THE HALFTONING OF ELECTROSTATIC LATENT IMAGE OF Se ELECTROPHOTOGRAPHIC LAYERS BY THE SCANNING OF THE FOCUSED LASER BEAM

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It is established, that scanning (step 200mcm) of selenium EPh layers by the focused (∅ 100mcm) laser beam with λ=0,354 and 0,514 mcm and radiation density W=10÷10^3 Vt/cm^2 provides the halftoning of the latent electrostatic image because of: Se evaporation till the substrate (W 10^3 Vt/cm^2); melting of the amorphous layer and shunting sublayer of trigonal Se (W=25÷10^2 Vt/cm^2); change of photoelectric properties of amorphous Se under the beam influence (W 10 Vt/cm^2).

The electric field of the latent image is created by the charges, situated on the external surface of the electrographical (EPh) layer and charges of the opposite sign, induced in the conducting layer substrate. The field, created by these charges, corresponds to the condenser field, the distances between the facings of which is equal to the width of the photosemiconductor, coated on the layer. The configuration of electric field under the latent electrostatic image plays the important role at its appearance. As rule, the big electric contrast on image bou7ndaries is caused by the dispersion field (fig.1). The field lines of latent image should be behind the boundaries of photosemiconductor layer, in other case the toner (developer) particles, charged negatively, won't gravitate to the layer. The field lines lock mainly through EPh layer inside the total locked image regions. That's why the toner particles are evaporated on the edges of total regions. This is the meaning of the "edge effect", that's why the dispersion field plays so important role near the edges of latent image.

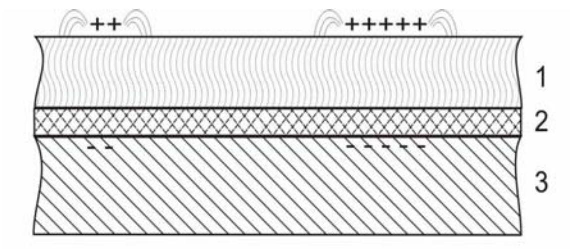

Fig.1. The configuration of electrostatic field of latent image under the exhibited EPh layer on the narrow and wide regions of original nigrescence.
1 – layer of amorphous Se;
2 – shunting sublayer of trigonal Se;
3 – conducting substrate.

By the methods of conformal transformations it was showed, that the biggest resistance of dispersion field took place near the edge of condenser facing $E_{max} = E/\sqrt{2(1+cos\varphi)}$, where φ is the conversion coefficient [1]. Even near the obtuse facing edge (φ 174°) that corresponds to the edge of latent image, the field resistance is higher on the order, than in the distant regions from the edge. The last plays the important role in the creation of the "edge effect". Thus the "edge effect" is caused by the nonhomogeneous of electric field of the latent image and dispersion field is significantly bigger near the element edges, than in central region.

The existence of the "edge effect" makes the obtaining of the image from the original, having the big parts of total nigrescence and moreover the gray-level, impossible. In this case only narrow regions of the image (texts and schemes) are well revealed.

There are three methods of the elimination of "edge effect": the method of revealing electrode, the method of the halftoning of electrostatic image and method, based on the use of the metallized carrier [2-4]. The first and third methods lead to the complication of the apparatus, that's why the halftoning of the electrostatic image is considered the perfect one. It includes the image transformation with the continuous optical density of the nigrescence in the system of the points or the lines, the one of which is the independent image region in the correspondence of the electric field resistance.

The halftoning can be carried out by mechanical, optical and electrical method. For the mechanical halftoning the strokes (grooves) by the depth and width 100 mcm, are coated on the polished surface of the substrate by the steel needle. At the coating on such substrate of the photosemiconductor, all irregularities are revealed on the EPh layer surface with all consequences. However, such raster is ineffective, i.e. the its meaning is the different width of EPh layer, the enough width of which is difficult to carry out.

The optical halftoning of latent image is the precip of the electrified (in corona discharge) EPh layer through optically total raster. The original image is exposed on the layer after raster precip. As the optical raster can be prepared photographically with big permissive ability, the raster grid won't be almost seen on the revealed image. However, the method of optical halftoning is low-yield, i.e. the raster is the temporary on the EPh layer surface.

The electric halftoning leads to the electrization of EPh layer (by corona discharge) through grid-screen, situated near the layer surface. Moreover, the irregular charge distribution appears the biggest densities of which take place in grid intervals, i.e. the temporary raster forms.

There are methods of physical halftoning [5,6], based on the creation of constant raster by the change of physical properties of definite regions of Eph layer. Thus, the separate rotational regions with low resistance are formed by ion doping way in high-ohmic photosemiconductor. The complexity of the method is the difficultness of the creation of narrow ion beams.

In the present paper the method of halftoning of latent image in EPh layer with the help of the focused (∅ 100 mcm) laser beam with photon energy ΔE_g (the width of forbidden band of photosemiconductor) is considered. EPh layer was established on the holder with microsupply, which provided its rotational-progressive (spiral) transference with step 200 mcm. The focused laser beam is directed on the layer surface (λ=0,354 and 0,514 mcm) and thus the scanning was carried out. The time of beam activity was given by the rotation speed of EPh layer and varied in enough wide limits, that allows to change the radiation density *W* from 10 till 103 Vt/cm^2 (without taking under the consideration of the reflection).

As it is known [7], at the Se coating on the oxidized aluminum substrate, the so-called shunting sublayer from trigonal Se (1mcm), which provides the photosensitivity of EPh layer in the red spectrum region forms under this substrate. In the coating process the layer of amorphous Se, by the width in several decades of microns is already formed under it. Thus, selenium EPh layer presents by itself the sandwich: the conducting substrate (with oxide layer), shunting sublayer from trigonal Se and thin layer of amorphous Se (fig.1.). For the raster creation, such multilayered structure is treated by the shoot by the laser beam.

The scanning results are the following ones. At *W* 10^3 Vt/cm^2 the output (evaporation) of Se till the substrate with the creation of delicate lines with crater-similar edges by the width 130 mcm was observed (fig.2.a). This circumstance leads to the formation of the structure of EPh layer, at which the regions with and without photosemiconductor layer by the width 200 and 130 mcm are regularly rotated correspondingly, i.e. the constant raster is created.

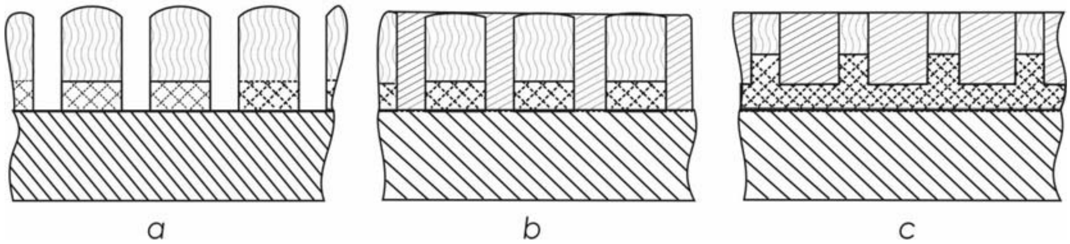

Fig.2. The scanning of selenium EPh layer by focused laser beam (λ=0,354 and 0,514 mcm) with the different radiation density *W*:
a – $W \gtrsim 10^3$ Vt/cm^2, Se evaporation till the substrate;
b – $W \approx 25 \div 10^2$ Vt/cm^2, the melting of shunting sublayer of trigonal Se till the substrate;
c – $W \lesssim 10$ Vt/cm^2, the increase of the width of shunting layer of trigonal Se in the result of the crystallization of the amorphous main layer.

At *W* $25 \div 10^2$ Vt/cm^2 the melting of Se layer under the beam till the substrate takes place, i.e. the sublayer of shunting trigonal Se is melting. Because of the speed cooling the shunting sublayer on these regions can't be in time in order to form, that decreases the photosensitivity. And the melting process of the upper amorphous layer itself, naturally changes the electric properties (it doesn't mean in what direction) and creates the character roughness (the shine is cone away). The regular rotation of the melted and initial regions by the beam creates the constant raster (fig.2b).

At *W* 10 Vt/cm^2 the crystallization of amorphous layer is observed. The crystallization takes place not immediately, and it has the cryptic period. It's important, that after influence by the laser beam, the photoelectric characteristics of these regions are significantly changed: the conductivity of amorphous Se increases, the time of dark slump of potential strongly decreases (EPh layer hasn't the charge). The regular rotation of such regions creates the constant raster. (fig.2.c).

The attempt of raster creation by beam scanning of the infrared laser (λ =1,06 and 10,6 mcm) of significant power wasn't successful (*W* 10^4 Vt/cm^2) – Se is limpid in this spectrum region. The irregular evaporation of Se because of the local substrate heating was observed.

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SELEN ELEKTROFOTOQRAFİK LAYLARINDA GİZLİ ELEKTROSTATİK TƏSVİRİN RASTRLANMASI

Müəyyən olunmuşdur ki, selen EF laylarının λ=0,354 və 0,514 mkm, şüalanma sıxlığı W=10÷10^3 W/sm^2 olan fokuslanmış (∅ 100 mkm) lazer şüası ilə skanirə edilməsi (addım 200 mkm): selenin altlığacan buxarlanması (W 10^3 W/sm^2); amorf təbəqənin və şuntlayıcı triqonal selen alttəbəqəsinin əriməsi (W 25 ÷ 10^2 W/sm^2); şüanın (W 10 W/sm^2) təsiri altında amorf selenin (kristallaşma) fotoelektrik xassələrinin dəyişməsi hesabına gizli elektrostatik təsvirin rastrlanmasını təmin edir.

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РАСТРИРОВАНИЕ СКРЫТОГО ЭЛЕКТРОСТАТИЧЕСКОГО ИЗОБРАЖЕНИЯ СЕЛЕНОВЫХ ЭЛЕКТРОФОТОГРАФИЧЕСКИХ СЛОЁВ СКАНИРОВАНИЕМ СФОКУСИРОВАННЫМ ЛУЧОМ ЛАЗЕРА

Установлено, что сканирование (шаг 200 мкм) селеновых ЭФ слоёв сфокусированным (∅ 100 мкм) лазерным лучом с λ = 0,354 и 0,514 мкм и плотностью излучения W = 10 ÷ 10^3 Вт/см^2 обеспечивает растрирование скрытого электростатического изображения за счёт выпаривания селена до подложки (W 10^3 Вт/см^2), оплавления аморфного слоя и шунтирующего подслоя тригонального селена (W 25 ÷ 10^2 Вт/см^2), а также за счет изменения фотоэлектрических свойств аморфного селена под воздействием луча (W 10 Вт/см^2).

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