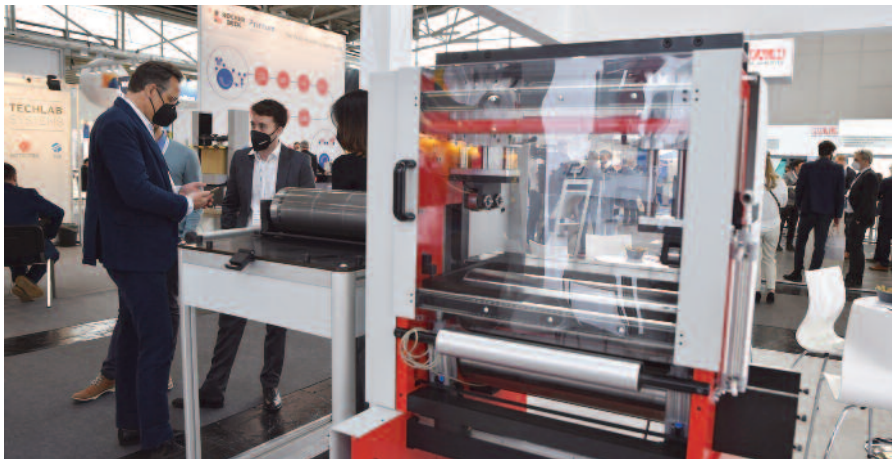
With ICE Europe, CCE International and InPrint Munich we provided a central marketplace for industry specialists in times where it was needed the most – explains **Patrick Herman, Event Director of the Converting, Paper and Print Events at Mack-Brooks Exhibitions**. – *Both exhibitors and visitors were highly satisfied with their newly established business relations. Some exhibitors were even able to sell their machines on-site.*

ICE Europe 2022 provided the ideal platform to finally meet with our existing and new customers again. We were really happy to be back on the show grounds and meet with people in person after such a long time. The quality of the generated business leads at our booth was outstanding and for us the exhibition was a success. We are looking forward to coming back next year – said **Dirk Schröder, Sales Division Manager, Erhardt+Leimer GmbH**.

ICE AWARDS 2022 & EXTENSIVE CONFERENCE PROGRAMMES

For the third time, the organisers Mack-Brooks Exhibitions honoured best practice, excellence, innovation and outstanding achievements of exhibitors with the ICE Awards, in three categories: "Digital Converting Solutions", "Sustainable Products and Manufacturing Processes", and "Efficient Production Solutions". Nicola Hamann, Managing Director of Mack-Brooks Exhibitions, presented the ICE Awards 2022 to the exhibiting companies on the first day of the show. The winners had been determined via an online voting on the show website. A total of 29 exhibitor entries made it onto the short list; and some 1,000 industry experts cast their vote to establish the winners of the individual categories.

The company DIENES Werke für Maschinenteile GmbH & Co. KG. received 44% of all votes in the category "Digital Converting Solutions" and won an ICE Award for their TEOC AddOn – the connectivity device for knife holders. TEOC is processing the collected machine-, environmental- and service data and the findings based on further data analysis are used primarily in



MANY EXHIBITORS AT THIS YEAR'S SHOW HAVE ALREADY ANNOUNCED THAT THEY WILL EXHIBIT AGAIN AT THE NEXT ICE EUROPE, CCE INTERNATIONAL AND INPRINT MUNICH 2023.

process optimization at the customer's site to reduce machine downtime and increase productivity.

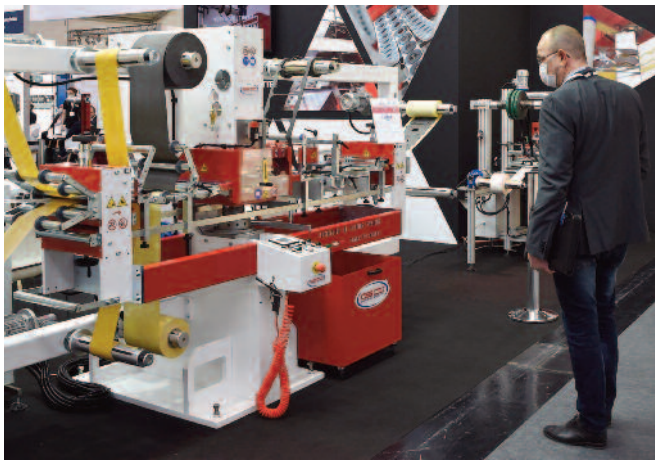
In the category 'Sustainable Products and Manufacturing Processes", the company WORK Microwave GmbH received 52% of all votes and won the ICE Award for their WORKSens SR Series. This solution offers an extensive solution for continuous accurate inline moisture monitoring during product manufacturing, which is able to integrate in established lines and is harmonizing with new digital Industry-4.0 concepts.

With 53% of all votes, the company tesa SE won the ICE Award in the category 'Efficient Production Solutions" for its tesa® 51948 Black X, which provides excellent wetting properties on high-slip films to ensure a secure splice performance even at high machine speeds and reduces waste at the same time.

The comprehensive conference programme at InPrint Munich, powered by XAAR and hosted by Werner Zapka (WZA-Consulting) offered attendees exciting insight into market developments and innovative projects. With more than 60 speaker slots on two bespoke conference stages, including the FuturePrint Sessions hosted by Frazer Chesterman and Marcus Timson, there were plenty of topics to choose from. The CCE Open Seminar Sessions featured case studies, technical talks and panel discussions on the latest trends and developments in the corrugated and cartonboard industry.

DATE OF THE NEXT SHOW

Many exhibitors at this year's show have already announced that they will exhibit again at the next ICE Europe, CCE International and InPrint Munich 2023. The next editions will take place from 21 – 23 March 2023 at the Munich Trade Fair Centre in Germany. <<



TRENDS AND KNOWLEDGE AT PACKAGING INNOVATIONS FAIR

The 14th edition of the International Packaging Fair Packaging Innovations will take place on May 31st – June 1st 2022 in Warsaw EXPO XXI Warsaw. Packaging Innovations is one of the few trade fairs in Poland which – despite the pandemic – has maintained its continuity and has even been expanded to include new formats. As a preview to the tradeshow online events are held and allow the visitors to stay in touch with the industry and provide access to knowledge and business contacts to those who cannot attend the fair in person. The theme of the fair is eco-packaging and e-commerce, and exhibitors will present their solutions in as many as 10 thematic zones!

The event has gained popularity among many industries like food, cosmetics, chemicals, pharmaceuticals, automotive, electronics and transport. It is a great opportunity to learn about innovations, see the latest solutions and establish valuable contacts. This is what **Bartosz Suski, area sales manager at Jokey Poland Sp. z. o.o.**, had to say about last year's meeting: *The name of the trade fair – Packaging Innovations – sounds adequate to what happens at the event, which is why we exhibit here. For us it's a platform for gaining knowledge, learning about trends, seeing what is happening on the market and what we can later adopt in our products.*

TRENDSETTING EVENT

Packaging Innovations presents solutions that set European and global industry trends, such as eco-packaging. One example is Rbeco – one of this year's exhibitors, a manufacturer and exclusive distributor of innovative and ecological products for

THE EVENT HAS GAINED POPULARITY AMONG MANY INDUSTRIES LIKE FOOD, COSMETICS, CHEMICALS, PHARMACEUTICALS, AUTOMOTIVE, ELECTRONICS AND TRANSPORT.

PACKAGING INNOVATIONS PRESENTS SOLUTIONS THAT SET EUROPEAN AND GLOBAL INDUSTRY TRENDS, SUCH AS ECO-PACKAGING.

luxury and industrial packaging. The company's offer includes ecological fillers, which perfectly fill the inside of the box. That can be later finished with a sticker or a ribbon with a personalized print, which creates a unique unboxing experience.
BÜHNEN, which recently presented the first hot melt adhesive on an organic basis, or Novo-Pak, whose priority is packaging with nature in mind, are innovative in their approach. All PET bottles can be made with rPET. And the traditional black pigment can be replaced by a carbon free one that allows recycling.

KNOWLEDGE SHARING

At 14th edition of Packaging Innovations we will see the continuation of Packaging Innovations' original podcasts. „Spakowane Rozmowy" (Packaged Talks) whose topics include top industry issues such as eco-design of packaging, packaging for e-commerce, as well as challenges for cosmetic packaging or legal aspects of packaging usage.

An inseparable element of the fair – the workShops zone – also seems to be interesting. The knowledge gained at the trade fair during lectures and presentations is particularly valued by Packaging Innovations participants. The topics of the speeches on the workShops stage will include industry trends, including eco-solutions and e-commerce.

A novelty of this year's edition of the tradeshow is free of charge service of making appointments with exhibitors via the electronic exhibitor directory.

The possibility of hybrid organization of the fair is both an opportunity to expand the audience and facilitate access to industry knowledge and trends, as well as proof that nothing can replace live meetings. *We are convinced that this year's edition will also surprise the visitors with a rich program, innovative solutions and the latest trends presented by our exhibitors, but most of all it will enable them to establish long-term relationships* – concludes the organizer.
Admission is free, but prior registration at packaginginnovations.pl is required. <<

Packaging Review

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ALL SCIENTIFIC ARTICLES ARE REVIEWED.

"PACKAGING REVIEW" REVIEWING PROCEDURE

"Packaging Review" quarterly magazine's reviewing procedure is multilevel in order to maintain high quality content and consists of the following steps:

- If Editor-in Chief decides that provided, scientific article fits the journal's scope, he appoints two Reviewers of recognized competence within the field of research, preferably with professor or postdoctoral degree. The reviewers are obliged to:
  - deliver an objective, independent opinion,
  - ensure that there is no conflict of interests – they should have no personal relationships or business relations with Authors,
  - keep any information regarding the content and opinion confidential.
- When the Reviewers are chosen, the Editor-in-Chief sends them a written offer with either a short description or an abstract of the article, defines the range of reviews and sets a deadline.
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- Reviewers' personal details are classified and they can be declassified only at the Author's request and with the reviewer's permission in case the review is negative or the article contains arguable elements. Once a year, the Editorial Board publishes in its journal the full list of the Reviewers cooperating with the journal.
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INFORMATION FOR THE AUTHORS

We kindly ask to submit to the editorial office author's application form available at www.packagingreview.eu with contact details, a title of the proposed article, number of pages, illustrations and tables as well as a brief abstract. After receiving information about the acceptance of the proposed article please submit the entire text prepared according to the editorial instructions as well as a complete declaration form. Submitted articles are subjected to editorial assessment and receive a formal editorial identification number used in further stages of the editorial process. Every submitted article is reviewed. Publication is possible after receiving positive reviews.

GUIDELINES FOR PREPARING THE ARTICLES

- Articles for publication in „Packaging Review" should have scientific and research character and focus on innovations, trends and challenges of the industry.
- Articles must be original, not previously published (if the article is a part of another work i.e. PhD thesis, habilitation etc. the information about that should be placed in the reference section).
- The article should involve a narrow topic but treated thoroughly without repeating general knowledge information included in the widely known literature.
- If the problem is extensive, it should be it split into few articles for separate publications.
- Articles should be of a clear and logical structure: the material should be divided into parts with titles reflecting its content. The conclusions should be clearly stated at the end of the paper.
- The article should be adequately supplemented with illustrations, photographs, tables etc. however, their number should be limited to absolute necessity.
- The title of the article should be given in Polish and English as well as the abstract and key words.
- The article should not exceed 10 pages (1 page – 1 800 characters).
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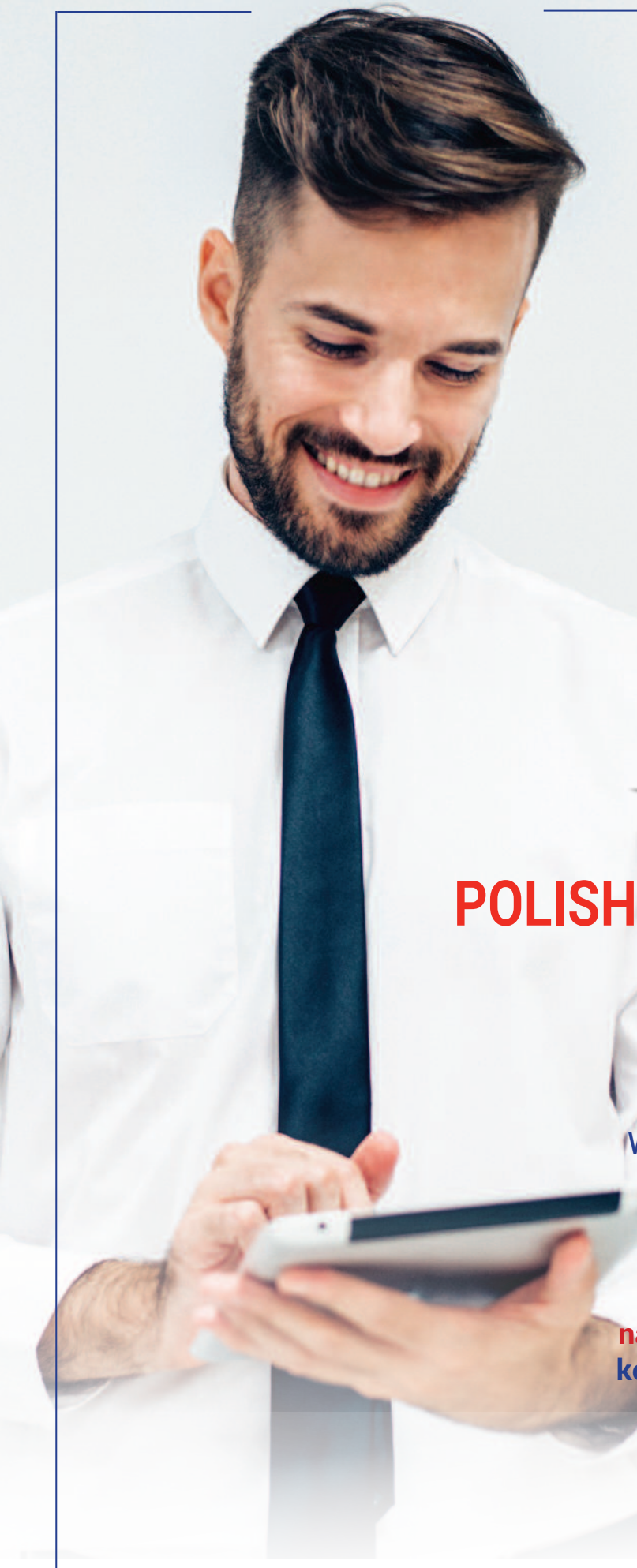

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