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REAL PROPERTIES OF METALIZED PRINTING COATINGS

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The article analyzes the influence of geometric and morphological parameters of the surface of materials used in printing. The article also talks about the possibility of combining MetalFX (or Color-Logic) with Maxwell Render — a material editor that provides a special approach to the creation of materials with a complex structure. In particular, layers are used that allow not only to mix two different materials but also to plan material from two or more components, taking into account their geometric relief, texture, transparency, and degree of reflection of these layers. The object of the study is the functional capabilities of the program «Material editor» and the main groups of parameters of geometric surface structures. The practical use of metal pigments with features of surface geometry of printing materials makes it possible to predict and optimize the creation of various optical combinations. The practical use of parametric estimation of geometric surface structures (GSS) opens up the possibilities of spatial evaluation for us and makes it possible to more correctly substantiate the kinetics of the processes that occur during the polymerization of paints. In addition, using the "Materials Editor", a 3-D printer and fractal geometry is the possibility of obtaining printing materials with a strong structure.

Keywords: *the surface of materials, MetalFX, Color Logic, Maxwell Render, metal pigments, fractals.*

Problem statement. The physical properties and microgeometry characteristics of rough surfaces are of paramount importance for the service optical characteristics of metallized printing coatings. One of the properties of metallized surfaces is the change in their tone and color. For example, depending on the lighting "gold" paint can be "light gold", "dark gold", "red-gold" etc., so for predictable and correct reflection in the print run one need to apply parametric assessment of geometric surface structures (GSS), where the presence of the "metal" is justified by marketing and advertising techniques. The special meaning of the problem of support on the long-term level of the "metallization" effect, which is stipulated by the spectrum of different optical combinations.

Given this, the problem of maintaining the "metalization" effect at the proper level, due to the spectrum of various optical combinations, is of particular importance.

Analysis of recent studies and publications. Many works, both domestic and foreign [2-7, 9] are devoted to the study of the influence of surface topography on the real

light through which it passes, is reflected, dissipated, etc. The large number and variety of publications attest to the complexity of the subject matter.

However, despite the breadth of theoretical and practical developments, significant difficulties lie not only in their particular but, above all, in their understanding, the validity of the theory of reflection of light waves from a surface with a random distribution of irregularities, which in turn have different morphological characteristics. Further development of such works took place in connection with the solution of important practical problems, especially in printing industry.

The relevance of the work is because:

– By adjusting the reflectivity of various surfaces (foil of hot and cold stamping, various metallized materials), one can get different pseudoholographic effects, hidden images that can be used as counterfeit protection in the manufacture of securities and certificates;
– creation of "nano-text" in holographic compositions, which is caused primarily by the defective surface, the roughness of which is formed by dislocation steps.

The purpose of the article. The purpose of the studies, the results of which are given in the article, is the analysis of structural surface defects and parameters of geometric structures.

Results of the research. Metal pigments used in the manufacture of metallized paints, are powders that are obtained by mechanical grinding of metals and their alloys. Aluminum powder is usually used to produce silver pigments, and bronze powder is used for golden pigments, which is obtained from an alloy of copper and zinc. The shade of "gold" depends on the ratio in the alloy of copper and zinc: the higher the copper content, the redder the shade. These ratios are presented in Table 1.

Table 1

Color shades of metallized pigments

name	Color hue	Copper (cuprum)	Zinc
Richgold	Greenish tint	70%	30%
Richpalegold	Yellowish tint	80%	20%
Palegold	Reddish tint	90%	10%

The initial material – aluminum or copper-zinc alloy is first melted and then passed through a pneumatic nozzle. The resulting grains of sand are sifted and ground in ball mills into bronze powder, which is then washed, dried and polished. Thus, extremely thin shiny metal scales are obtained. With a large increase, it is clearly visible that each metal pigment or grinding particle is not a lump, but an irregular shape flat sheet, scales, a plate of finely flattened metal. Figure 1 shows particles of metallic pigment in an enlarged form [1].

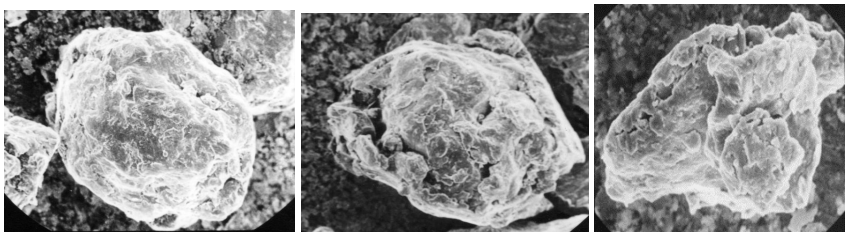

Figure 1. Metal pigment particle (241 times increase)

MetalFX technology produces millions of color shades with metallic luster and helps to hide the hidden image, readable codes, and codes contained in the hologram. For this purpose, special diffraction pigments can be used to produce simple holographic images by incorporating the ferromagnetic layer into pigment particles and applying a magnetic field at the time of printing to orientate particles. When the printed object is returned before the viewing device, the degree of shimmering of the diffraction effect will be different, and if printed with two different pigments separately, the appearance will vary from a dark image on a light background to a light image on a dark one. In another way, the pseudo-holographic effect can be achieved by reducing the concentration of main silver in special areas or completely eliminating it, keeping the triadic color unchanged.

First, apply a MetalFX gold or silver paint, which has a metallic gloss, high fastening speed, abrasion resistance, and then triad paints. Pigments of high purity and transparency guarantee minimum blackout at application, which is the main condition for transfer of high shine translucency MetalFX Silver Base or MetalFX Gold. The base's own paint color is selected so that it is as neutral as possible (without chromatic coloring). This combination of properties guarantees a high gloss and minimizes the loss of metallic luster during the subsequent application of process paints.

New possibilities for describing the processes occurring on the surface of printed materials in initial contact with metallized paint, gives parametric estimation of geometric surface structures (GSS) in the 3D system. Research in the 3D system opens up new possibilities of spatial-volume estimation of GSS, as well as a more correct substantiation of kinetics of ongoing processes in the polymerization of paints. Figure 2 shows the main characteristics by which the surface structure can be analyzed [8].

The basis for the objective analysis of the GSP is formed using the Hausdorf-Kolmogorov dimension. Lapidary in the 3D system, this volumetric (or fractal) dimension can be represented as a dependence:

$$D = \lim_{x \to 0} \frac{\lg \frac{N(\varepsilon)}{\varepsilon}}{\varepsilon} \to \lg \frac{1}{\varepsilon}, \tag{1}$$

where D is the fractal size (for GSS, the S_{td} parameter); ε is an elementary cubic volume; N(ε) is the minimum set of elementary cubic volumes required to cover the entire surface volume.

The paper surface roughness exhibits fractal characteristics with a Hausdorff dimension of less than 1.05 for linear profiles [8, 10].

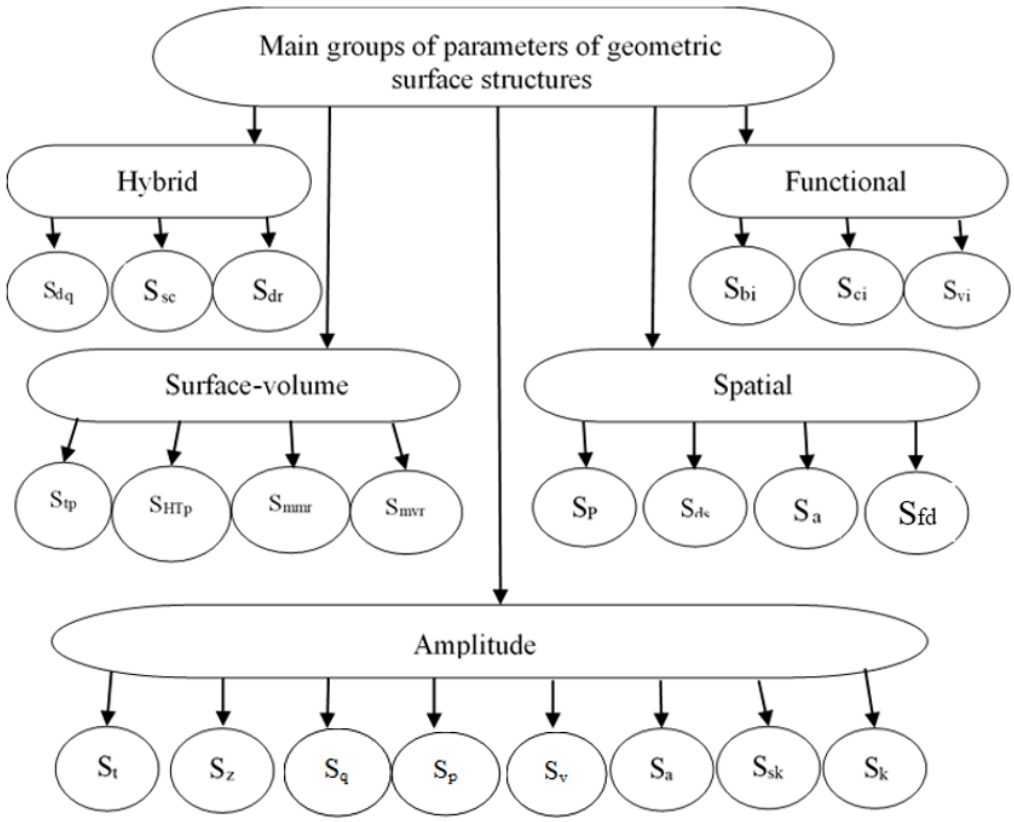

Figure 2. Main groups of parameters of geometric surface structures

Where S_{dq} – *the RMS slope of surface irregularities, μm/*μm*;*

S_{sc} – *arithmetic mean curvature of the vertex, 1/μм;*

S_{dr} – *surface development, %;*

S_{bi} – *indicator of carrier property, μ;*

S_{ci} – *indicator of lubrication retention by the root of irregularities;*

S_{vi} – *indicator of lubrication retention by residual depressions;*

S_{Tp} – *carrier property indicator, at an arbitrally given height relative to the highest vertex, %;*

S_{HTp} – *the height of the support zone, μm;*

S_{mmr} – *material volume indicator, mm³/mm²;*

S_{mvr} – *cavity volume indicator, mm³/mm²;*

S_{Pc} – *the density of the distribution of local vertices between the arbitrally given levels C1 and C2, the number of vertices, mm²;*

S_{ds} – *vertex density; number of vertices, mm²;*

S_{al} – *coefficient of decay of the autocorrelation function;*

S_{fd} – *fractal dimension;*

S_t – *roughness height, Mm;*

S_z – height of inequalities at ten points, Mm;
S_q – standard deviation of ordinates, μm;
S_p – maximum height of the vertices (from the middle plane), μm;
S_v – maximum depth of the cavity (from the middle plane), μm;
S_a – ordinate mean deviation (from the middle plane), μm;
S_{sk} – displacement coefficient, μm;
S_{ku} – density coefficient, μm.

But it should be noted that due to the rapid development of printing this technology is outdated. And replaced Metal FX new company Color Logic. Color-Logic® is a new company developing color communication systems creating special effects for print. The first Color-Logic system launched, the Color-Logic Process Metallic Color System, encompasses a completely new, patent pending, fully chromatic process spot color space, fully accounting for ink saturation limits, transparency, and intercoat adhesion between the process inks and the new range of Color-Logic metallic inks. This new system also brings the industry new image separation algorithms to create a much more natural and photorealistic range of metallic images. Today Color-Logic is also developing other decorative effects systems for the design and print industry. We also recommend combining Color-Logic with Maxwell Render. Despite being a new company, it is rapidly gaining popularity and deserves attention [11].

MetalFX can be combined with Maxwell Render, a material editor that provides a special approach to creating materials with a complex structure. In particular, layers are used, allowing not only to mix two different materials, but also to plan a material of two or more components, taking into account their geometric relief, texture, transparency, degree of reflection of these layers. The program allows one to get a different level of mixing of these layers, which is especially important for use in printing processes, where the printed materials have a primer and a varnishing operation is planned. At the same time it is possible to adjust the optical parameters of layers and sublayers: reflection of color at a certain angle, inversion of light through the thickness of the object, influence of surface roughness on the reflection brightness, control of angle of anisotropic reflection, the use of a black-and-white texture with a circular gradient from black to white is the construction of almost any light source by the user. The special block of this program "Image Properties" contains settings that are responsible for the image of the texture as a whole and allow adjustment: inverting, filtering, brightness, contrast, saturation, possibility of image sequencing for texture animation (Figure 3). The functionality of this program is shown in Figure 3.

From http://mographplus.com/40-learn-how-to-create-metal-materials-in-maxwell-render-for-cinema-4d/

Also interesting is using metalized surfaces on such a printing material as fractal paper. The proposed method of making fractal paper is based on the fractal structure and the use of 3D printing. Fractal — any of various extremely irregular curves or shapes for which any suitably chosen part is similar in shape to a given larger or smaller part when magnified or reduced to the same size.

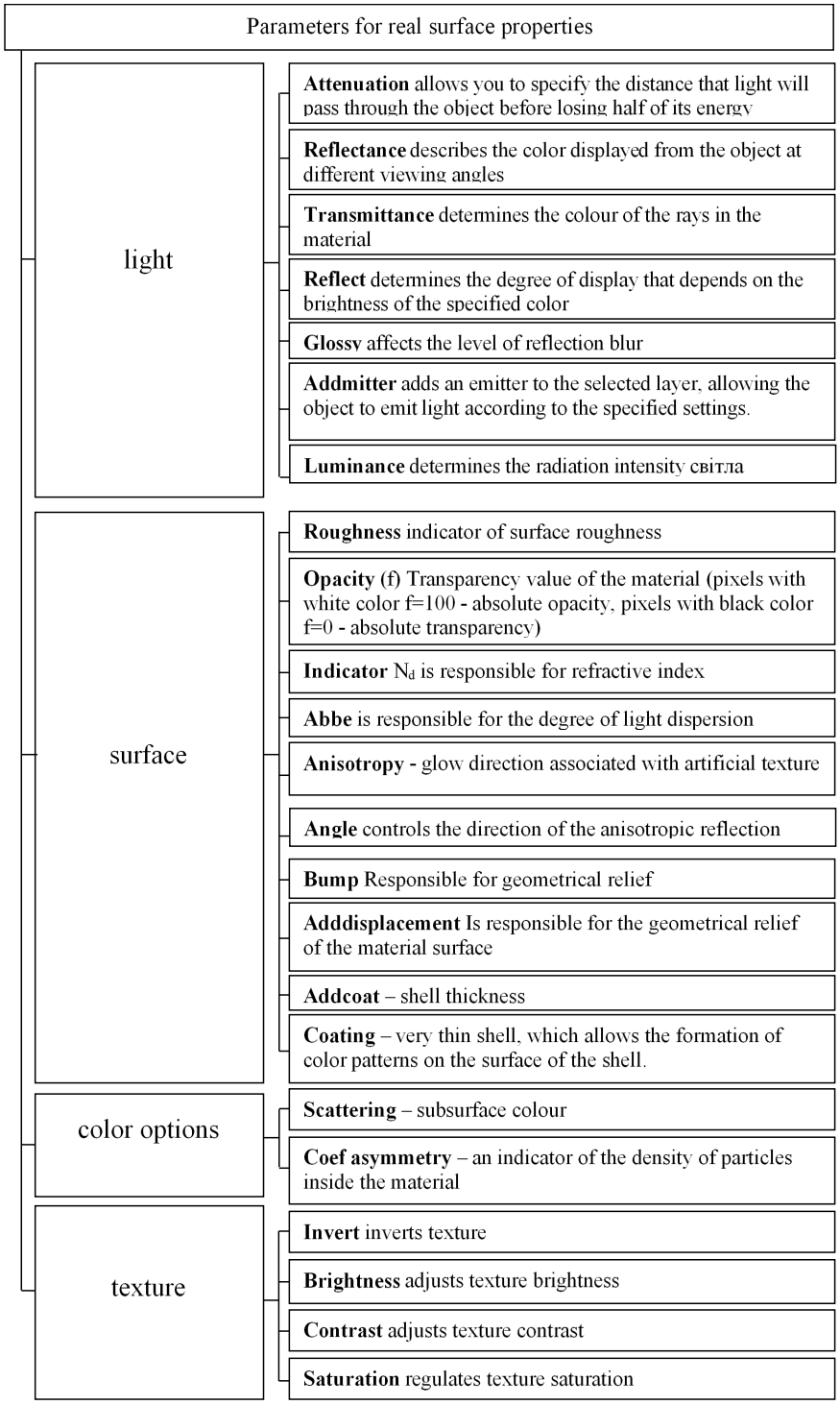

Figure 3. Features of the “Material Editor” program

Figure 4 shows the screenshots of the editor.

Figure 4. Maxwell Render

Conclusions. It should be noted that in order to optimize the formation of protective elements on any surface (especially metalized), the designer should pay attention to the possibility of combining MetalFX (or Color-Logic) and Maxwell Render (material editor), allowing the user to apply settings, reflecting the real properties of surfaces. The possibility of using artificially constructed defective structure on the surface of printed materials as a basis for special microrelief, where appropriate is presented.

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РЕАЛЬНІ ВЛАСТИВОСТІ МЕТАЛІЗОВАНИХ ПОЛІГРАФІЧНИХ ПОКРИТТІВ

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Проаналізовано вплив геометричних і морфологічних параметрів поверхні матеріалів, застосовуваних в поліграфії. Показана можливість поєднання програми MetalFX (або Color-logic) з програмою Maxwell Render — редактор матеріалів, який забезпечує спеціальний підхід для створення матеріалів із складною структурою. Зокрема, використовуються шари, які дають змогу не тільки змішувати два різних матеріали, а й спланувати матеріал із двох чи більше складових з урахуванням їх геометричного рельєфу, текстури, прозорості, ступеня відбиття цих шарів. Об'єктом дослідження є функціональні можливості програми «Редактор матеріалів» та основні групи параметрів геометричних структур поверхні. Практичне використання металевих пігментів з особливостями геометрії поверхні поліграфічних матеріалів дає змогу прогнозувати та оптимізувати створення різних оптичних комбінацій. Результати проведених досліджень свідчать, що нові можливості для описання процесів, які відбуваються на поверхні задруковуваних матеріалів за початкового контакту з металізованою фарбою, дає параметричне оцінювання геометричних структур поверхні (ГСП) в системі 3D. Наведено принципові можливості ймовірності використання штучно створеної дефектної структури на поверхні задруковуваних матеріалів як основу для спеціального мікрорельєфу у тих випадках, де це доречно. При аналізі геометричних структур поверхні встановлено, що залучено популярний напрям, пов'язаний із фрактальною геометрією, основи якої в середині XX ст. заклав французький математик Б. Мандельброт. Найбільш об'єктивно фрактальний аналіз проводиться за допомогою т.н. розміру Гаусдорфа-Колмогорова. Подальші дослідження потребують, на думку авторів, використання певних математичних методів, які саме описують топографію поверхні, а також векторізацію її каналів.

Ключові слова: *поверхні матеріалів, MetalFX, Color-Logic, Maxwell Render, металеві пігменти, фрактали.*

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