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STUDY OF THE INFLUENCE OF LAMINATION ON THE QUALITY OF DIGITAL IMPRINTS

The operational and reproductive — graphic indicators of digital imprints obtained on popular brands of cardboard, presented on the Ukrainian market of printing consumables, before and after the process of their lamination with glossy and matte film were studied.

Keywords: digital printing; imprint; cardboard; packaging; quality; optical density; gradation transmission; tone reproduction; operational stability.

Introduction

In the manufacture of printing products, a variety of finishing processes are used, as high-quality exterior design of products provides higher sales figures. Due to the trends in printing to reduce the cost and reduce the time to fulfill the order, as well as economic and technological parameters of possible ways to finish cardboard packaging, such as cheapness, simplicity, efficiency, prevalence, the technology of lamination of products has become widespread over the last decade, which involves the application of a special film of protective and decorative purposes on various printing products [1, 2]. Laminated cardboard is most widely used in the manufacture of food and beverage packaging, medicines, household chemicals and other goods that need protection from grease, moisture and contamination. This packaging extends the shelf life, protects products from moisture and oxidation when interacting with air. An important factor is, of course, the attractive appearance, which increases the demand for goods in such packaging.

It is known that lamination is carried out using lamination films having different densities and thicknesses. Films with a thickness of 32 μm to 250 μm are usually used. A small thickness can be useful, in particular, when laminating thin sheets of paper or if you want to maintain the flexibility of the material, while lamination with a thick film allows you to add rigidity to the material and provide additional protection [3, 4].

Most often, lamination is carried out using a glossy or matte

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film. Accordingly, the final result will depend on the type of selected film. Thanks to the matte film, the graphic picture begins to differ in color depth, and the glossy film makes it brighter. Glossy films have good protective properties, they give the image saturation and contrast. The only disadvantage is the formation of glare in bright light, which is an obstacle to the perception of the image at an angle and the difficulty of distinguishing small inscriptions. Therefore, before laminating a printing or advertising product, it is necessary to determine under what lighting, and where such products will be used. And in order to give the product velvet and reveal the full depth of its image, to make small inscriptions clear to the perception, it is necessary to use matte lamination. Matte film gives the product a specific charm and business presentability [5–8].

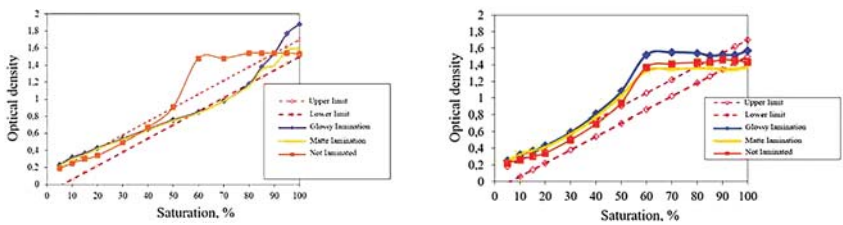
Methods

The most common papers used in the manufacture of packaging products were selected for the study, namely the Finnish coated paper company UPM DIGI COLOR of three weights: 200 g/m^2, 300 g/m^2 and 320 g/m^2. The layout for packaging was printed on a XEROX 700i Digital Color Press. Studies of the gradation characteristics of the obtained imprints were performed using a spectrocolorimeter GRETAG SPM 50 [9, 10]. Foliant 520 laminator and polypropylene glossy film thickness of 24–27 microns and matte film thickness of 25–30 microns of the Cosmo Film brand (India) were used for high-speed single-sided hot lamination of printed impressions. Tensile strength and elongation at break of the paper strip were determined on the RMB-30-2m breaking machine [11, 12]. Statistical processing of the results of experimental studies was performed using the software package Microsoft Office Excel 2010.

Results

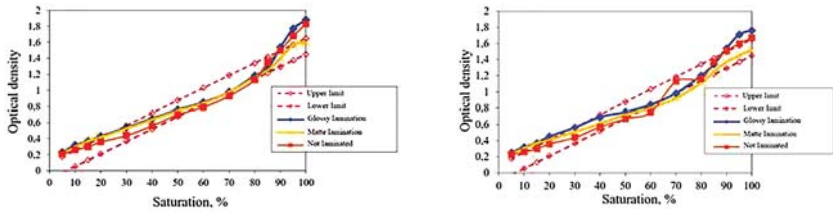
The obtained values of densitometric studies of these cardboard samples are presented in tabular form (table 1) and in the form of graphical dependences of their gradational transfer of CMYK inks (fig. 1–4.)

As a result of studies of gradational transmission of blue ink on cardboard weighing 200 g/m^2 and



a b

Fig. 1. Graduation transfer of Cyan ink on cardboard by grammar:
а — 300 g/m^2, б — 320 g/m^2



a b

Fig. 2. Graduation transfer of Magenta ink on cardboard by grammar:
а — 300 g/m^2, б — 320 g/m^2

Table 1

The results of the measured values of the optical density of inks on the imprints obtained on coated cardboard with a weight of 200 g/m^2

Paper	Optical densities % of scale saturation fields														
% of saturation	5	10	15	20	30	40	50	60	70	80	85	90	95	100	
Standardized value	0,08	0,16	0,24	0,32	0,48	0,64	0,80	0,96	1,12	1,28	1,36	1,44	1,52	1,60	
Glossy lamination	0,23	0,32	0,37	0,42	0,62	0,81	1,07	1,64	1,67	1,65	1,65	1,65	1,63	1,63	Cyan
Matte lamination	0,24	0,27	0,37	0,42	0,61	0,79	0,97	1,45	1,44	1,44	1,45	1,46	1,42	1,41	
Not laminated	0,19	0,25	0,32	0,37	0,57	0,74	1,06	1,61	1,6	1,51	1,52	1,54	1,57	1,49	
Glossy lamination	0,23	0,32	0,37	0,42	0,62	0,81	1,07	1,64	1,67	1,65	1,65	1,65	1,63	1,63	Magenta
Matte lamination	0,24	0,3	0,37	0,42	0,53	0,64	0,77	0,88	0,97	1,17	1,25	1,39	1,52	1,53	
Not laminated	0,23	0,28	0,35	0,41	0,5	0,62	0,75	0,87	1	1,21	1,37	1,48	1,7	1,66	
Glossy lamination	0,25	0,32	0,37	0,42	0,51	0,62	0,68	0,83	1	1,18	1,35	1,41	1,48	1,5	Yellow
Matte lamination	0,27	0,3	0,35	0,38	0,45	0,55	0,64	0,78	0,94	1,05	1,18	1,32	1,32	1,34	
Not laminated	0,21	0,26	0,28	0,33	0,4	0,5	0,61	0,71	0,9	1,09	1,18	1,29	1,35	1,34	
Glossy lamination	0,24	0,32	0,37	0,45	0,61	0,75	0,9	1,05	1,23	1,39	1,45	1,6	1,71	1,83	Black
Matte lamination	0,23	0,3	0,35	0,42	0,56	0,71	0,85	0,97	1,08	1,19	1,25	1,36	1,45	1,52	
Not laminated	0,22	0,29	0,34	0,4	0,54	0,69	0,84	0,99	1,14	1,29	1,34	1,48	1,6	1,6	

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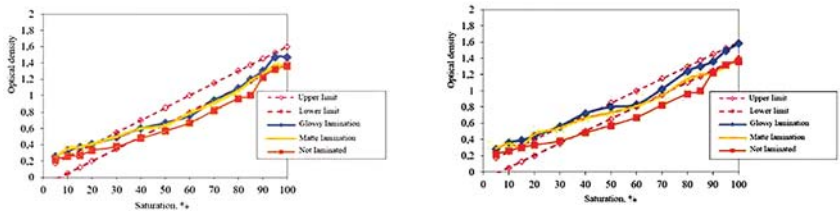


a b

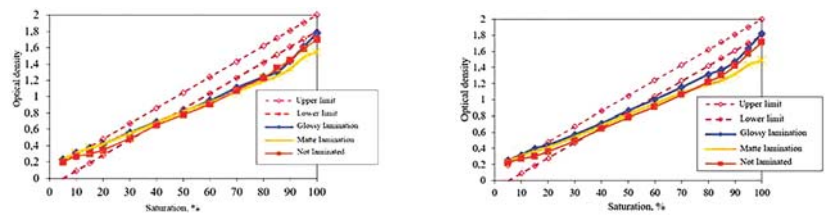
Fig. 3. Graduation transfer of Yellow ink on cardboard by grammar:
a — 300 g/m^2, b — 320 g/m^2

320 g/m^2, it was found that all samples show similar values of gradational transmission: in light and halftone areas, optical densities are approximately the same and within the upper limits. From halftone to dark areas, there is a slight deviation from the allowable data. Whereas for purple inks on cardboards with a weight of 300 g/m^2 there is a stable transfer of gradations in light and significant deviations in halftone areas, especially for non-laminated cardboard samples, and passing to a dark area, the data are adjusted to admissible values, instead, the optical densities of the glossy lamination samples start to increase.

Gradation transfer of purple ink on cardboard with a weight of 200 g/m^2 showed the stability of optical densities in all areas, while on samples of cardboard covered with glossy film, significant deviations from halftone and dark areas were recorded.

The tone transfer of purple ink on cardboard weighing 300 g/m^2 demonstrates smooth transitions of gradations of all samples from light to dark areas. In dark areas, all samples, except for imprints with matte lamination, have increased data and do not lie within acceptable limits.

Stable color rendering is demonstrated by all tested samples of cardboard with a weight of 320 g/m^2, the values of optical densities of which are within the allowable upper and lower limits, and only in dark areas samples with glossy lamination have increased performance.



a b

Fig. 4. Graduation transfer of BLACK ink on cardboard by grammar:
a — 300 g/m^2, б — 320 g/m^2

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Good indices of optical densities of yellow ink are recorded on cardboard weighing 200 g/m^2, which are within acceptable limits and do not have significant deviations. Approximate curves were recorded for samples on cardboard weighing both 300 and 320 g/m2 with matte and glossy lamination, the density of which is within acceptable limits and is close to the lower limit. Non-laminated paper has slight deviations in the halftone areas, in light and dark values are close to acceptable.

Gradation transfer of the studied samples of cardboard with a weight of 200 g/m^2 with glossy lamination in all areas demonstrates the stability of optical densities, which are within acceptable limits, compared with samples on cardboard with matte lamination and without it, which in halftone and dark areas go beyond the permissible limits, and non-laminated cardboard is almost tangent to the permissible limits.

The transmission of optical densities of black ink of all samples with a paper weight of 300 and 320 g/m^2 coincides from light to dark areas, but at the same time exceeds the permissible limits starting from halftone and moving to dark areas.

Diagrams of color coverage of imprints on cardboard before and after pressing the polymer film are presented in fig. 5.

The conducted studies of color coverage of all tested samples show that their color coordinates are within the regulated limits according to the ISO 12647 standard. Lamination with a polymer film (both matte and glossy) of the surface of imprints on cardboard with a weight of 200 g/m^2 significantly improves their color coverage, while for samples on cardboard with a weight of 300 g/m^2 glossy lamination does not significantly affect color coverage. A slightly different situation is observed on samples of cardboard with a weight of 320 g/m^2, where matte lamination provides on the contrary better indicators of imprints color than glossy lamination.

As a result of the conducted experimental researches of operational indicators of the investigated samples of cardboard packaging the diagram of tensile strength is constructed (fig. 6).

Violation of the «imprint—film» system during stretching occurs in several stages: first, the cardboard is stretched, where the imprint sticks to the film, the film is destroyed and the strip of paper is torn, and the film continues to stretch.

The tensile strength of laminated imprints, compared with non-laminated, increases within 20–100 times. As can be seen from fig. 6 with increasing grammar of the paper significantly increases the amount of effort applied to destroy the imprint both before and after pressing the film to it, moreover, for breaking thick grades of paper with a weight of 320 g/m^2 and above, a load of more than 300 N is required (maximum possible load of this breaking equipment), as at lower load there is only stretching of the studied samples laminated with both matte and glossy films. It is also worth noting that imprints laminated with glossy film can withstand higher tensile loads, compared to imprints with pressed matte film.

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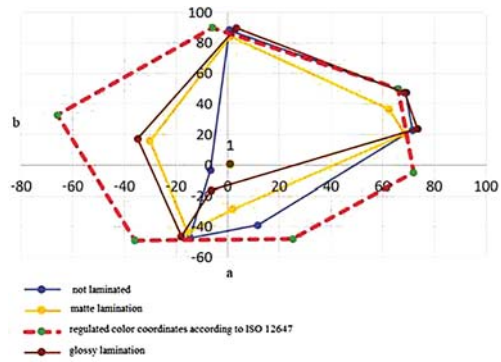
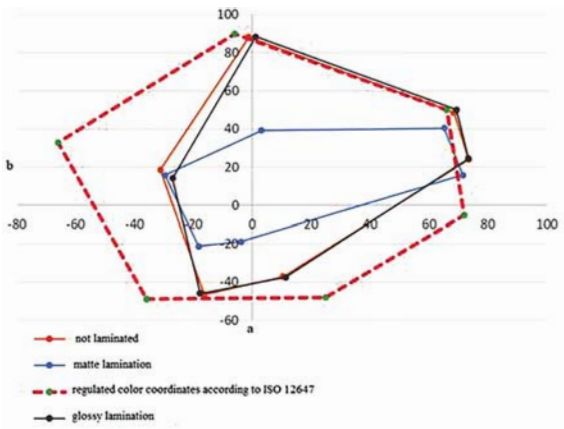


a



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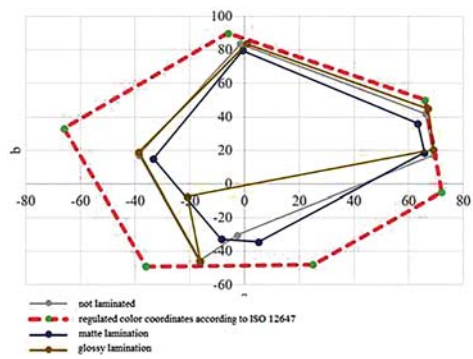

c

Fig. 5. Diagrams of color coverage L * a * b * of imprints on cardboard by grammar: a — 200 g/m^2, b — 300 g/m^2, c — 320 g/m^2

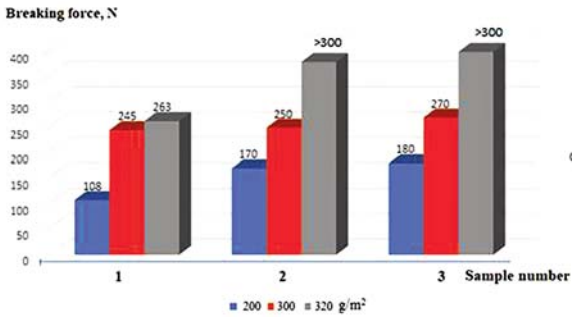

Fig. 6. Diagram of tensile strength of cardboard packaging

Conclusions

The results of studies of imprints gradation transmission before and after their lamination with polymer films show that due to lamination, both matte and glossy, significantly improves the tone transfer of all inks, and consequently the quality of the printed image in general.

From the conducted experimental researches of resistance to breaking it is noticeable that lamination of imprints essentially influences increase of their operational stability. A direct relationship between the weight of the paper and the magnitude of the applied force of destruction was detected. It was also found that the characteristics of the used film affect the strength of the imprints obtained by lamination.

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В роботі досліджено експлуатаційні та репродукційно-графічні показники відбитків цифрового друку, отримані на популярних марках картону, представлених на українському ринку поліграфічних витратних матеріалів, до та після процесу їх ламінування глянцевою та матовою плівкою.

Ключові слова: цифровий друк; відбиток; картон; паковання; якість; оптична густина; градаційна передача; тоновідтворення; експлуатаційна стійкість.

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